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FIG. 1B

Description

TECHNICAL FIELD

5 **[0001]** The present invention relates generally to elevators and measuring masses or forces that affect the operation of the elevators.

BACKGROUND OF THE INVENTION

10 **[0002]** A typical elevator includes an elevator car, a hoisting machine for moving the elevator car, at least one counter weight, and traction means such a rope, cable, chain, or belt. Those traction means connects the elevator car and the at least one counter weight to each other. The traction means pass through a traction sheave which is connected to the hoisting machine, for example, to a drive shaft of the hoisting machine. The counter weight is also termed a compensating weight. A person skilled in the art knows that the typical elevator includes more components but the above-mentioned
15 components are the most relevant from a point of view of the invention.

[0003] It is known to measure a load in an elevator car, i.e. the mass of human being(s) and/or mass of object(s). The load can be measured at the point where the elevator car is attached to the traction means. A sensor, such as a load sensor, can be arranged to that point to measure the load. Then the sensor in fact measures how much the elevator car and the load weight together. Alternatively, the sensor can be arranged in the floor of the elevator car. Then the sensor
20 measures only the load of the elevator car.

[0004] In addition to the elevator car, the load, and the counter weight, a fourth mass affects the operation of the elevator. The fourth mass is the mass of the traction means. If the elevator car is located at the bottom part of the hoistway, the major portion of the traction means is located on the same side as the elevator car. In more detail, the major portion of the traction means is located on the same side of the traction sheave as the elevator car. Correspondingly,
25 if the elevator car is located at the top part of the hoistway (as in FIG. 8B), the major portion of the traction means is located on the same side as the counter weight.

[0005] It is possible to compensate the mass of the traction means by using support means. For example, a cable connecting the bottom of the elevator car to the bottom of the counter weight operates as the support means. Especially the support means having great mass balance mechanically the masses on the opposite sides of the traction sheave.

30 **[0006]** US 7,784,589 describes an assembly for measuring a load in a lift cage, wherein the lift cage can be considered to correspond to the elevator car and a drive engine (a term used in US 7,784,589) can be considered to correspond to the hoisting machine. This assembly includes a small-area load sensor that measures vibration. The small-area load sensor is, for example, 0.2 mm thick, and it can be placed between a support and a first damping body of the drive engine to measure vibration caused by the drive engine. The vibration increases when the load has increased in the lift cage and the drive engine moves the lift cage. An electronic evaluating system using the small-area load sensor is calibrated so that the system is first calibrated to zero when the lift cage is empty. Then the system is calibrated to a standardized output voltage, e.g. 10 volts, when there is the maximum load in the lift cage. As described US 7,784,589,
35 a single sensor can be placed in the machine bed to measure the total weight of the elevator car, the load, and a certain portion of the traction means.

40 **[0007]** As generally known, a hoisting machine of an elevator includes a brake which affects the traction sheave connected to the hoisting machine. When the brake is on, the hoisting machine is not in action and the elevator car does not move. Correspondingly, when the brake is off, the hoisting machine is running and is able to move the elevator car up or down.

[0008] A load in the elevator car and other masses naturally affect torques on the traction sheave. The elevator car causes either clockwise torque or anticlockwise torque on the traction sheave. Correspondingly, the counter weight causes opposite torque compared to the torque caused by the elevator car. The sum of the clockwise torque and the anticlockwise torque is termed in this specification "torque on the traction sheave".

[0009] When the brake is on, the torque reaches its maximum value, if the elevator car has the maximum load and it is located at the bottom part of the hoistway because then the mass of the traction means has its greatest possible effect
50 to the torque on the traction sheave. Usually the counter weight has a mass that is as great as a sum of the mass of the elevator car and half of the maximum load. Then the torque on the traction sheave reaches its minimum value when the elevator car has half of the maximum load. It is known to form a mathematical formula to estimate the effect of the traction means to the torque on the traction sheave, but masses are only one factor that affects the torque. In addition to the masses of the elevator car, a load of the elevator car, the counter weight and the traction means, static friction affects
55 the torque. Furthermore, the tension of support means also affect the torque on the traction sheave, if the support means are used to connect the elevator car to the counter weight.

[0010] When the brake is to be released the hoisting machine should at first provide such torque, which has the same magnitude than the torque on the traction sheave but in the opposite direction, to keep the elevator car at its current

position in the hoistway. When the hoisting machine aims to move the elevator car the torque provided by the hoisting machine should be changed to move the elevator car either up or down. In addition to the above-mentioned masses, acceleration resulted by the hoisting machine and kinetic friction affect the torque on the traction sheave. When using the support means the tension of the support means also affect the torque.

[0011] Measuring the mass of the elevator car, or measuring the mass of its load, do not necessarily provide such measuring data that it would be possible to determine accurate enough the forces on the both sides of the traction sheave.

SUMMARY OF THE INVENTION

[0012] Due to certain safety instructions the load measuring must be performed so that the brake of the hoisting machine is on. The invention aims to measure, in an accurate manner, the forces that have effect on the traction sheave when the brake is on or off. These measuring results are suitable for controlling the break and the hoisting machine. For example, when the torque is calculated in the accurate manner, the hoisting machine can be used with an exactly appropriate power. Then the hoisting machine moves the elevator car very smoothly up or down. Thus, one advance of the invention is that it may enhance user experience of the people using the elevator because the elevator car moves very smoothly. This feature is also termed "ride comfort".

[0013] As mentioned in the above, the elevator car causes either clockwise torque or anticlockwise torque on the traction sheave, and the counter weight causes the opposite torque. Therefore, forces are measured on the both sides of the traction sheave of the hoisting machine by utilizing, not only one sensor, but at least two sensors. In more detail, a first sensor is arranged to measure a magnitude of a first force on one side of the traction sheave and a second sensor is arranged to measure a magnitude of a second force on the other side of the traction sheave. Then, in one embodiment of the invention, the torque on the traction sheave can be determined from a difference between the measuring result of the first sensor and the measuring result of the second sensor.

[0014] In addition the difference between the first and the second force, also a sum of the first and the second force can be computed. The difference and the sum are examples of items of control information which are usable in the controlling of the elevator. The difference and/or sum can also be used to calculate other items of control information, such as a mass of a load in the elevator car.

[0015] The invention comprises an arrangement for an elevator, the elevator comprising at least an elevator car, a hoisting machine for moving the elevator car, at least one counter weight, and traction means that connect the elevator car and the at least one counter weight to each other, wherein the traction means pass through a traction sheave connected to the hoisting machine, and wherein a first mass includes at least the mass of the elevator car and a second mass includes at least the mass of the at least one counter weight, the arrangement comprising a first sensor for providing a first measuring result, the first measuring result representing a magnitude of a first force which is affected by at least the first mass, characterized in that the arrangement further comprises a second sensor for providing a second measuring result, the second measuring result representing a magnitude of a second force which aims to rotate the traction sheave to an opposite direction then the first force; and a computing unit for computing, on the basis of the first measuring result and the second measuring result, at least one of the following:

- a difference between the first measuring result and the second measuring result,
- a difference between the first force and the second force,
- a sum of the first measuring result and the second measuring result,
- a sum of the first force and the second force.

[0016] An advance of the invention is that, due to the two sensors, the difference between the measuring results is an accurate piece of measuring information. For example, rope tensions related to the elevator car do not deteriorate this piece of measuring information and, if needed, the rope tensions can be calculated.

