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(54) **Thermal protection of electromagnetic actuators**

Thermischer Schutz für elektromagnetische Aktuatoren

Protection thermique d'un déclancheur électromagnétique

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Description

[0001] The present invention relates to a method and apparatus for preventing overheating of an electromagnetic actuator.

[0002] EP-B-0731051 describes an elevator installation in which the ride quality is actively controlled using a plurality of electromagnetic linear actuators. Such a system in commonly referred to as an active ride control system. As an elevator car travels along guide rails provided in a hoistway, sensors mounted on the car measure the vibrations occurring transverse to the direction of travel. Signals from the sensors are input to a controller which computes the activation current required to suppress the sensed vibrations for each linear actuator. These activation currents are supplied to the linear actuators which actively dampen the vibrations and thereby the ride quality for passengers traveling within the car is enhanced.

[0003] Considering the case where a large asymmetric load is applied to the car or where the car is poorly balanced, it would be necessary for one or more of the linear actuators to be powered continuously to overcome the imbalance. This continual energization would cause the actuator to heat up and if left unchecked could potentially lead to the thermal destruction of the actuator itself. It will be appreciated that the above is only an example and that there are other cases where conditions imposed on the elevator car similarly lead to overheating.

[0004] A conventional solution to this problem would be to incorporate a bimetallic strip into the actuator to control its energization. Accordingly when the temperature of the actuator rises to the predetermined activation temperature of the bimetallic strip, the bimetallic strip within the actuator would break the energization circuit and the respective actuator would be de-energized until its temperature falls to below the predetermined activation temperature of the bimetallic strip. It will be appreciated that at this switch off point there would be an instantaneous deterioration in the performance of the active ride control system since a force would no longer be generated by the effected actuator to stabilize the elevator car. Furthermore this deterioration in performance would be immediately perceptible to any passengers traveling in the elevator car and would therefore defeat the purpose of, and undermine user confidence in, the active ride control system.

[0005] The objective of the present invention is to overcome the problems associated with the prior art electromagnetic actuators by providing an apparatus and method according to the appended claims.

[0006] In particular the present invention provides a thermal protection device for an electromagnetic actuator, comprising a temperature evaluation unit that determines an estimate temperature of the actuator from a signal proportional to a current supplied to the actuator, and a limiter that restricts the current supplied to the actuator if the actual temperature of the actuator exceeds a first predetermined temperature. Hence, the actuator is protected from thermal deterioration and destruction. Furthermore, the temperature evaluation unit can be located remote from the actuator in any circuit controlling the current delivered to the actuator.

[0007] Preferably, the current supplied to the actuator is restricted to a minimal level if the actual temperature of the actuator exceeds a second predetermined temperature. The minimal level can be determined such that energy dissipated in the actuator due to the current is equal to or less than heat lost from the actuator due to conduction and convection. Accordingly, the actuator can be continuously energized albeit with a limited driving current.

[0008] The invention is particularly advantageous when applied to actuators used in elevator systems to dampen the vibration of an elevator car as it travels along guide rails in a hoistway. The current to the actuators is gradually limited as the temperature exceeds the first predetermined temperature, as opposed to being switched off completely. Hence, and deterioration in the ride quality is less perceptible to passengers.

[0009] Furthermore, the thermal protection device and method can be easily incorporated in a controller for the actuators without any additional hardware components.

[0010] By way of example only, preferred embodiments of the present invention will be described in detail with reference to the accompanying drawings, of which:

FIG. 1 is a schematic representation of an elevator car traveling along guide rails, the car incorporating linear actuators to suppress vibration of the car;

FIG. 2 is a side elevation illustrating the arrangement of the middle roller and lever together with the associated actuator of one of the guide assemblies of FIG. 1;

FIG. 3 is a perspective view of one of the actuators from FIG. 1 and FIG. 2;

FIG. 4 is an empirical model of the actuators from FIGS. 1 to 3;

FIG. 5 is a graph of the results obtained using the model of FIG. 4;

FIG. 6 shows a signal flow scheme of the active ride control system for the elevator installation of FIG. 1 incorporating thermal protection according to a first embodiment of the invention; and

FIG. 7 shows a signal flow scheme of the active ride control system for the elevator installation of FIG. 1 incorporating thermal protection according to a second embodiment of the invention.

[0011] FIG. 1 is a schematic illustration of an elevator installation incorporating an active ride control system according to the EP-B-0731051 which further includes a thermal protection unit in accordance with the present invention. An elevator car 1 is guided by roller guide assemblies 5 along rails 15 mounted in a shaft (not shown). Car 1 is carried elastically in a car frame 3 for passive oscillation damping. The passive oscillation damping is performed by several rubber springs 4, which are designed to be relatively stiff in order to isolate sound or vibrations having a frequency higher the 50 Hz.

[0012] The roller guide assemblies 5 are laterally mounted above and below car frame 3. Each assembly 5 includes a mounting bracket and three rollers 6 carried on levers 7 which are pivotally connected to the bracket. Two of the rollers 6 are arranged laterally to engage opposing sides of the guide rail 15. The levers 7 carrying these two lateral rollers 6 are interconnected by a linkage 9 to ensure synchronous movement. The remaining, middle roller 6 is arranged to engage with a distal end of the guide rail 15. Each of the levers 7 is biased by a contact pressure spring 8 towards the guide rail 15. This spring biasing of the levers 7, and thereby the respective rollers 6, is a conventional method of passively dampening vibrations.

