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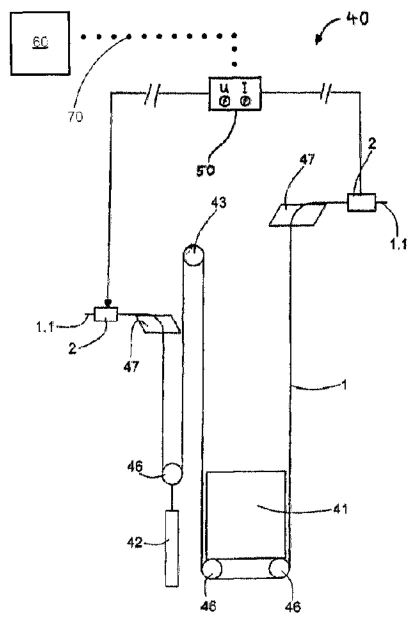


(57) **Abrégé/Abstract:**
An elevator system (40) comprises a car (41), a counterweight (42), a drive (43) and at least one carrying element (1). The car (41) and the counterweight (42) are carried by the carrying element (1), and the carrying element (1) is driven by the drive (43), in order to move the car (41) and the counterweight (42) in the opposite direction. The carrying element (1) comprises at least one test element (8), wherein the test element (8) is connected by at least one connecting device (2) and is linked to a measuring device (50), with the result that an electric resistance of the test element (8) can be determined by the measuring device (50), wherein the electric resistance of the test element (8) changes as a result of an elongation of the test element (8), so that at least one of the following states of the elevator system (40) can be determined by a measurement of the electric resistance of the test element (8): a load of the car (41), or a slack carrying element (1), or a tensioning difference between at least two carrying elements (1), or damage of the carrying element (1).

Abstract

A lift installation (40) comprises a cage (41), a counterweight (42), a drive (43) and at least one support element (1). The cage (41) and the counterweight (42) are supported by the support element (1) and the support element (1) is driven by the drive (43) in order to move the cage (41) and the counterweight (42) in opposite directions. The support element (1) comprises at least one test element (8), wherein the test element (8) is contacted by at least one contacting device (2) and connected with a measuring device (50) so that an electrical resistance of the test element (8) is determinable by the measuring device (50), wherein the electrical resistance of the test element (8) changes due to stretching of the test element (8) so that through measurement of the electrical resistance of the test element (8) at least one of the following states of the lift installation (40) is ascertainable: loading of the cage (41), a slack support element (1), a tension difference between at least two support elements (1) and damage of the support element (1).

(Fig. 1)

LIFT INSTALLATION

FIELD

The disclosure relates to a lift installation, also known as an elevator installation, as well as a method of checking states of a lift installation.

BACKGROUND

In lift installations it is of substantial importance to recognise safety-critical states in good time. Such safety-critical states are, for example, failure of a support element, overloading of a cage or driving of a cage without a counterweight in that case being moved oppositely. Such and other safety-critical states are monitored by respectively associated safety systems. Thus, for example, loading of the cage is monitored by load measuring sensors. The state of a support element is monitored by, for example, optical checking systems or by magnetic sensors. It is disadvantageous with these known monitoring systems that a separate monitoring system has to be used for each component of the lift.

SUMMARY

In at least some embodiments, a device or method allows multiple safety-critical states of a lift installation to be monitored by only one monitoring device. The device or method, in at least some embodiments may be simple and reliable as well as usable in different lift installations.

Some embodiments include a method for monitoring states of the lift installation, wherein the lift installation comprises a cage, a counterweight, a drive and at least one support element, wherein the cage and the counterweight are supported by the support element and wherein the drive drives the support element in order to move the cage and the counterweight in opposite directions. The support element comprises a casing and at least one tensile carrier and at least one test element, wherein the test element is constructed as an element separate from the tensile carrier and wherein tensile loading is accepted substantially by the tensile carrier. The method comprises the steps of:

applying an electrical voltage to at least one test element, which is arranged in the support element;

determining an electrical resistance of the test element, wherein the electrical resistance of the test element changes due to stretching of the test element;

detecting a travel state of the cage; and

evaluating the electrical resistance of the test element and the travel state of the cage in order to be able to ascertain at least one of the following states of the lift installation:

- loading of the cage;
- slack support element;
- tension differences between at least two support elements; and
- damage of the support element.