[0017] Another advance of the invention is that the forces on the both sides of the traction sheave can be calculated. Thus, there is less need to estimate those forces. For example, kinetic friction and its possible (abnormal) change can be detected.

[0018] In one embodiment of the arrangement the hoisting machine is mounted on a first part of a machine bed and the first measuring result and the second measuring result disclose a position of the first part in relation to a second part of the machine bed.

[0019] In one embodiment of the arrangement the first sensor and the second sensor are located between the first part and the second part of the machine bed.

[0020] In one embodiment of the arrangement the first sensor is located between the traction sheave and the elevator car and the second sensor is located between the traction sheave and the at least one counter weight.

[0021] In one embodiment of the arrangement the elevator car and the at least one counter weight are further connected to each other by support means.

[0022] In one embodiment of the arrangement the first sensor is located between the traction means and the elevator car and the second sensor is located between the support means and the elevator car.

[0023] In one embodiment of the arrangement the first sensor is located between the traction means and a roof of the elevator car and the second sensor is located between the traction means and a bottom of the elevator car.

[0024] In one embodiment of the arrangement the first force is further affected by at least one of the following: static friction, kinetic friction, acceleration of the first mass.

[0025] In one embodiment of the arrangement the second force is affected by at least one of the following: the second mass, static friction, kinetic friction, acceleration of the second mass, a device for providing rope tension.

[0026] In one embodiment of the arrangement comprises the first sensor and the second sensor for measuring one of the following quantities: load, pressure, distance, resistance.

[0027] In one embodiment of the arrangement the traction means comprise at least one of the following means: a rope, cable, chain, or belt.

[0028] The invention comprises a method of computing control information for an elevator, the elevator comprising at least an elevator car, a hoisting machine for moving the elevator car, at least one counter weight, and traction means that connect the elevator car and the at least one counter weight to each other, wherein the traction means pass through a traction sheave connected to the hoisting machine, and wherein

a first mass includes at least the mass of the elevator car and a second mass includes at least the mass of the at least one counter weight, method comprising

obtaining from a first sensor a first measuring result representing a magnitude of a first force which is affected by at least the first mass; characterized in that the method further comprises

obtaining from a second sensor a second measuring result representing a magnitude a of second force which aims to rotate the traction sheave to an opposite direction than the first force; and

computing, on the basis of the first measuring result and the second measuring result, at least one of the following:

- a difference between the first measuring result and the second measuring result,
- a difference between the first force and the second force,
- a sum of the first measuring result and the second measuring result,
- a sum of the first force and the second force

[0029] In one embodiment of the method the hoisting machine is mounted on a first part of a machine bed and the first measuring result and the second measuring result disclose a position of the first part in relation to a second part of the machine bed.

[0030] In one embodiment of the method the first sensor and the second sensor are located between the first part and the second part of the machine bed.

[0031] In one embodiment of the method the first sensor is located between the traction sheave and the elevator car and the second sensor is located between the traction sheave and the at least one counter weight.

[0032] In one embodiment of the method the elevator car and the at least one counter weight are further connected to each other by support means.

[0033] In one embodiment of the method the first sensor is located between the traction means and the elevator car and the second sensor is located between the support means and the elevator car.

[0034] In one embodiment of the method the first sensor is located between the traction means and a roof of the elevator car and the second sensor is located between the traction means and a bottom of the elevator car.

[0035] In one embodiment of the method the first force is further affected by at least one of the following: static friction, kinetic friction, acceleration of the first mass.

[0036] In one embodiment of the method the second force is affected by at least one of the following: the second mass, static friction, kinetic friction, acceleration of the second mass, a device for providing rope tension.

[0037] In one embodiment of the method comprises the first sensor and the second sensor for measuring one of the following quantities: load, pressure, distance, resistance.

[0038] In one embodiment of the method the traction means comprise at least one of the following means: a rope, cable, chain, or belt.

[0039] In one embodiment, the method comprises calculating, on the basis of the difference, a mass of a load in the elevator car.

[0040] In one embodiment, the method comprises calculating, on the basis of the difference, calculating, on the basis of the difference, torque on the traction sheave.

[0041] In one embodiment, the method comprises calculating, on the basis of the sum, load on bearings of the traction sheave.

[0042] In one embodiment, the method comprises calculating, on the basis of the sum, at least one of the following tensions: a tension of the traction means, a tension of support means, wherein the elevator car and the at least one counter weight are connected to each other by the support means.

BRIEF DESCRIPTION OF THE DRAWINGS

[0043] The drawings constitute a part of this specification and include certain exemplary embodiments of the invention.

FIGURE 1A illustrates a machine bed and an empty elevator car.

FIGURE 1B illustrates the machine bed and the elevator car with a load.

FIGURE 2A illustrates an empty elevator car in an elevator that comprises support means.

FIGURE 2B illustrates the elevator car with a load in the elevator that comprises the support means.

FIGURE 3A illustrates masses and forces when an elevator car is empty.

FIGURE 3B illustrates masses and forces when the elevator car carries a load.

FIGURE 4A illustrates torques when an elevator car is empty.

FIGURE 4B illustrates torques when the elevator car carries a load.

FIGURE 5 shows an elevator arrangement.

FIGURE 6 shows a method of computing control information for an elevator.

FIGURE 7A shows a hoisting machine located on the floor of a hoistway.

FIGURE 7B shows a hoisting machine located on a wall of a hoistway.

FIGURE 7C shows a flat hoisting machine and an appropriate machine bed for it.

FIGURE 8A shows a hoisting machine located on a top of a hoistway.

FIGURE 8B shows an arrangement comprising traction means and support means.

DETAILED DESCRIPTION OF THE INVENTION

[0044] It is appreciated that the following embodiments are exemplary. Although the specification may refer to "one" or "some" embodiment(s), the reference is not necessarily made to the same embodiment(s), or the feature in question may apply to multiple embodiments. Single features of different embodiments may be combined to provide further embodiments.

[0045] FIGURE 1A illustrates an empty elevator car 6 and a machine bed. The machine bed comprises a first part 3a and a second part 3b which are connected to each other, for example, with bolts and nuts through machine bed springs 4a and 4b (the bolts and nuts are not shown). A hoisting machine 2 is attached to the first part 3a of the machine bed. The hoisting machine 2 may include the first part 3a, or alternatively, the first part 3a may be a separated part. The hoisting machine 2 comprises a drive shaft 1 to which a traction sheave 9 is attached. Traction means 8 comprises, for example, a hoisting rope that passes through the traction sheave 9 and connects the elevator car 6 to a counter weight 7. The counter weight 7 is heavier than the elevator car 6 when the elevator car is empty. Thus, the machine bed spring 4a has constricted and the machine bed spring 4b has stretched. The position of the first part 3a (of the machine bed) has changed in relation to the second part 3b so that the first part 3a is tilted to the left. The illustration shown in FIG. 1A as well as other illustrations in FIG. 1B, 2A, and 2B are simplified and exaggerated. The elevator car 6 and the counter weight 7 are in practice much larger than the hoisting machine 2 and the traction means 8 are in practice longer.

[0046] FIGURE 1B illustrates the same machine bed and the elevator car 6 with a load. The elevator car 6 and the load are together heavier than the counter weight 7 and thus the machine bed spring 4b has constricted and the machine bed spring 4a has stretched. In addition, the position of the first part 3a is changed in relation to the second part 3b. In other words, the first part 3a is tilted to the right.