[0013] Each roller guide assembly 5 further includes two actuators 10 disposed to actively move the middle lever 7 in the y direction and the two interconnected, lateral levers 7 in the x direction, respectively.

[0014] Unevenness in rails 15, lateral components of traction forces originated from the traction cables, positional changes of the load during travel and aerodynamic forces cause oscillations of car frame 3 and car 1, and thus impair travel comfort. Such oscillations of the car 1 are to be reduced. Two position sensors 11 per roller guide assembly 5 continually monitor the position of the middle lever 7 and the position of the interconnected lateral levers 7, respectively. Furthermore, accelerometers 12 measure transverse oscillations or accelerations acting on car frame 3.

[0015] The signals derived from the positions sensors 11 and accelerometers 12 are fed into a controller and power unit 14 mounted on the car 1. The controller and power unit 14 processes these signals to produce a current I to operate the actuators 10 in directions such to oppose the sensed oscillations. Thereby, damping of the oscillations acting on frame 3 and car 1 is achieved. Oscillations are reduced to the extent that they are imperceptible to the elevator passenger.

[0016] Although FIG. 2 provides a further illustration of the arrangement of the middle roller 6 and lever 7 together with the associated actuator 10, it will be understood that the following description also applies to the two lateral rollers 6 and interconnected levers 7. Due to the parallel arrangement of the contact pressure spring 8 and the actuator 10 to the lever 7, the roller guide assembly 5 remains capable of operating even after a partial or complete failure of the active ride control system because the contact pressure spring 8 urges roller 6 against the guide rail 15 independently of the actuator 10. Hence, even when no current I is supplied to the actuator 10, the car frame 3 is passively dampened by the contact pressure springs 8.

[0017] As shown in FIG. 3, the actuator 10 is based on the principle of a moving magnet and comprises a laminated stator 17, windings 16 and a moving actuator part 18 comprising a permanent magnet 19. The moving actuator part 18 in connected to the top of the lever 7 so that as the current I supplied to the windings 16 changes, the magnetic flux changes thus causing the moving actuator part 18, lever 7 and coupled roller 6 towards or away from the guide rail 15. The actuator 10 has the advantage of simple controllability, low weight and small moving masses, and great dynamic and static force (e.g. 800N) for relatively low energy consumption.

[0018] The objective of the present invention is to ensure maximum availability of the active ride control system but at the same time preventing thermal destruction of the actuators 10, particularly when a large asymmetric load is applied to the car 1 or where the car 1 is poorly balanced. In such circumstances it would be necessary for one or more of the actuators 10 to be powered continuously to overcome the imbalance. This continual energization would cause the actuator 10 to heat up and if left unchecked could potentially lead to the thermal destruction of the actuator 10 itself. The first step to achieving the objective is to assess the thermal characteristics of the actuators 10. From first principles, the power dissipated as heat by the electrical circuit (i.e. the windings 16) produces an increase in the temperature of the actuator 10. This can be expressed generally as:

EQN. 1 Power dissipated -> Temperature increase in actuator – (effects of heat conduction & convention)

[0019] This expression gives rise to EQN. 2:

EQN. 2 $$I^2R = \frac{cM(T_n - T_{n-1})}{\Delta t} - (T_n - T_{amb})(\lambda A_1 + h_c A_2)$$

where:

I = average (or RMS) current delivered to actuator during sample period Δt;
R = electrical resistance of coils;
c = specific heat capacity;
M = mass;
T_n = actual temperature after sample period Δt;
T_{n-1} = previous temperature at the start of sample period Δt;
T_{amb} = ambient temperature;
λ = thermal conductivity;
A_1 = conductive surface area;
h_c = convective heat transfer coefficient;
A_2 = convective surface area;

[0020] This equation can be solved for T_n as follows:

EQN. 3 $$T_n = \frac{I^2R\Delta t + cMT_{n-1} - T_{amb}\Delta t(\lambda A_1 - h_c A_2)}{cM - \Delta t(\lambda A_1 + h_c A_2)}$$

[0021] For a specific type of actuator 10, the values for c, M, λ, A_1, h_c and A_2 can easily be determined from experimentation in a climate test chamber. Furthermore, the resistance R of the windings 16 can be set to an average constant value, or for more accurate results the true temperature dependent function for the resistance R can be evaluated and used.

[0022] In practice, the thermal characteristics of the actuator 10 were modeled using the transfer function shown in FIG. 4, which yielded the temperature characteristics shown in FIG. 5.

[0023] FIG. 6 shows a signal flow scheme of the active ride control system for the elevator installation of FIG. 1 incorporating thermal protection according to the invention. External disturbances act of the car 1 and frame 3 as they travel along the guide rails 15. These external disturbances generally comprise high frequency vibrations due mainly to the unevenness of the guide rails 15 and relatively low frequency forces 27 produced by asymmetrical loading of the car 1, lateral forces from the traction cable and air disturbance or wind forces. The disturbances are sensed by the positions sensors 11 and accelerometers 12 which produce signals that are fed into the controller and power unit 14.