In a further aspect, some embodiments include a method of checking states of an elevator installation, the method comprising: applying an electrical voltage to a test element, the elevator installation comprising a cage, a counterweight, a drive and a support element supporting the cage and the counterweight, the support element comprising a casing, a tensile carrier and the test element, the test element being constructed as a separate element from the tensile carrier, the test element being in the casing of the support element, a tension loading being substantially accepted by the tensile carrier; determining an electrical resistance of the test element, the electrical resistance of the test element being changeable by stretching of the test element; detecting a travel state of the cage; and evaluating the electrical resistance of the test element and the travel state of the cage to determine an elevator state for at least one of loading of the cage, support element slack, support element damage, and a tension difference between the support element and a further support element.

These method can provide that a plurality of safety-critical states of a lift installation can be monitored by only one monitoring system, namely a test element which is arranged in the support element. Since information about the travel state of the cage at any point of time can be called up from a lift control, no additional monitoring systems are needed for that purpose. In addition, through integration of the test element in the support element no additional space in the lift installation is demanded. Moreover, such an integrated test element is less susceptible to defects.

In some embodiments, through the method of checking states of a lift installation at least two or three or four of the following states of the lift installation are ascertainable:

- loading of the cage;
- slack support element;
- tension differences between at least two support elements; and
- damage of the support element.

Use of this method for checking a plurality of safety-critical states of a lift installation has the advantage that separate monitoring systems do not have to be used for the individual ones of these states, which is expensive and complicated in installation as well as operation.

In some embodiments the method for checking states of a lift installation ascertains a loading of the cage in that an electrical resistance in the at least one test element is determined during standstill of the cage. For this purpose, use can be made of a single test element or, alternatively thereto, a plurality of test elements in a plurality of support elements can be provided. Since in lift installations with a plurality of support elements usually not all support elements are loaded to the same extent at a specific point of time, it is advantageous to use at least one test element in each support element in order to be able to ascertain the loading of the cage as precisely as possible. Since the electrical resistance of the test element is correlated with loading of the support element, a conclusion about a load in the cage can be derived from the determined electrical resistance of the test element. In order to ascertain overloading of the cage, the determined value of the electrical resistance of the test element is compared with a first threshold value, wherein overloading is present if the determined value is greater than the first threshold value. Thus, loading or overloading of the cage can be ascertained by the proposed method without separate measuring devices having to be provided in the cage for that purpose.

In further embodiments of the method for checking states of a lift installation a slack support element is ascertained in that an electrical resistance in the at least one test element is determined during standstill or during travel of the cage and in that the measured value is compared with a second threshold value, wherein a slack support element is present if the determined value is smaller than the second threshold value. In an alternative form of embodiment a slack support element is ascertained in that an electrical resistance in the at least one test element is repeatedly determined during standstill or during travel of the cage and in that a change in the measured values per unit of time is ascertained, wherein a slack support element is present if the ascertained change in the determined values per unit of time exceeds a predetermined amount. Here, too, it is possible to provide a single test element in a support element or alternatively thereto to provide a plurality of test elements in a single support element or also to provide a plurality of test elements in a plurality of support elements. Early recognition of a slack tensile carrier is of special importance particularly in a case of lift installations with tensile carriers encased by plastics material, since such tensile carriers encased by plastics material have a higher traction on a drive pulley than conventional steel cables.

In further embodiments of a method for checking states of a lift installation a tension difference between at least two support elements is ascertained in that electrical resistances in at least two test elements of two different support elements are determined during standstill or during travel of the cage. The determined values are then compared with one another, wherein a tension difference is present if the determined values lie further apart than a predefined difference. Such a method for early recognition of tension differences between at least two support elements offers the advantage that overloadings of individual support elements and thus premature failure of such support elements can be precluded. Such a method can in addition be used at the time of mounting a lift installation in order to set a tension between several support elements to be uniform. Uniformly tensioned support elements have the advantage that not only travel behaviour of the lift installation, but also service life of the support elements are optimised.

In further embodiments of a method for checking states of a lift installation damage of the support elements is ascertained in that an electrical resistance in the at least one test element is determined during standstill or during travel of the cage and in that the determined value is compared with a third threshold value, wherein damage of the support element is present if the determined value is greater than the third threshold value. Such a method for monitoring damage of the support element has the advantage that even support elements which have encased tensile carriers can thereby be checked in simple mode and manner. Depending on the respective arrangement of the test element in the support element it is possible through such a method to monitor either a tensile carrier or, however, a casing of the support element.

In a further embodiment of a method for checking states of a lift installation at least one of the following steps is triggered in the case of ascertaining a safety-critical state of the lift installation:

- transmitting a signal to a service centre;
- stopping the lift; and
- holding the cage until the triggering state is no longer present.