[0047] FIGURE 2A illustrates an empty elevator car 6 in an elevator that comprises support means 10. Also this elevator comprises a hoisting machine 2 with a machine bed, but those components are omitted from the figure. The support means 10 connect the elevator car 6 via the diverting pulleys 11 to the counter weight 7. A first spring 4a connects the traction means 8 to the elevator car 6 and a second spring 4b connects the support means 10 to the elevator car 6. One benefit of the support means 10 is that they solve the known loose rope problem. FIG. 2A illustrates in which manner the springs 4a and 4b stretch. When the elevator car 6 is empty the second spring 4b is slightly more stretched than the first spring 4a.

[0048] When comparing the springs 4a and 4b in FIG. 2A to the machine bed springs 4a and 4b in FIG. 1A certain similarities can be detected between the lengths of the springs. For example, the spring 4b in FIG. 2A has stretched approximately as much as the spring 4b in FIG. 1A.

[0049] FIGURE 2B illustrates the elevator car 6 with a load (in the elevator comprising the support means 10). Due to the load the first spring 4a has stretched more and the second spring 4b has constricted. When comparing the springs 4a and 4b to the machine bed springs 4a and 4b in FIG. 1B certain similarities can be again detected. For example, the

spring 4b in FIG. 2B has constricted approximately as much as the spring 4b in FIG 1B.

[0050] Figures 2A and 2B includes an assumption that the support means 10 are not tighten and thus the mass of the elevator car 6 (with a load or not) and the mass of the counter weight affect the spring 4b and the measuring result of the second sensor 5b. In fact, the support means 10 must be tighten for safety reasons. When the support means 10 are tighten the spring 4b stretches and also the spring 4a stretches. Because the support means 10 are tighten, the first sensor 5a and the second sensor 5b provide in FIG. 2B greater measuring values than in FIG. 2A. Nevertheless, the difference between the measuring result of the first sensor 5a and the measuring result of the second sensor 5b are usable in the invention. For example, the mass of the load in the elevator car 6 can be determined on basis of the difference between the measuring results.

[0051] FIGURE 3A illustrates masses and forces when an elevator car is empty. A first mass M_1 comprises at least the mass of the elevator car, such as the mass of the elevator car 6 shown in FIG. 1A or 2A. A second mass M_2 comprises at least the mass of the counter weight, such as the mass of the counter weight 7 shown in FIG. 1A or 2A. When the brake is on, the traction sheave 9 does not rotate and forces F_1 and F_2 can be considered as gravity forces that affect the masses M_1 and M_2 . When the brake is released, the hoisting machine rotates the traction sheave 9 and moves the elevator car. Then, in addition to gravity, the acceleration caused by the hoisting machine affects the forces F_1 and F_2 .

[0052] FIGURE 3B illustrates masses and forces when the elevator car has a load. The load is, for example, a human being as shown in FIG. 1B or 2B. The second mass M_2 and the second force F_2 are the same as in FIG. 3A because nothing has changed on that side of the traction sheave 9 (assuming that the brake is on in FIG. 3A and 3B). On the other side of the traction sheave 9 the first mass M_1 has increased because the load has increased. Thus, the force F_1 is greater in FIG. 3B than in FIG. 3A.

[0053] In figures 3A and 3B counterforces of the forces F_1 and F_2 are omitted. If the elevator car does not move, the force affecting the elevator car and the counterforce are as great and thus their net force (F) is zero. Newton's second law states that the net force (F) acting upon an object is equal to the rate at which its momentum changes with time. If the mass (m) of the object is constant, this law implies that the acceleration (a) of an object is directly proportional to the net force acting on the object. The same subject matter can be expressed as a formula: $F = m \cdot a$. When the elevator car moves, the force affecting the elevator car differs from the counterforce and then their net force (F) is also differs from zero.

[0054] FIGURE 4A illustrates torques on the traction sheave 9 when the elevator car is empty. The first mass M_1 (or the first force F_1) shown in 3A causes a first torque T_1 and correspondingly, the second mass M_2 (or the second force F_2) shown in 3A causes a second torque T_2 . The torques T_1 and T_2 have opposite directions. The force F_2 (in FIG 3A) is greater than the force F_1 and thus also the torque T_2 is greater than the torque T_1 .

[0055] The torque on the traction sheave 9 is marked with T_s . The torque T_s is the sum of the first torque T_1 and the second torque T_2 .

[0056] FIGURE 4B illustrates torques when the elevator car is loaded. The first mass M_1 (or the first force F_1) shown in FIG. 3B causes a first torque T_1 and the second mass M_2 (or the second force F_2) shown in FIG. 3B causes a second torque T_2 . Torque T_s is the sum of the first torque T_1 and the second torque T_2 . Because of the load, the first mass M_1 and the first force F_1 have increased so much that the torque T_s has the opposite direction compared to the torque T_s shown in FIG. 4A.

[0057] FIGURE 5 relates to some elevator arrangement comprising at least an elevator car 6, a hoisting machine 2, at least one counter weight 7, and traction means 8. The traction means 8 connect the elevator car 6 and the at least one counter weight 7 to each other and the traction means pass through a traction sheave 9 connected to the hoisting machine 2. Masses affect the traction sheave 9 so that a first mass M_1 includes at least the mass of the elevator car 6 and a second mass M_2 includes at least the mass of the at least one counter weight 7. The elevator arrangement comprises a first sensor 5a and a second sensor 5b, wherein the first sensor 5a provides a first measuring result and the second sensor 5b provides a second measuring result. The first measuring result represents a magnitude of a first force F_1 which is affected by at least the first mass M_1 . The second measuring result represents a magnitude of a second force F_2 which aims to rotate the traction sheave 9 to an opposite direction than the first force F_1 . The elevator arrangement further comprises a computing unit 12 to compute, on the basis of the first measuring result and the second measuring result, a difference between the first mass M_1 and the second mass M_2 .

[0058] The first sensor 5a and the second sensor 5b comprise wiring 51 through which the computing unit 12 is able to obtain the first measuring result and the second measuring result. In one embodiment the computing unit 12 comprises a processor and a memory for storing at least program code. In one embodiment the wiring 51 is omitted, i.e. the measuring results are transmitted wirelessly to the computing unit 12.

[0059] FIG. 1A and 1B shows such embodiment for the arrangement of FIG. 5 wherein the first sensor 5a and the second sensor 5b are located in the machine bed of the hoisting machine 2. In more detail, the sensors 5a and 5b are arranged between the first part 3a and the second part 3b of the machine bed. The sensors 5a and 5b disclose a position of the first part 3a in relation to the second part 3b of the machine bed. The first part is, for example, slightly tilted or twisted in relation to the second part.

[0060] FIG. 2A and 2B shows another embodiment for the arrangement of FIG. 5. In this embodiment the first sensor 5a is located between the traction means 8 and the elevator car 6 and the second sensor 5b is located between the support means 10 and the elevator car 6.