[0024] In the controller and power unit 14, the sensed acceleration signal is inverted at the summation point 21 and fed into an acceleration controller 23 as an acceleration error signal e_a. The acceleration controller 23 determines the current I_a required by the actuator 10 in order to counteract the vibrations causing the sensed acceleration. Similarly, the sensed position signal is compared with a reference value P_{ref} at summation point 20 to produce a position error signal e_p. The position error signal e_p is then fed into a position controller 22 which determines the current I_p required by the actuator 10 in order to counteract the disturbances causing the sensed position signal to deviate from the reference value P_{ref}. In the prior art, the two derived currents I_a and I_p are simply combined at a summation point 26 and then delivered as a combined current I to the actuator 10.

[0025] In the present embodiment the current I_p from the position controller 22 is further processed by a limiter 25 producing a current I_{plim} which is passed to the summation point 26 for combination with the current I_a from the acceleration controller 23 to provide a combined current I to the actuator 10.

[0026] The current value I_{plim} from the limiter 25 is also used as an input to a temperature evaluation unit 24 incorporating a transfer function corresponding to EQN. 3. Since the resistance R of the windings 16 is either a constant or represented as a temperature dependent function and the sampling period Δt can be set to that of the controller 14, the only variables (inputs) required by the transfer function are current I_{plim}, which as explained above is derived from the limiter 25, the ambient temperature T_{amb}, which can either be a preset constant or measured using a temperature sensor, and the previously recorded value for the actuator temperature T_{n-1}, which is stored in a register 24a in the temperature evaluation unit 24. Accordingly, the actual actuator temperature T_n is determined by the temperature evaluation unit 24 and input to the limiter 25.

[0027] The limiter 25 determines a maximum permissible current value I_{pmax} deliverable to the actuator 10 for a given actuator temperature T_n such as not to cause thermal deterioration of the actuator 10. As shown in FIG. 4, the maximum permissible current value I_{pmax} is constant for all temperatures up to a lower threshold actuator temperature T_{nL}. This constant current value is purely dependent on the power electronics driving the position controller 22. As the temperature of the actuator 10 exceeds the lower threshold T_{nL}, the limiter 25 restricts the maximum permissible current value I_{pmax}. If the temperature of the actuator 10 reaches an upper threshold T_{nH}, no current is derived from the limiter 25. Hence, the actuator 10 is protected from thermal deterioration and destruction.

[0028] Although the maximum permissible current I_{pmax}, and therefore current I_{plim}, is zero for actuator temperatures above T_{nH} in the present embodiment, it is clear from EQNs. 1 and 2 that a nonzero current I_{plim} can still be delivered even in this temperature range without causing a temperature rise in the actuator 10. In such circumstances, the energy dissipated in the actuator 10 due to the current I_{plim} flowing in the windings 16 is equal to or less than the heat loss from the actuator 10 due to conduction and convection and consequently there is no temperature rise in the actuator 10. Accordingly, it is possible to continuously energize the actuator 10 albeit with a limited driving current I_{plim}.

[0029] In the present embodiment, the limiter 25 and temperature evaluation unit 24 are applied to the current I_p output from the position controller 22 only. The reason for this is that it is the low frequency disturbances 27, such as asymmetric loading of the car 1, which require the continuous energization of the actuator 10 and thereby cause the greatest heating effect on the actuator 10. These low frequency disturbances 27 manifest themselves primarily in the position error signal e_p. Naturally an additional limiter 25 and temperature evaluation unit 24 can be installed on the output of the acceleration controller 23. Alternatively, a single current limiter 25 and temperature evaluation unit 24 can be applied to the output from summation point 26 to limit the combined current I.

[0030] It will be appreciated that the temperature evaluation unit 24 and current limiter 25 can be combined as a single unit in the controller.

[0031] A presently preferred embodiment of the invention is illustrated in FIG. 7. In this embodiment, the combined analogue controller and power unit 14 from FIG. 4 have been separated into a discrete digital controller 30 and a discrete actuator power unit 31. This enables the digital processing of signals within the controller 30 which greatly improves efficiency and accuracy. All components of the controller 30 correspond to those in FIG. 6, however it will be understood that the digital signals from the position controller 22, acceleration controller 23, the limiter 25 and the summation point 26 referred to as force command signals F in the drawing are proportional to the currents I in the previous embodiment. It is only after the combined force command signal F from the summation point 26 in the controller 30 is passed to the power unit 31 that the actual driving current I is supplied to the actuator 10. In contrast to the previous embodiment, the limiter 25 and temperature evaluation unit 24 monitor and limit the combined force command signal (F) derived from the summation of the position force command signal (F_p) and the acceleration force command (F_a) at the summation point 26.

[0032] Again, the alternatives arrangements discussed in relation to the previous embodiment apply equally to the present embodiment.

[0033] Furthermore, the guide assemblies 5 may incorporate guide shoes rather then rollers 6 to guide the car 1 along the guide rails 15.

[0034] Although the present invention has been specifically illustrated and described for use on d.c. linear actuators in an active ride control system to dampen vibrations of an elevator car 1, it will be appreciated that the thermal protection described herein can be applied to any electromagnetic actuator.