Such a method has the advantage that not only a safety-critical state can thereby be recognised, but also the necessary steps for overcoming the safety-critical state are initiated.

In at least some embodiments, a lift installation, also referred to as an elevator installation, comprises a cage, a counterweight, a drive and at least one support element, wherein the cage and the counterweight are supported by the support element and wherein the support element is driven by the drive in order to move the cage and the counterweight in opposite direction. The support element comprises a casing and at least one tensile carrier and at least one test element, wherein the test element is constructed as an element separate from the tensile carrier and wherein a tension loading is substantially accepted by the tensile carrier and wherein the test element is connected by at least one contacting device with a measuring device so that an electrical resistance of the test element is determinable by the measuring device. The electrical resistance of the test element changes due to stretching of the test element so that at least one of the following states of the lift installation is ascertainable by measuring the electrical resistance of the test element:

- loading of the cage;
- slack support element;
- tension differences between at least two support elements; and
- damage of the support element.

In a further aspect, some embodiments include a lift installation, also referred to as an elevator installation, comprising a cage; a counterweight; a drive; a support element coupled to the cage and the counterweight, the support element being driven by the drive, the support element comprising a casing, a tensile carrier and a test element, the test element being constructed as a separate element from the tensile carrier, the test element being in the casing of the support element, a tension loading being substantially accepted by the tensile carrier, a contacting device, the contacting device being electrically connected to the test element; and a measuring device for an electrical resistance of the test element, the measuring device being connected to the test element, the electrical resistance of the test element being changeable according to a stretching of the test element, the elevator installation using a determined electrical resistance of the test element to determine an elevator state for at least one of loading of the cage, support element slack, support element damage, and a tension difference between the support element and a further support element.

In some embodiments of such a lift installation the test element extends substantially over the entire length of the support element. This has the advantage that changes in the support element leading to a safety-critical state can be monitored over the entire length of the support element.

In some embodiments several test elements are arranged parallel to one another in one support element. In that case, the parallelly arranged test elements can be connected in parallel or in series depending on whether individual tensile carriers or the entire support element is to be monitored. Several test elements connected in series in a support element have the advantage that due to the thereby-achieved effective increase in the length of the test element changes in electrical resistance, which come into being due to a changed elongation of the test elements, are greater than in the case of shorter test elements, whereby a state of the lift installation can be ascertained more precisely. In addition, in such an arrangement of the test elements in the support element only one contacting device can be used when free ends of the test elements connected in series lie at the same end of the support element. This has the advantage that contacting of the test elements can take place at only one end of the support element, which has the consequence of simpler assembly. Several test elements connected in parallel in a support element have the advantage that together with a suitable design of the circuits the individual tensile carriers of a support element can be monitored individually. Consequently, the number of test elements in the entire lift installation, the number of test elements in a support element and the electrical connection of the individual test elements can all be matched to the respective monitoring conditions.

In some embodiments of such a lift installation the test element is arranged in a casing of the support element. As a result, for example, wear of the casing can be monitored or, however, loading of the casing at a specific place. Such an arrangement additionally has the advantage that the test element is electrically insulated by the casing.

In some embodiments of such a lift installation the test element is arranged in a tensile carrier of the support element. This has the advantage that direct monitoring of the respective tensile carrier is thereby made possible. In the case of electrically non-conductive tensile carriers the test element can be directly integrated in the tensile carrier. In the case of electrically conductive tensile carriers such as, for example, tensile carriers of steel wires, the test element is advantageously embedded in an electrically insulating material so that the test element is electrically insulated from its environment.

In some embodiments the test element is arranged in a neutral axis of the support element. This has the advantage that the test element is not prematurely worn by excessive loading in bending.

In some embodiments of such a lift installation the test element comprises at least one of the following elements: copper, nickel, manganese, iron, platinum, tungsten, silicon, boron and phosphorous. Such and other elements can be used individually or in combination with one another in order to impart to the test element the desired characteristics with respect to electrical resistance in dependence on the loading of the test element. One combination of some of the above-mentioned elements is, for example, constantan. In an alternative form of embodiment the test element comprises carbon fibres or coated fibre materials. In the case of coated fibre materials the coating is preferably electrically conductive and the fibre material is substantially electrically non-conductive.