[0061] It is reasonable that the first sensor 5a and the second sensor 5b measure the same quantity though they could measure different quantities. The sensors 5a and 5b measure, for example, one of the following quantities: load, pressure, distance, resistance. The sensors 5a and 5b disclose the quantity, for example, in millivolts from 0 mV to 10 mV. In one embodiment of the arrangement at least one of the first sensor 5a and the second sensor 5b is calibrated to provide a zero value (e.g. 0 mV) as its measurement result when the mass M_1 reaches its minimum value. This happens when elevator car is empty and is located at the top part of the hoistway. A person skilled in the art knows that the calibration of the sensors 5a and 5b can be performed in various manners.

[0062] A difference between the first measuring result (provided by the first sensor 5a) and the second measuring result (provided by the second sensor 5b) is, for example, $6.7 \text{ mV} - 4.4 \text{ mV} = 2.3 \text{ mV}$.

[0063] In one embodiment the difference between the first force F_1 and the second force F_2 is calculated from the difference between the first measuring result and the second measuring result. For example, if this difference (marked with Δd) is 2.3 mV, the numeric value 2.3 can be input in a formula which results in the difference (marked ΔD) between the first force F_1 and the second force F_2 . The formula is, for example, $\Delta D = \Delta d \cdot 100 \text{ N}$. Thus, the Δd value 2.3 would result in 230 N.

[0064] As mentioned in the background of the invention, measuring the mass of the elevator car 6, or measuring the mass of its load, do not necessarily provide such measuring data that it would be possible to determine accurate the forces on the both sides of the traction sheave.

[0065] When the elevator car stays in its location, in addition to the first mass M_1 , the first force F_1 is affected by static friction and the first measuring result (provided by the first sensor 5a) includes the static friction. Correspondingly, the second force F_2 is affected by static friction and the second measuring result (provided by the second sensor 5a) includes the static friction.

[0066] When the elevator car moves, in addition to the first mass M_1 , the first force F_1 is affected by kinetic friction and the first measuring result includes the kinetic friction. Correspondingly, the second force F_2 is affected by kinetic friction and the second measuring result includes the kinetic friction. In addition, the first force F_1 is affected by acceleration of the first mass M_1 and the second force F_2 is affected by acceleration of the second mass M_2 .

[0067] The elevator arrangement shown in FIG. 5 provides measuring results about the forces F_1 and F_2 shown in FIG. 3A and 3B. These measuring results can be utilized when computing control information for the elevator.

[0068] FIGURE 6 shows a method of computing the control information for an elevator. The method comprises the steps of:

obtaining 601 from a first sensor 5a a first measuring result representing a magnitude of a first force F_1 which is affected by at least the first mass M_1 ;
 obtaining 602 from a second sensor 5b a second measuring result representing a magnitude of a second force F_2 which aims to rotate the traction sheave 9 to an opposite direction than the first force F_1 ; and
 computing 603, on the basis of the first measuring result and the second measuring result, at least one of the following items of control the information: a difference between the first force F_1 and the second force F_2 , or a sum of the first force F_1 and the second force F_2 .

[0069] As described in the above, the elevator arrangement shown FIG. 5 comprises various embodiments. Also those embodiments are usable in the method and can be combined with it.

[0070] The difference between the first force F_1 and the second force F_2 is an example of an item of the control information and the sum of the first force F_1 and the second force F_2 is other example of an item of the control information.

[0071] The elevator can be controlled with one or more items of the control information, for example, to enhance the ride comfort. The following pseudo code illustrates in which manner the power of the hoisting machine of the elevator is controlled by the difference of the first force F_1 and the second force F_2 . In this pseudo code the difference is stored in a variable termed "diff" and a variable termed "torque" is set such value of the torque that the hoisting machine should provide when the brake is released:

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IF 0 ≤ diff < 1 THEN torque = 15 Nm ELSE
IF 1 ≤ diff < 2 THEN torque = 45 Nm ELSE
IF 2 ≤ diff < 3 THEN torque = 69 Nm ELSE
...
IF 8 ≤ diff < 9 THEN torque = 165 Nm ELSE
IF 9 ≤ diff < 10 THEN torque = 189 Nm

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[0072] The difference and/or sum can be used to in the calculation of other items of control information, such as:

- a mass of a load in the elevator car 6
- the torque (T_s) on the traction sheave 9
- a load on bearings of the traction sheave 9
- a tension of the traction means 8
- a tension of the support means 10.

[0073] For example, the mass Δm of the load in the elevator car 6 can be calculated by using a formula:

$\Delta m = \Delta d \cdot 35 \text{ kg}$. For example, a Δd value 2.3 representing the difference would result in 80.5 kg.

[0074] In one embodiment the method comprises calculating, on the basis of the sum, load on bearings of the traction sheave 9. The bearings connect the traction sheave 9 to hoisting machine 2.

[0075] In one embodiment the method comprises calculating, on the basis of the sum, at least one of the following tensions: a) a tension of the traction means 8 or b) a tension of support means 10 assuming that the elevator car (6) and the at least one counter weight 7 are connected to each other by the support means 10. The following pseudo code illustrates in which manner the sum of the first measuring result, 6.7 mV (provided by the first sensor 5a), and the second measuring result 4.4 mV (provided by the second sensor 5b) is used in the calculation of the tension of the traction means 8. In this example the sum of the measuring results is:

$$6.7 \text{ mV} + 4.4 \text{ mV} = 11.1 \text{ mV}.$$

[0076] According to the pseudo code the tension is 1150 N when the numeric value of the sum is 11.1:

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IF 9 ≤ sum < 10 THEN tension = 950 N ELSE
IF 10 ≤ sum < 11 THEN tension = 1050 N ELSE
IF 11 ≤ sum < 12 THEN tension = 1150 N ELSE
...

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[0077] Instead of a pseudo code, an appropriate formula could also be used to calculate the sum.

[0078] A rope tension related to the traction means 8 (or support means 10) may increase because of an abnormal change in kinetic friction. This change can be detected, if the sum is calculated repeatedly when the elevator moves. Then the elevator car can be stopped for safety reasons.

[0079] The following three figures illustrate different embodiments for hoisting machines.

[0080] FIGURE 7A shows a hoisting machine 2 located on the floor 3b of a hoistway. Therefore the traction means 8 pass upwards from the hoisting machine 2. By using diverting pulleys the elevator car can be moved up and down though the hoisting machine is located on the floor of the hoistway. The first part 3a of the machine bed of the hoisting machine 2 is made of steel. The floor of the hoistway, which is made of reinforced concrete, operates as the second part 3b of the hoisting machine. Special bolts extend deep in the reinforced concrete. The first part 3a of the machine bed includes holes so that the bolts penetrate the holes and the nuts can be screwed into the bolts. A dashed line 71 separates the hoisting machine 2 and the traction sheave 9 into two sides. As in the above, forces are measured on the both sides of the traction sheave 9. A first sensor 5a and a second sensor 5b are located as far from the dashed line 71 because then the sensors (5a, 5b) probably provide the most reliable measurement results.

[0081] FIGURE 7B shows a hoisting machine located on a wall of a hoistway. Also in this embodiment a second part 3a of the machine bed is made of concrete and a dashed line 71 separates the hoisting machine 2 and its traction sheave 9 into two sides. A first portion 81 of the traction means 8 meets the traction sheave 9 in a different angle than a second portion 82 of the traction means 8. In more detail, the second portion 82 of the traction means 8 is parallel to the dashed line 71 but the angle between the first portion 81 of the traction means 8 and the dashed line 71 is about 45 degrees. At least one diverting pulley 71 or 72 can be used to make the traction means 8 to meet the traction sheave 9 in a certain angle. A person skilled in the art knows that the traction sheave 9 must provide enough touching surface for the traction means 8.