Claims

1. An elevator installation comprising:

   an elevator car (1) guided by guide assemblies (5) along guide rails (15) mounted in a hoistway;
   at least one electromagnetic actuator (10) mounted between the car (1) and each guide assembly (5); and
   a controller (14;30) controlling an energization of the actuators (10) in response to sensed vibrations
   CHARACTERISED IN further comprising a temperature evaluation unit (24), remotely determining a temperature (T_n) of the actuator (10); and
   a limiter (25), restricting a current (I) supplied to the actuator (10) if the determined temperature (T_n) of the actuator (10) exceeds a first predetermined temperature (T_{nL}).

2. An elevator installation according to claim 1, wherein the temperature evaluation unit (24) includes a register (24a) storing at least one previously recorded value for the actuator temperature (T_{n-1}).

3. An elevator installation according to claim 1 or claim 2, wherein the temperature evaluation unit (24) and the limiter (25) are incorporated in the controller (14;30).

4. An elevator installation according to claim 3, wherein the controller (14;30) includes a position controller (22) responsive to sensed positional signals and an acceleration controller (23) responsive to sensed accelerations, and wherein the output (I_p;F_p) from the position controller (22) is combined with the output (I_a;F_a) from the acceleration controller (23) at a summation point (26) to produce a signal (I; F_{lim}) proportional to the current (I) supplied to the actuator (10).

5. An elevator installation according to claim 4, wherein the controller (14) is an analogue controller and the output from the summation point (26) is the current (I) supplied to the actuator (10).

6. An elevator installation according to claim 4, wherein the controller (30) is a digital controller and the output from the summation point (26) is a force command signal (F_{lim}), which is fed to a power unit (31) which subsequently supplies the current (I) supplied to the actuator (10).

7. An elevator installation according to any of claims 4 to 6, wherein the temperature evaluation unit (24) and the limiter (25) are installed between the position controller (22) and the summation point (26), and the temperature evaluation unit (24) determines the temperature (T_n) on the basis of a signal output from the limiter (25).

8. An elevator installation according to any of claims 4 to 6, wherein the temperature evaluation unit (24) and the limiter (25) are installed between the summation point (26) and the actuator (10), and the temperature evaluation unit (24) determines the temperature (T_n) on the basis of a signal output from the limiter (25).

9. A method for thermally protecting an electromagnetic actuator (10) mounted between the car (1) and a guide assembly (5) of an elevator installation to suppress sensed vibrations comprising the steps of:

   a) remotely determining an temperature (T_n) of the actuator (10); and
   b) restricting the current (I) subsequently supplied to the actuator (10) if the determined temperature (T_n) of the actuator (10) exceeds a predetermined temperature (T_{nL}).

10. A method according to claim 9 further comprising the step of restricting the current (I) supplied to the actuator (10) to a minimal level if the actual temperature (T_n) of the actuator (10) exceeds a second predetermined temperature (T_{nH}).

11. A method according to claim 10, wherein the minimal level is determined such that energy dissipated in the actuator (10) due to the current (I_{plim}) is equal to or less than heat lost from the actuator (10) due to conduction and convection.

Patentansprüche

1. Aufzugsanlage, umfassend:

   eine Aufzugskabine (1), die von Führungsbaugruppen (5) entlang Führungsschienen (15) geführt wird, die in einem Schacht montiert sind;
   mindestens einen elektromagnetischen Aktuator (10), der zwischen der Kabine (1) und jeder Führungsbaugruppe (5) montiert ist; und
   einen Controller (14; 30), der als Reaktion auf erfaßte Schwingungen eine Bestromung der Aktuatoren (10) steuert,
   dadurch gekennzeichnet, daß sie weiterhin folgendes umfaßt: eine Temperaturauswerteeinheit (24), die eine Temperatur (T_n) des Aktuators (10) entfernt bestimmt; und
   einen Begrenzer (25), der einen dem Aktuator (10) zugeführten Strom (I) beschränkt, wenn die bestimmte Temperatur (T_n) des Aktuators (10) eine erste vorbestimmte Temperatur (T_{nL}) übersteigt.

2. Aufzugsanlage nach Anspruch 1, wobei die Temperaturauswerteeinheit (24) ein Register (24a) enthält, das mindestens einen zuvor aufgezeichneten Wert für die Aktuatortemperatur (T_{n-1}) speichert.

3. Aufzugsanlage nach Anspruch 1 oder 2, wobei die Temperaturauswerteeinheit (24) und der Begrenzer (25) in den Controller (14; 30) integriert sind.

4. Aufzugsanlage nach Anspruch 3, wobei der Controller (14; 30) einen auf erfaßte Positionssignale reagierenden

Positionscontroller (22) und einen auf erfaßte Beschleunigungen reagierenden Beschleunigungscontroller (23) enthält und wobei die Ausgabe (I_p; F_p) von dem Positionscontroller (22) mit der Ausgabe (I_a; F_a) von dem Beschleunigungscontroller (23) an einem Summierungspunkt (26) verknüpft wird, um ein Signal (I; F_{lim}) proportional zu dem dem Aktuator (10) gelieferten Strom (I) zu erzeugen.