The test element is constructed as an element separate from the tensile carrier and accepts substantially no tensile loads. The tensile loads acting on the support element are accepted by the tensile carrier. The test element is constructed as a separate element additionally to the tensile carriers. Since it is arranged in the support means, it experiences the same bendings and stretchings as the support means as a whole, but without in that case having to fulfill a supporting function. This has the advantage that the test element can be constructed independently of further functionalities, i.e. the test element can, for example, be formed from materials which would not be suitable for construction of tensile carriers. Thus, a test element can be formed which is optimally suitable for its function, namely a change, which is as predictable as possible, in the electrical resistance in the case of different states of stretching.

Further aspects of the invention will become apparent upon reading the following detailed description and drawings, which illustrate the invention and preferred embodiments of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

Details and advantages of the invention are described in the following by way of embodiments and with reference to the schematic drawings, in which:

Figure 1 shows an exemplifying form of embodiment of a lift installation;

Figures 2a to 2d show exemplifying forms of embodiment of support elements for use in a lift installation; and

Figure 3 shows an exemplifying form of embodiment of a safety-critical state of a lift installation.

DETAILED DESCRIPTION

An exemplifying lift installation 40, also referred to as an elevator installation, is illustrated in Figure 1. The lift installation 40 has a lift cage 41, a counterweight 42 and a support element 1 as well as a drive 43. The drive 43 drives the support element 1 and thus moves the lift cage

41 and the counterweight 42 in opposite sense. The cage 41 is designed to receive persons and/or goods and to transport them between storeys of a building. Cage 41 and counterweight 42 are guided along guides (not illustrated). In the illustrated example, the cage 41 and the counterweight 42 are each suspended at support rollers 46. The support element 1 is in that case fixed to a first support means fastening device 47 and then guided initially around the support roller 46 of the counterweight 42. The support element 1 is then laid over a drive pulley of the drive 43, led around the support roller 46 of the cage 41 and finally connected with a fixing point by a second support means fastening device 47. This means that the support element 1 runs at a higher speed over the drive 43 in correspondence with a suspension factor. In the example the suspension factor is 2:1.

The support element 1 comprises a test element (not illustrated). A free end 1.1 of the support element 1 is provided with a contacting device 2 for contacting the test element. In the illustrated example, a contacting device 2 of that kind is arranged at both ends of the support element 1. In an alternative form of embodiment, which is not illustrated, only one contacting device 2 is arranged at one of the support means ends 1.1. In this case the test element is guided in a loop by the support means so that the start and end are arranged at one support element end 1.1 and can be correspondingly contacted by the contacting device 2. The support element ends 1.1 are no longer loaded by the tension force in the support element 1, since this tension force has already been conducted beforehand into the building by way of the support means fastenings 47. The contacting devices 2 are thus arranged in a region of the support element 1 which is not rolled over.

The two contacting devices 2 are connected together by a measuring device 50. The measuring device 50 thus closes an electrical circuit comprising the test element. The measuring device 50 is designed for the purpose of measuring the electrical current as well as the electrical voltage or changing them in their magnitudes. Since not only the electrical voltage, but also the electrical current in this electrical circuit are known, an electrical resistance of the test element can be determined. From the thus-determined electrical resistance of the of the test element a conclusion about a state of the installation 40 can then be made. In the case of exceeding or falling below specific threshold values it can be ascertained, in dependence on the travel state of the cage 41, whether or not a specific safety-critical state is present. The measuring device 50 can also provide a signal 70 that is transmitted to a service center 60 relaying whether the safety-critical state is present.

The illustrated lift installation 40 in Figure 1 is by way of example. Other suspension factors and other arrangements are possible. The contacting devices 2 for contacting the test element are then arranged in correspondence with the placement of the support means fastenings 47.

Different exemplifying embodiments of support elements 1 with integrated test element are illustrated in Figures 2a to 2d. It is apparent from the different exemplifying embodiments that the test element 8 can be arranged in different modes and manners in the support element 1. Depending on the respective purpose of use of the measurement results the test element 8 can be arranged at a different place in the support element 1.

A support element 1 consisting of tensile carrier 5 and a casing 6 is illustrated in Figure 2a. The test element 8 is in that case arranged outside the centre of the tensile carrier 5. In order to electrically insulate the test element 8 relative to the immediate environment the test element 8 is embedded in an electrically insulating material 9.

A support element 1 consisting of two tensile carriers 5 and a common casing 6 is illustrated in Figure 2b. In this example a test element 8 is arranged in one of the two tensile carriers 5, wherein the second tensile carrier 5 is constructed without a test element. Depending on the respective purpose of checking it can be sufficient to monitor only a part of the tensile carrier 5. In this embodiment the test element 8 is arranged in the neutral axis of the tensile carrier 5. This has the advantage that the test element 8 is not excessively loaded in the case of reverse bending of the support element 1.