[0082] FIGURE 7C shows a flat hoisting machine 2 and an appropriate machine bed for it. The hoisting machine 2 is placed on the floor of a hoistway so that the drive shaft 1 of the hoisting machine 2 is parallel to the hoistway. The machine bed is made of two steel plates 3a, 3b which are twisted as shown in the figure. The steel plates function as a first part 3a and as a second part 3b of the machine bed. Four holes 74, 75, 76, 77 penetrate the parts 3a, 3b so that the first part 3a of the machine bed can be attached to the second part 3b by bolts and nuts. In accordance with the invention a first sensor 5a and a second sensor 5b should be placed between the parts 3a, 3b of the machine bed so that they are able to provide reliable measurement results about the torque on the traction sheave 9. Therefore, the sensors 5a, 5b are placed between the parts 3a, 3b close to holes 74 and 75. If the hoisting machine 2 rotates the traction sheave 9 to clockwise direction 78, the first part 3a pressures against the second part 3b at the first sensor 5a and simultaneously the first part 3a draws apart from the second part 3b at the second sensor 5b. The sensors 5a and 5b measure this movement of the first part 3a.

[0083] The invention can be implemented in various manners. The following figures show two examples of implementing the invention.

[0084] FIGURE 8A shows a hoisting machine located on a top of a hoistway 83. Traction means 8 pass from the roof 61 of an elevator car 6 via the traction sheave 9 of the hoisting machine and via diverting pulleys 84, 85 to a counter weight (the counter weight not shown in the figure). In one embodiment the first sensor 5a is located between the traction sheave 9 and the elevator car 6 and the second sensor 5b is located between the traction sheave 9 and the at least one counter weight (not shown in the figure). In FIG. 8 the first sensor 5a is located between the traction means 8 and the elevator car 6 and the second sensor 5b is located at the diverting pulley 85. Alternatively, the second sensor 5b could be located at the bearings of diverting pulley 84, or between the traction means 8 and the counter weight.

[0085] FIGURE 8B shows an elevator arrangement comprising a hoisting machine which is located on the floor of a hoistway 86 and which uses a special type of traction means 8. The traction means 8 pass from the roof of an elevator car 6 via diverting pulleys 89, 88 to the top of the counter weight 7 and from the bottom of the counter weight 7 via a diverting pulley 87 and via the traction sheave 9 to the bottom of the elevator car 6. Sensors 5a and 5b (for providing measurement results of the forces F_1 and F_2) are located as follows. The first sensor 5a is located between the traction means 8 and the roof of the elevator car 6 and the second sensor 5b is located between the traction means 8 and the bottom of the elevator car 6. A device for providing rope tension is usually located in the bottom of the elevator car 6 as in this example. The device keeps the tension of the traction means 8 on an appropriate level, which is illustrated by the second force F_2 .

[0086] All or a portion of the exemplary embodiments described in the above can be implemented using known sensors, elevator components, a processor etc. One or more persons skilled in electronics and/or mechanics are able to advice preparation of the program code that is needed in the implementation of the invention.

[0087] While the invention has been described in connection with a number of exemplary embodiments, and implementations, the invention is not limited to them, but rather covers various modifications which fall within the purview of prospective claims.

Claims

1. An arrangement for an elevator, the elevator comprising at least an elevator car (6), a machine bed, a hoisting machine (2) for moving the elevator car (6), at least one counter weight (7), and traction means (8) that connect the elevator car (6) and the at least one counter weight (7) to each other, wherein the traction means (8) pass through a traction sheave (9) connected to the hoisting machine (2), and wherein a first mass (M_1) includes at least the mass of the elevator car (6) and a second mass (M_2) includes at least the mass of the at least one counter weight (7), the arrangement further comprising:

a first sensor (5a) for providing a first measuring result, the first measuring result representing a magnitude of a first force (F_1) which is affected by at least the first mass (M_1),
a second sensor (5b) for providing a second measuring result, the second measuring result representing a

magnitude of a second force (F_2) which aims to rotate the traction sheave (9) to an opposite direction than the first force (F_1); and
a computing unit (12) for computing, on the basis of the first measuring result and the second measuring result, at least one of the following:

- a difference between the first measuring result and the second measuring result,
- a difference between the first force (F_1) and the second force (F_2),
- a sum of the first measuring result and the second measuring result,
- a sum of the first force (F_1) and the second force (F_2)

characterized in that

the machine bed comprises a first part (3a) and a second part (3b);
the hoisting machine (2) is mounted on the first part (3a) of the machine bed; and
the first sensor (5a) and the second sensor (5b) are located between the first part (3a) and the second part (3b) of the machine bed.

2. The arrangement as in claim 1, **characterized in that** the elevator car (6) and the at least one counter weight (7) are further connected to each other by support means (10).
3. The arrangement as in claim 1, **characterized in that** the first force (F_1) is further affected by at least one of the following: static friction, kinetic friction, acceleration of the first mass (M_1).
4. The arrangement as in claim 1, **characterized in that** the second force (F_2) is affected by at least one of the following: the second mass (M_2), static friction, kinetic friction, acceleration of the second mass (M_2), a device for providing rope tension.
5. The arrangement as in claim 1, **characterized in that** the arrangement comprises the first sensor (5a) and the second sensor (5b) for measuring one of the following quantities: load, pressure, distance, resistance.
6. The arrangement as in claim 1, **characterized in that** the traction means (8) comprise at least one of the following means: a rope, cable, chain, or belt.