5. Aufzugsanlage nach Anspruch 4, wobei der Controller (14) ein analoger Controller ist und die Ausgabe von dem Summierungspunkt (26) der dem Aktuator (10) zugeführte Strom (I) ist.

6. Aufzugsanlage nach Anspruch 4, wobei der Controller (30) ein digitaler Controller ist und die Ausgabe von dem Summierungspunkt (26) ein Kraftbefehlssignal (F_{lim}) ist, das einer Leistungseinheit (31) zugeführt wird, die danach den dem Aktuator (10) gelieferten Strom (I) liefert.

7. Aufzugsanlage nach einem der Ansprüche 4 bis 6, wobei die Temperaturauswerteeinheit (24) und der Begrenzer (25) zwischen dem Positionscontroller (22) und dem Summierungspunkt (26) installiert sind und die Temperaturauswerteeinheit (24) die Temperatur (T_n) auf der Basis eines vom Begrenzer (25) ausgegebenen Signals bestimmt.

8. Aufzugsanlage nach einem der Ansprüche 4 bis 6, wobei die Temperaturauswerteeinheit (24) und der Begrenzer (25) zwischen dem Summierungspunkt (26) und dem Aktuator (10) installiert sind und die Temperaturauswerteeinheit (24) die Temperatur (T_n) auf der Basis eines vom Begrenzer (25) ausgegebenen Signals bestimmt.

9. Verfahren zum thermischen Schützen eines zwischen der Kabine (1) und einer Führungsbaugruppe (5) einer Aufzugsanlage montierten elektromagnetischen Aktuators (10) zum Unterdrücken erfaßter Schwingungen, umfassend die folgenden Schritte:

a) entferntes Bestimmen einer Temperatur (T_n) des Aktuators (10) und
b) Einschränken des dann dem Aktuator (10) gelieferten Stroms (I), wenn die bestimmte Temperatur (T_n) des Aktuators (10) eine vorbestimmte Temperatur (T_{nL}) übersteigt.

10. Verfahren nach Anspruch 9, weiterhin umfassend den Schritt des Einschränkens des dem Aktuator (10) gelieferten Stroms (I) auf einen Minimalpegel, wenn die Ist-Temperatur (T_n) des Aktuators (10) eine zweite vorbestimmte Temperatur (T_{nH}) übersteigt.

11. Verfahren nach Anspruch 10, wobei der Minimalpegel derart bestimmt wird, daß im Aktuator (10) aufgrund des Stroms (I_{plim}) abgeführte Energie kleiner oder gleich von dem Aktuator (10) aufgrund von Leitung und Konvektion verlorengegangener Wärme ist.

Revendications

1. Installation d'ascenseur comprenant :

- une cabine d'ascenseur (1) qui est guidée par des ensembles de guidage (5) le long de rails de guidage (15) montés dans une gaine ;
- au moins un actionneur électromagnétique (10) qui est monté entre la cabine (1) et chaque ensemble de guidage (5) ; et
- un régulateur (14 ; 30) qui régule une excitation des actionneurs (10) en réaction aux vibrations détectées,

CARACTERISEE en ce qu'elle comprend aussi une unité d'évaluation de température (24) qui détermine à distance une température (T_n) de l'actionneur (10) ; et un limiteur (25) qui limite un courant (I) fourni à l'actionneur (10) si la température (T_n) déterminée de l'actionneur (10) dépasse une première température prédéterminée (T_{nL}).

2. Installation d'ascenseur selon la revendication 1, dans laquelle l'unité d'évaluation de température (24) comprend un enregistreur (24a) qui stocke au moins une valeur relevée précédemment pour la température d'actionneur (T_{n-1}).

3. Installation d'ascenseur selon la revendication 1 ou 2, dans laquelle l'unité d'évaluation de température (24) et le limiteur (25) sont intégrés dans le régulateur (14 ; 30).

4. Installation d'ascenseur selon la revendication 3, dans laquelle le régulateur (14 ; 30) comprend un régulateur de position (22) qui est sensible aux signaux de position captés, et un régulateur d'accélération (23) qui est sensible aux accélérations captées, et dans laquelle la sortie (I_p ; F_p) du régulateur de position (22) est combinée avec la sortie (I_a ; F_a) du régulateur d'accélération (23) au niveau d'un point de sommation (26), pour produire un signal (I ; F_{lim}) proportionnel au courant (I) fourni à l'actionneur (10).

5. Installation d'ascenseur selon la revendication 4, dans laquelle le régulateur (14) est un régulateur analogique et la sortie du point de sommation (26) est le courant (I) fourni à l'actionneur (10).

6. Installation d'ascenseur selon la revendication 4, dans laquelle le régulateur (30) est un régulateur numérique et la sortie du point de sommation (26) est un signal de commande de force (F_{lim}) qui est transmis à une unité de puissance (31), laquelle fournit ensuite le courant (I) à l'actionneur.

7. Installation d'ascenseur selon l'une quelconque des revendications 4 à 6, dans laquelle l'unité d'évaluation de température (24) et le limiteur (25) sont installés entre le régulateur de position (22) et le point de sommation (26), et l'unité d'évaluation (24) détermine la température (T_n) sur la base d'une sortie de signal du limiteur (25).