A support element 1 consisting of five tensile carriers 5, which are arranged in a common casing 6, is illustrated in Figure 2c. The support element 1 has a traction side with longitudinal ribs and a rear side, which is formed to be substantially straight. In this embodiment two test elements 8 are arranged in the casing 6 of the support element 1. Through the arrangement of the test elements 8 in the casing 6 the test elements 8 are electrically insulated by the tensile carriers 5.

A further embodiment of a support element 1 is illustrated in Figure 2d. In this embodiment the support element 1 comprises four tensile carriers 5 in a common casing 6 and a centrally arranged test element 8.

It will be self-evident that many more arrangements of the test element 8 - or the test elements 8 - in many more forms of embodiment of support elements 1 are possible. Depending on the respective demands on monitoring and depending of the respective construction of the lift installation different arrangements of the test element 8 in the support element 1 can be advantageous. Thus, for example, it can be advantageous for monitoring the support element 1 for damage to provide each individual support element 1 of a lift installation with a test element 8 or even to provide each individual tensile carrier 5 of a support element 1 with a test element 8. For monitoring loading of the cage it can, on the other hand, be sufficient to provide merely one test element 8 in a support element 1 of a lift installation. In addition, the length of the support element 1 as well as guidance of the support element 1 in the lift installation may require a specific arrangement of the test element 8.

An exemplifying lift installation 40 in a safety-critical state is illustrated in Figure 3. As in Figure 1, here, too, not only the cage 41, cut also the counterweight 42 are suspended by support rollers 46 from the support element 1. In the illustrated situation the counterweight 42 has run onto a buffer 10 associated with the counterweight 42. If now the drive 43 transports the support element 1 further on one side of the counterweight 42, the lift cage 41 can be further raised without the counterweight 42 in that case being able to further sink. However, this is possible only if the traction of the support element 1 on the drive pulley of the drive 43 is sufficiently large. If the cage 41 is now raised further, the support element 1 slackens on the side of the counterweight 42. In that case it can happen that the traction of the support element 1 on the drive pulley 43 is no longer sufficient in order to hold the cage 41 in its too-high position. In the case of such a traction loss, the cage 41 drops back at least to such an extent until the entire support element 1 is stretched again. Such a dropping back is dangerous for any passengers and has to be avoided in all circumstances.

Through the method proposed here or through the device proposed here for the checking of states of a lift installation such a safety-critical state can be recognised in good time. As soon as a slack support element 1 forms on one side of the drive pulley the loading of the support element 1 diminishes and the test element in the support element 1 is thereby less stretched. The specific electrical resistance of the test element in this situation is then smaller than it should be in a non-critical state. Consequently, it can be ascertained that a safety-critical state prevails.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A method of checking states of an elevator installation, the method comprising:

applying an electrical voltage to a test element, the elevator installation comprising a cage, a counterweight, a drive and a support element supporting the cage and the counterweight, the support element comprising a casing, a tensile carrier and the test element, the test element being constructed as a separate element from the tensile carrier, the test element being in the casing of the support element, a tension loading being substantially accepted by the tensile carrier;

determining an electrical resistance of the test element, the electrical resistance of the test element being changeable by stretching of the test element; detecting a travel state of the cage; and

evaluating the electrical resistance of the test element and the travel state of the cage to determine an elevator state for at least one of loading of the cage, support element slack, support element damage, and a tension difference between the support element and a further support element.

2. The method of claim 1, the evaluating comprising determining the elevator state for at least two of loading of the cage, support element slack, support element damage, and the tension difference between the support element and the further support element.

3. The method of claim 1, the evaluating comprising determining the elevator state for loading of the cage.

4. The method of claim 1, the electrical resistance of the test element being determined during a standstill of the cage to determine the loading of the cage.

5. The method of claim 4, further comprising:

determining that the electrical resistance is greater than a threshold value; and

determining that overloading has occurred.

6. The method of claim 1, the electrical resistance in the test element being determined during standstill of the cage or during travel of the cage, the method further comprising:

determining that the electrical resistance is smaller than a threshold value; and

determining that the support element is slack.

7. The method of claim 1, the electrical resistance in the test element being determined repeatedly during standstill of the cage or during travel of the cage, the method further comprising:

determining a change over time in the repeatedly determined electrical resistance in the test element, the determined change over time exceeding a predetermined amount; and

determining that the support element is slack.