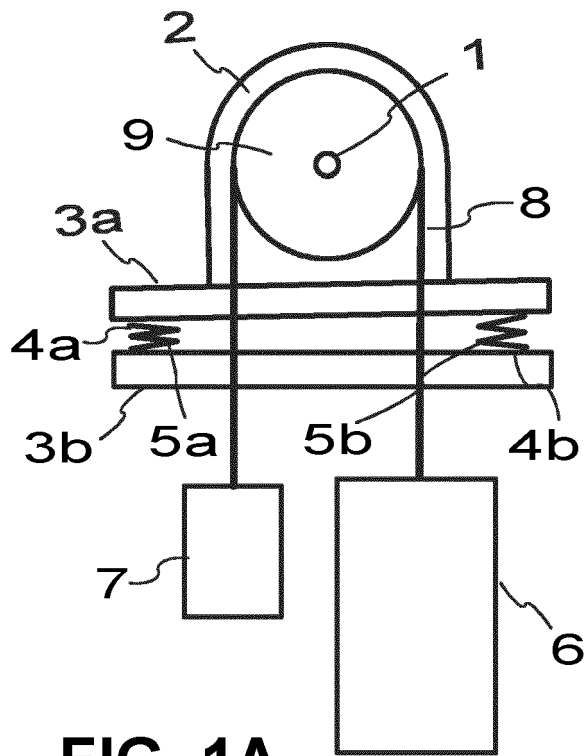


FIG. 1A

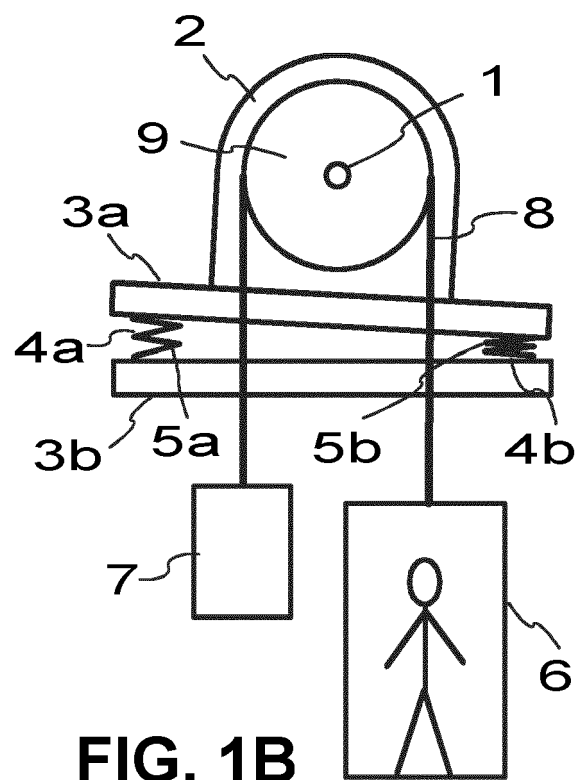


FIG. 1B

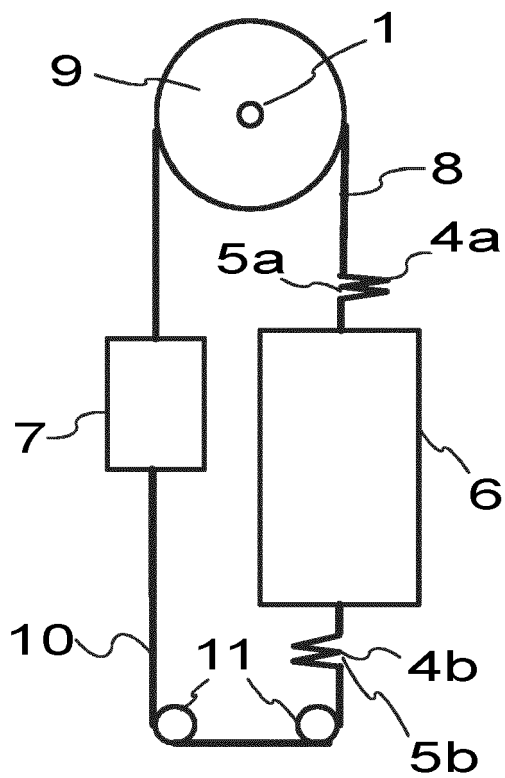


FIG. 2A

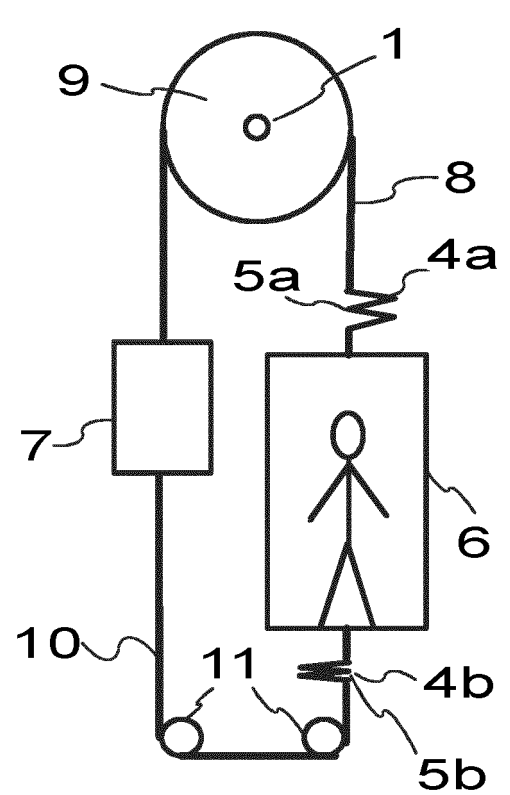


FIG. 2B

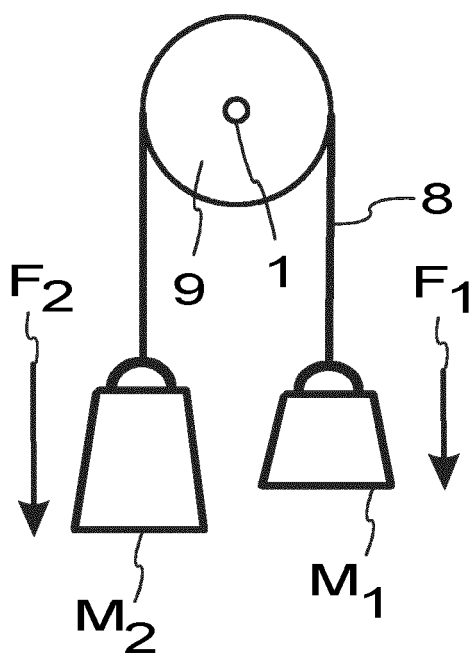