8. Installation d'ascenseur selon l'une quelconque des revendications 4 à 6, dans laquelle l'unité d'évaluation de température (24) et le limiteur (25) sont installés entre le point de sommation (26) et l'actionneur (10), et l'unité d'évaluation de température (24) détermine la température (T_n) sur la base d'une sortie de signal du limiteur (25).

9. Méthode pour la protection thermique d'un actionneur électromagnétique (10) qui est monté entre la cabine (1) et un ensemble de guidage (5) d'une installation d'ascenseur pour supprimer les vibrations détectées, comprenant les étapes qui consistent :

a) à déterminer à distance une température (T_n) de l'actionneur (10) ; et
b) à limiter le courant (I) fourni ensuite à l'actionneur (10), si la température (T_n) de l'actionneur qui est déterminée dépasse une température (T_{nL}) prédéterminée.

10. Méthode selon la revendication 9, comprenant également l'étape qui consiste à limiter à un niveau minimal le courant (I) fourni à l'actionneur (10) si la température réelle (T_n) de l'actionneur (10) dépasse une seconde température prédéterminée (T_{nH}).

11. Méthode selon la revendication 10, dans laquelle le niveau minimal est déterminé de telle sorte que l'énergie dissipée dans l'actionneur (10) à cause du courant (I_{plim}) soit inférieure ou égale à la chaleur perdu à partir de l'actionneur (10) à cause de la conduction et de la convexion.