8. The method of claim 1, the elevator installation further comprising an additional support element, the additional support element comprising an additional test element, the electrical resistance of the test element being determined during standstill of the cage or during travel of the cage, the method further comprising:

determining an electrical resistance of the additional test element;

determining that a difference between the electrical resistance of the test element and the electrical resistance of the additional test element exceeds a predefined difference; and

determining that a tension difference is present.

9. The method of claim 1, the electrical resistance in the test element being determined repeatedly during standstill of the cage or during travel of the cage, the method further comprising: determining that the electrical resistance is greater than a threshold value; and determining that the support element is damaged.

10. The method of any one of claims 1 to 9, further comprising transmitting a signal to a service center, stopping the elevator installation, or holding the cage until the determined elevator state is no longer present.

11. An elevator installation, comprising:

a cage;

a counterweight;

a drive;

a support element coupled to the cage and the counterweight, the support element being driven by the drive, the support element comprising a casing, a tensile carrier and a test element, the test element being constructed as a separate element from the tensile carrier, the test element being in the casing of the support element, a tension loading being substantially accepted by the tensile carrier,

a contacting device, the contacting device being electrically connected to the test element; and a measuring device for an electrical resistance of the test element, the measuring device being connected to the test element, the electrical resistance of the test element being changeable according to a stretching of the test element, the elevator installation using a determined electrical resistance of the test element to determine an elevator state for at least one of loading of the cage, support element slack, support element damage, and a tension difference between the support element and a further support element.

12. The elevator installation of claim 11, the test element extending substantially over the entire length of the support element.

13. The elevator installation of claim 11 or claim 12, the test element being arranged in the tensile carrier of the support element.

14. The elevator installation of any one of claims 11 to 13, the test element being embedded in an electrically insulating material.

15. The elevator installation of any one of claims 11 to 14, the test element comprising one or more of copper, nickel, manganese, iron, platinum, tungsten, silicon, boron and phosphorus.

16. The elevator installation of any one of claims 11 to 15, the test element comprising fiber materials.

17. A method according to any one claims 1 to 10 wherein the method is performed by the elevator installation according to any one of claims 11 to 16.