FIG. 3A

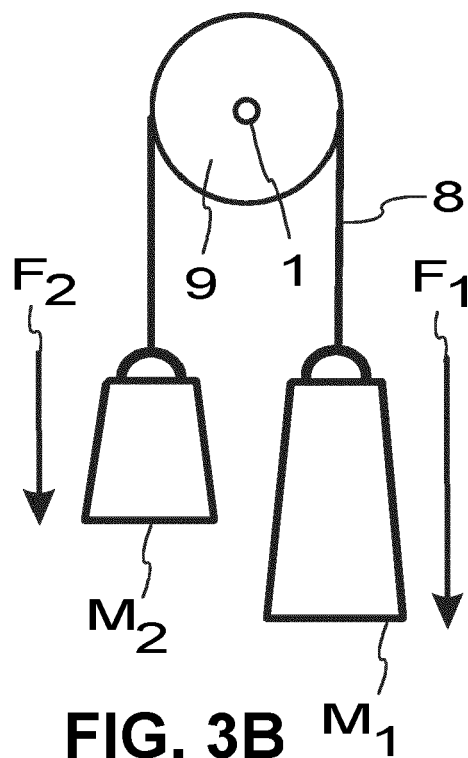


FIG. 3B

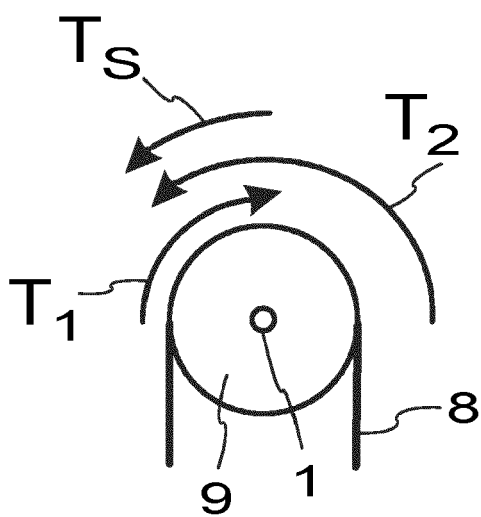


FIG. 4A

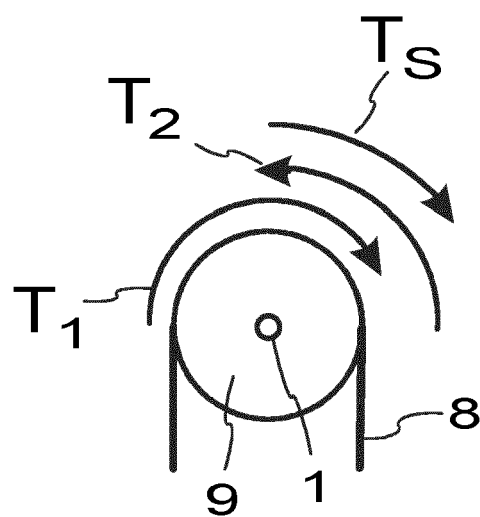
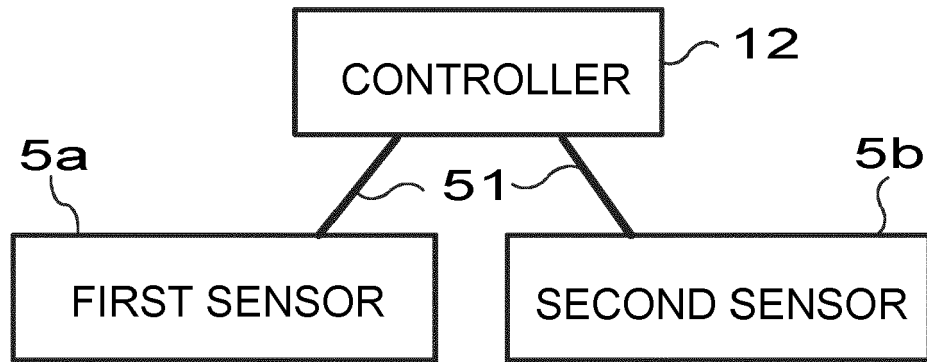
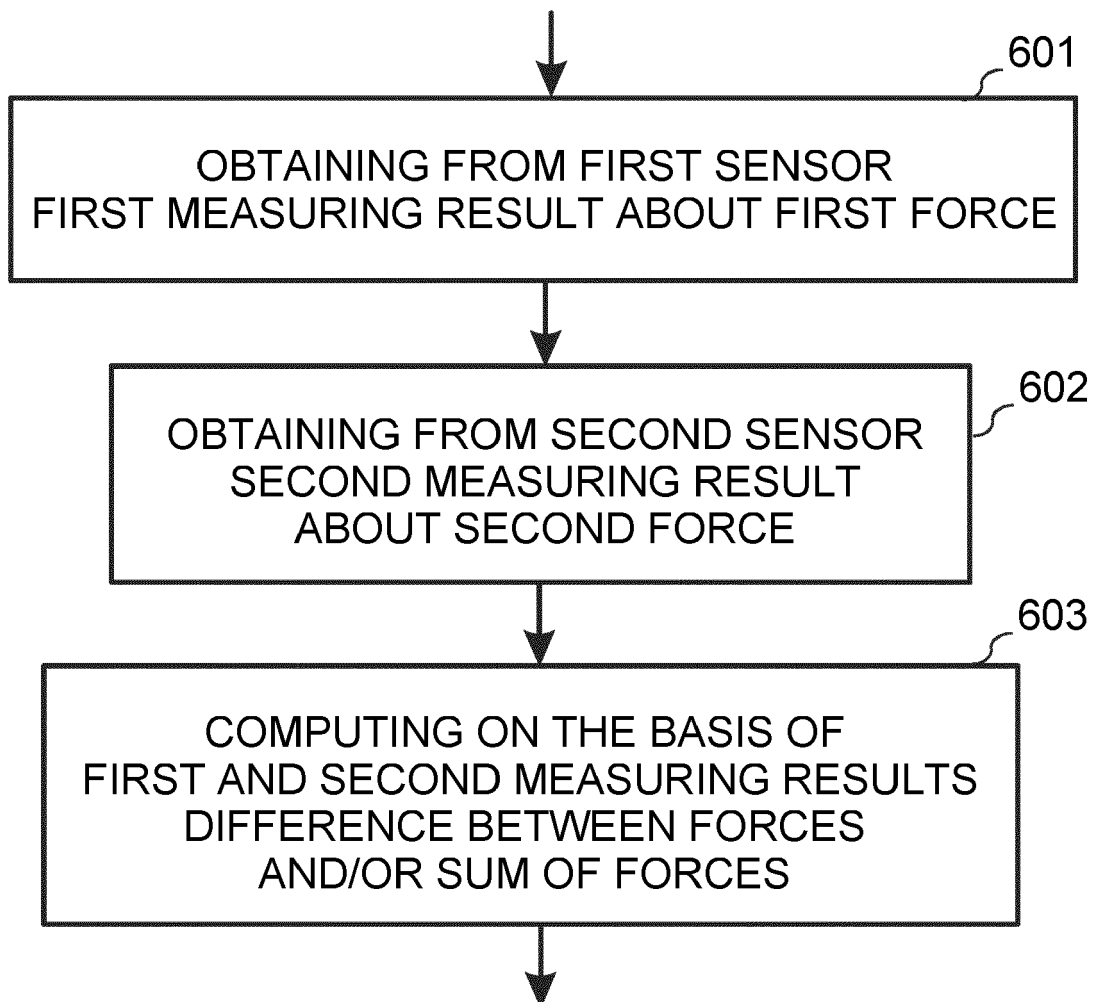