Fig. 1

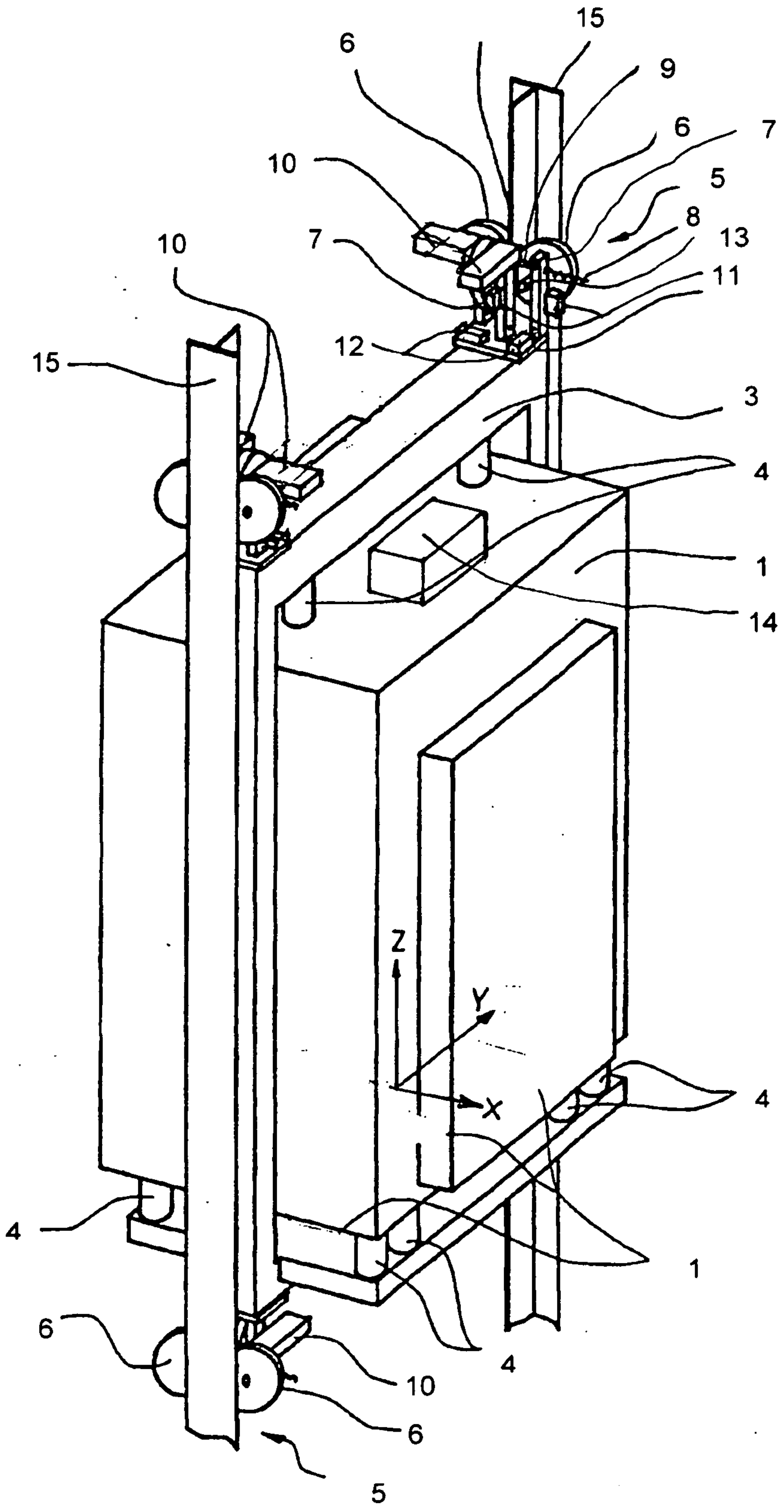


Fig. 2

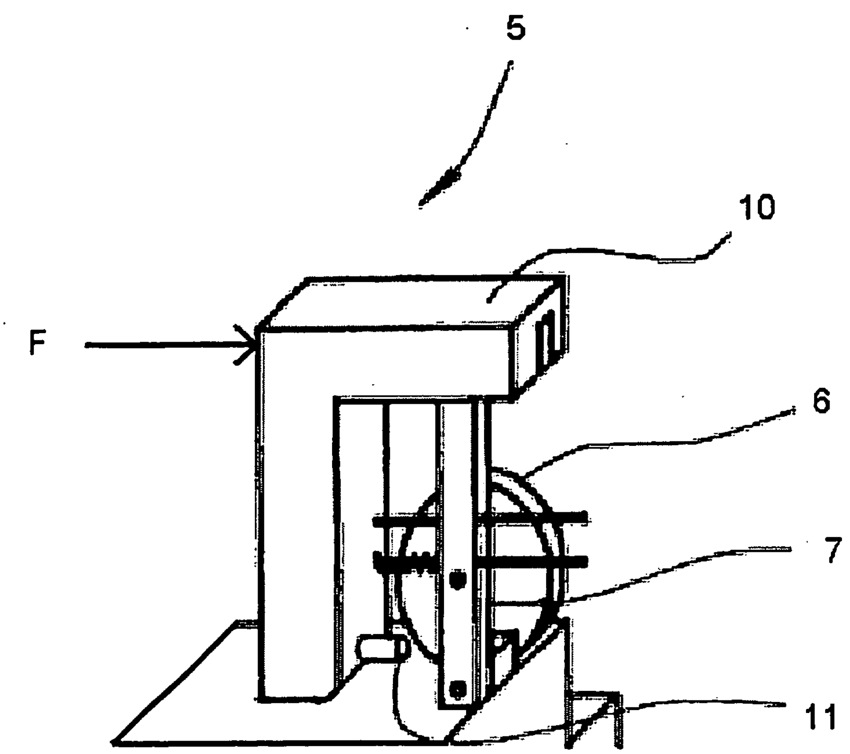


Fig. 3

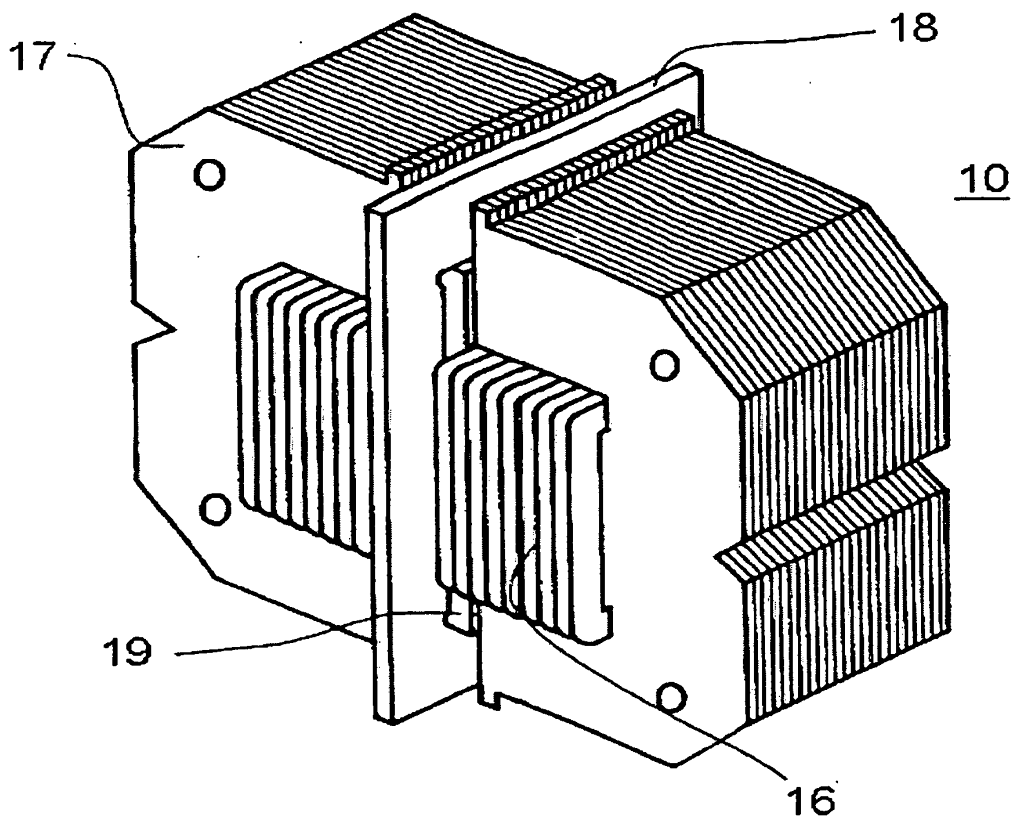


Fig. 4

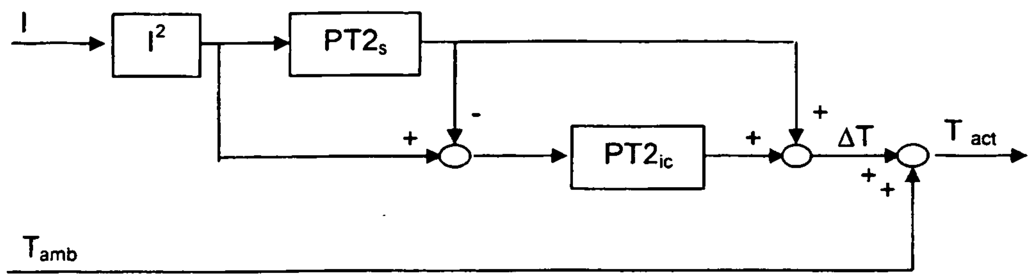


Fig. 5

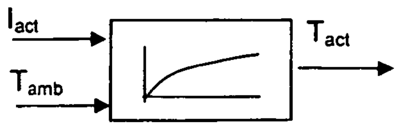