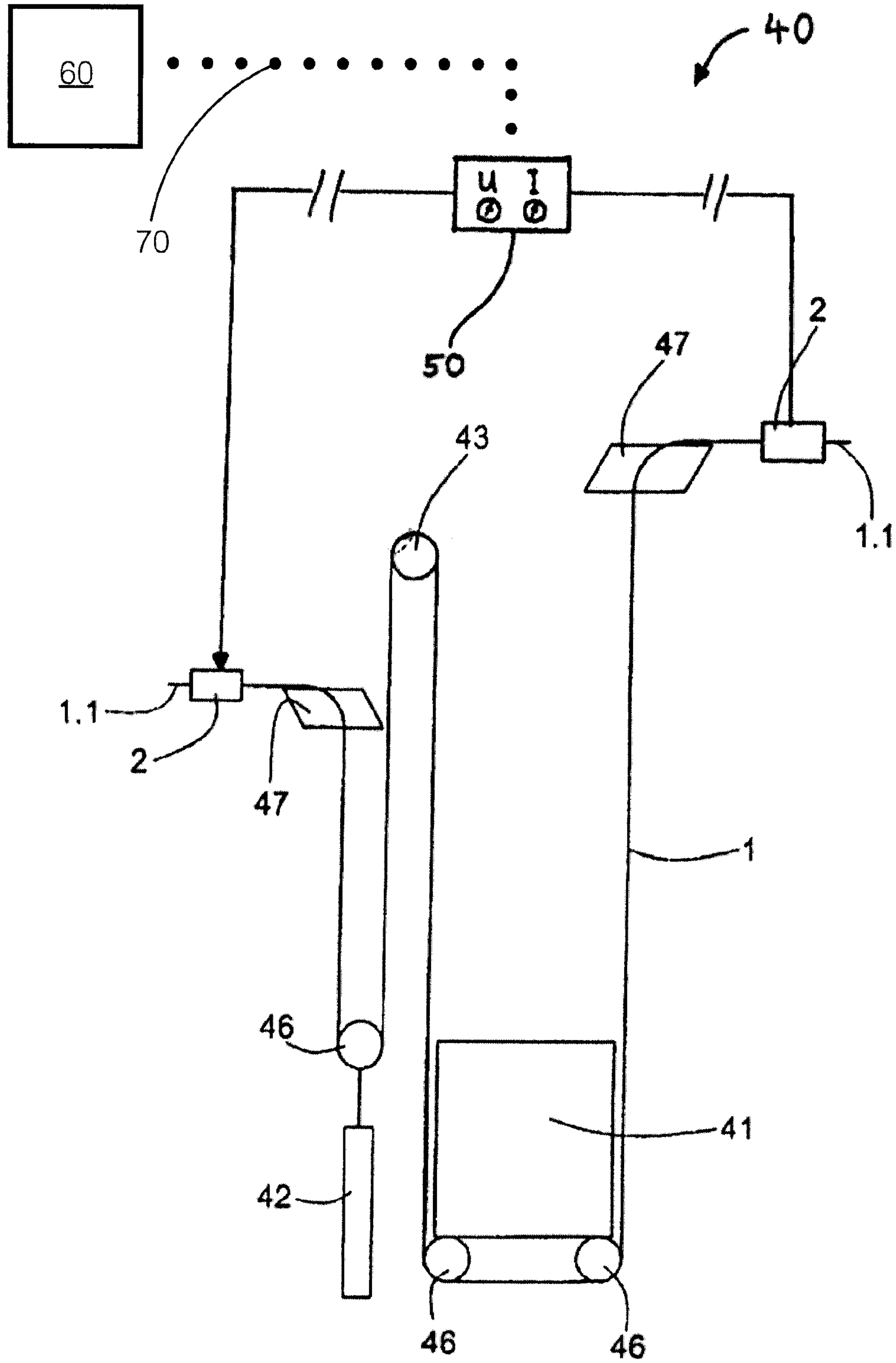


FIG. 1

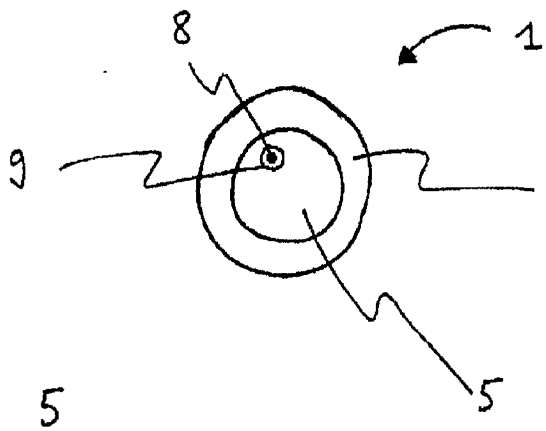


FIG. 2A

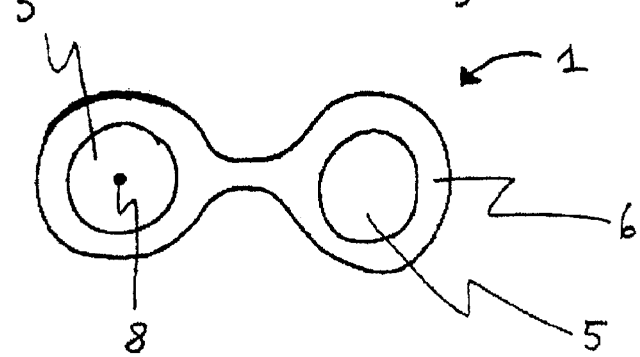


FIG. 2B

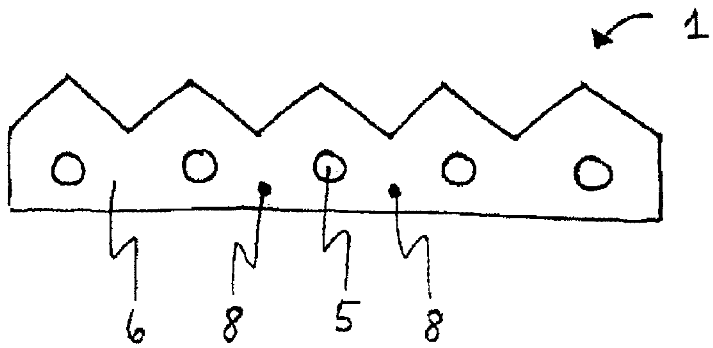


FIG. 2C