FIG. 4B

**FIG. 5****FIG. 6**

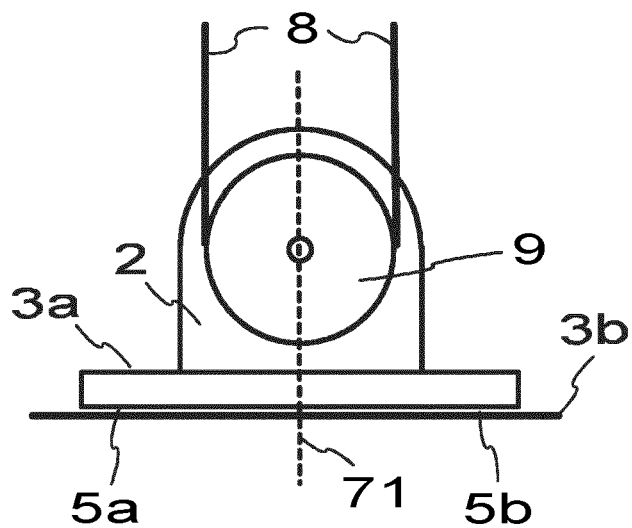


FIG. 7A

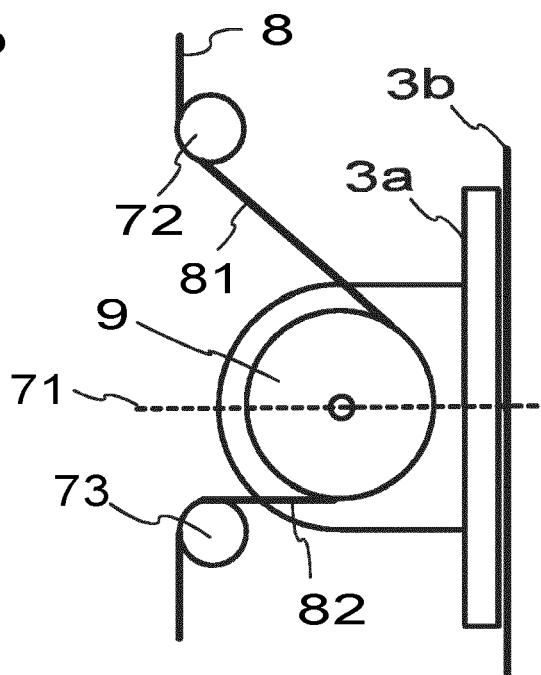


FIG. 7B

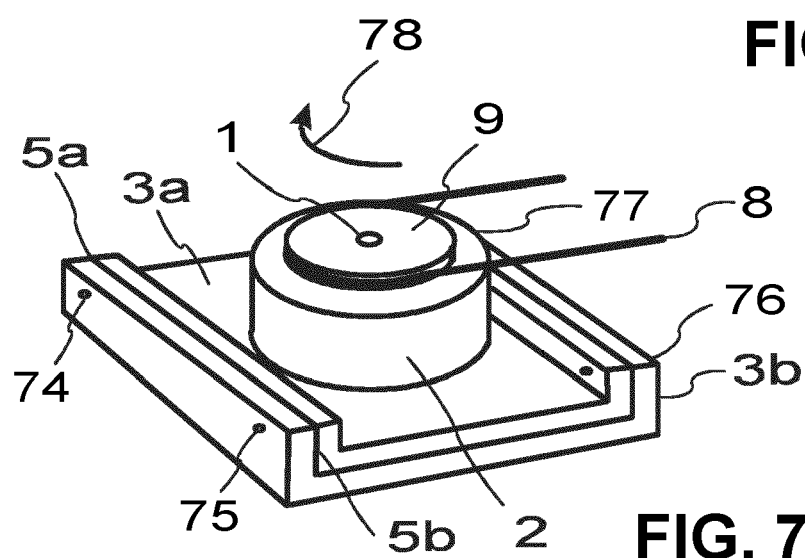
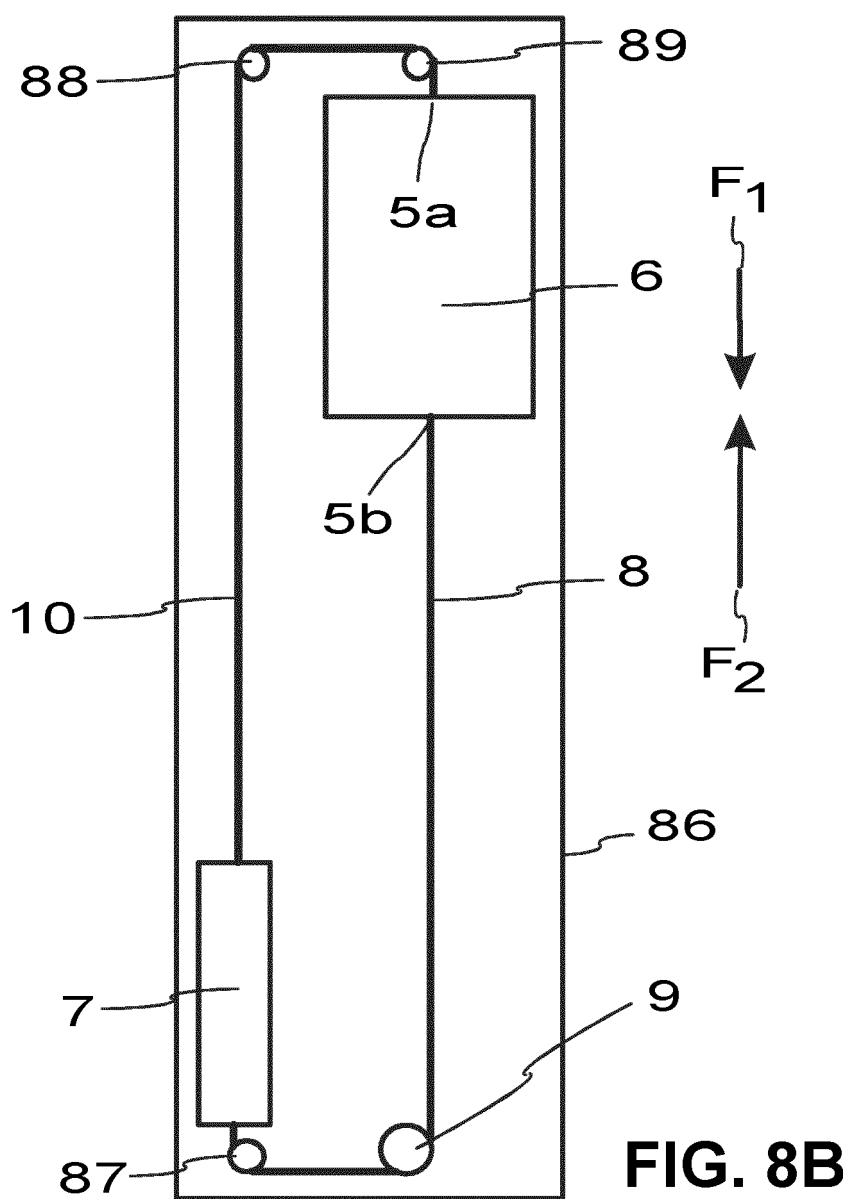
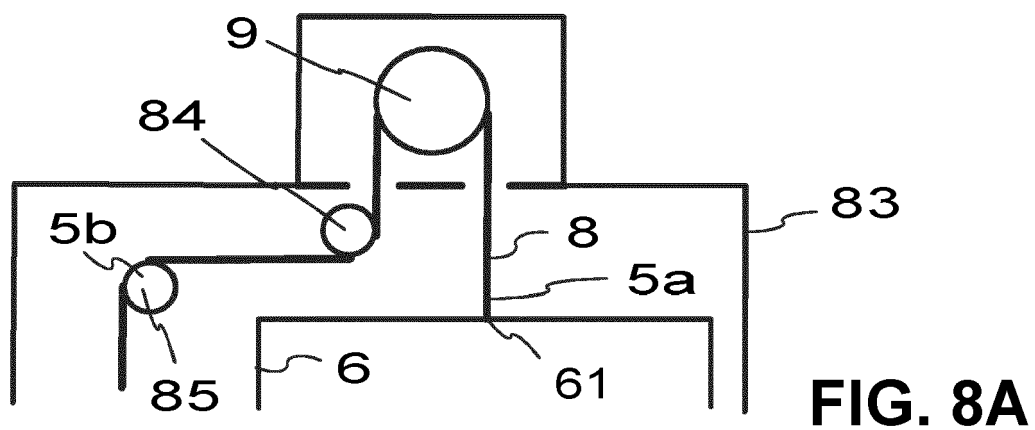


FIG. 7C





EUROPEAN SEARCH REPORT

Application Number
EP 17 18 7981

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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)
A	DE 33 07 020 A1 (ASEA AB [SE]) 30 August 1984 (1984-08-30) * page 7, lines 25-35; claim 1 * * page 9, lines 15-21; figures 1,3 * -----	1-6	INV. B66B1/34
A	US 3 614 996 A (SAITO KENJI ET AL) 26 October 1971 (1971-10-26) * column 4, line 64 - column 5, line 7; figure 9 * -----	1-6	
			TECHNICAL FIELDS SEARCHED (IPC)
			B66B
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 7 December 2017	Examiner Janssens, Gerd
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			

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**ANNEX TO THE EUROPEAN SEARCH REPORT
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5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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07-12-2017

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