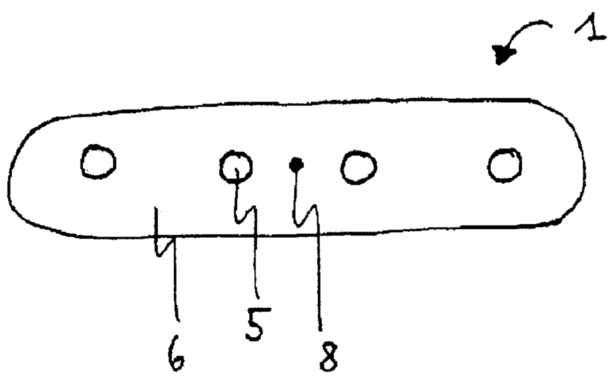


FIG. 2D

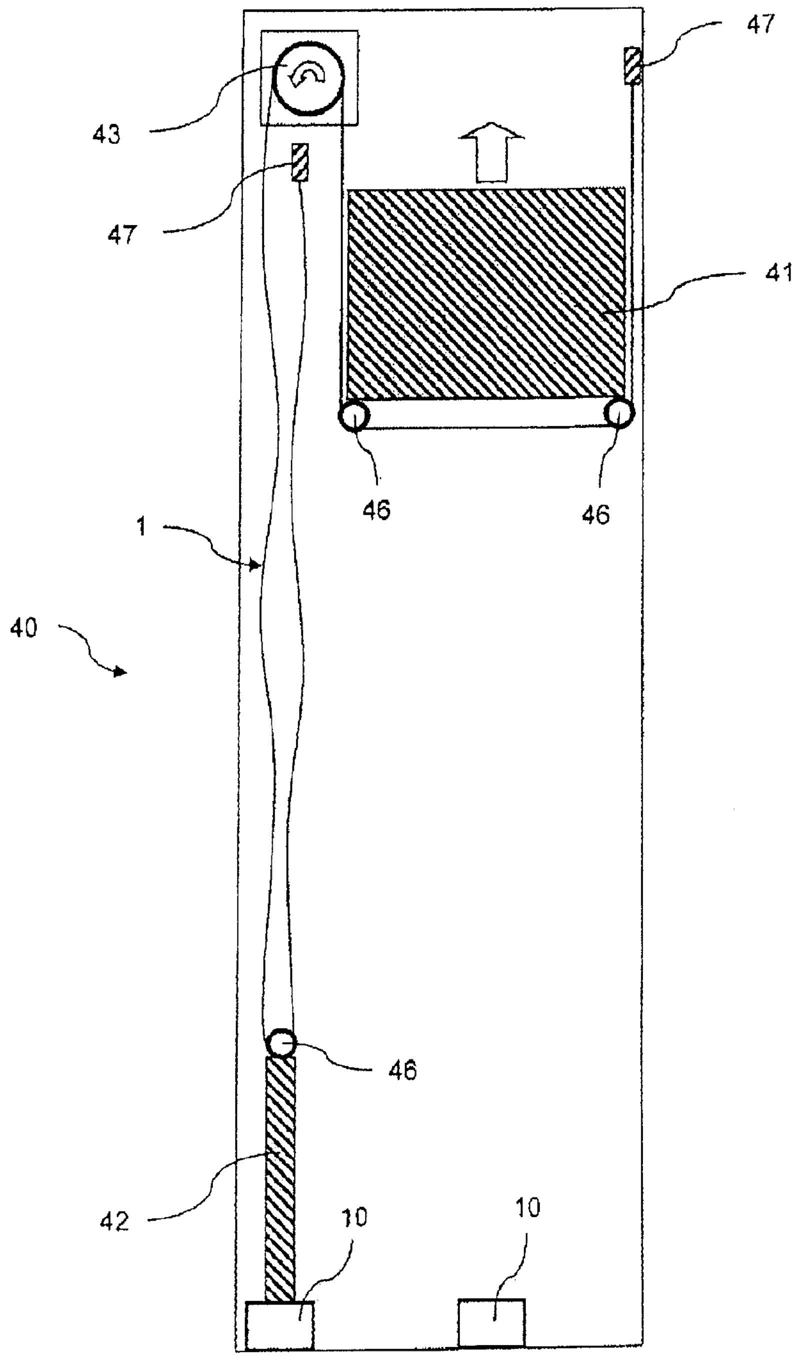
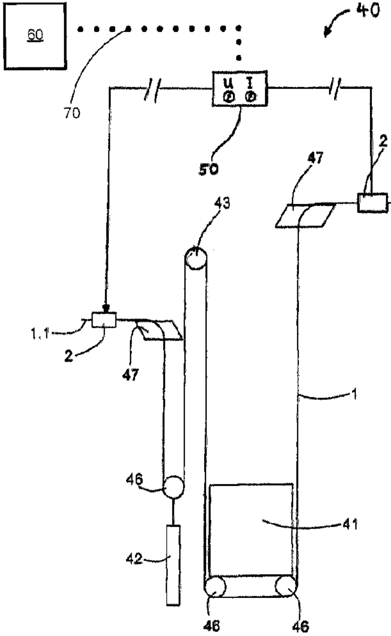


FIG. 3



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