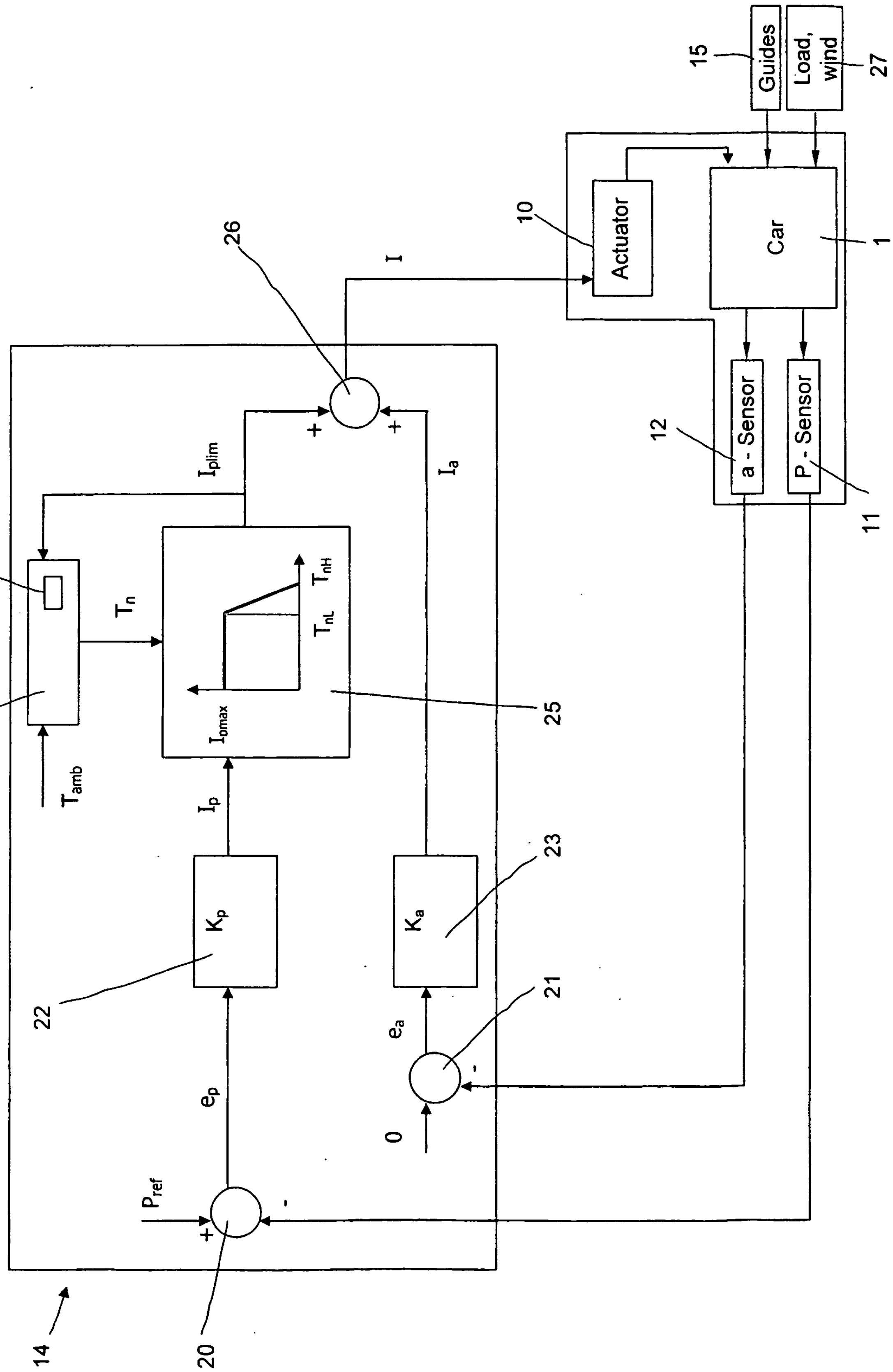


Fig. 6


Guides
Load, wind
Actuator
Car
a - Sensor
P - Sensor
I
I_{plim}
I_a
T_n
T_{nH}
T_{nL}
I_{pmax}
I_p
T_{amb}
K_p
K_a
e_a
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P_{ref}
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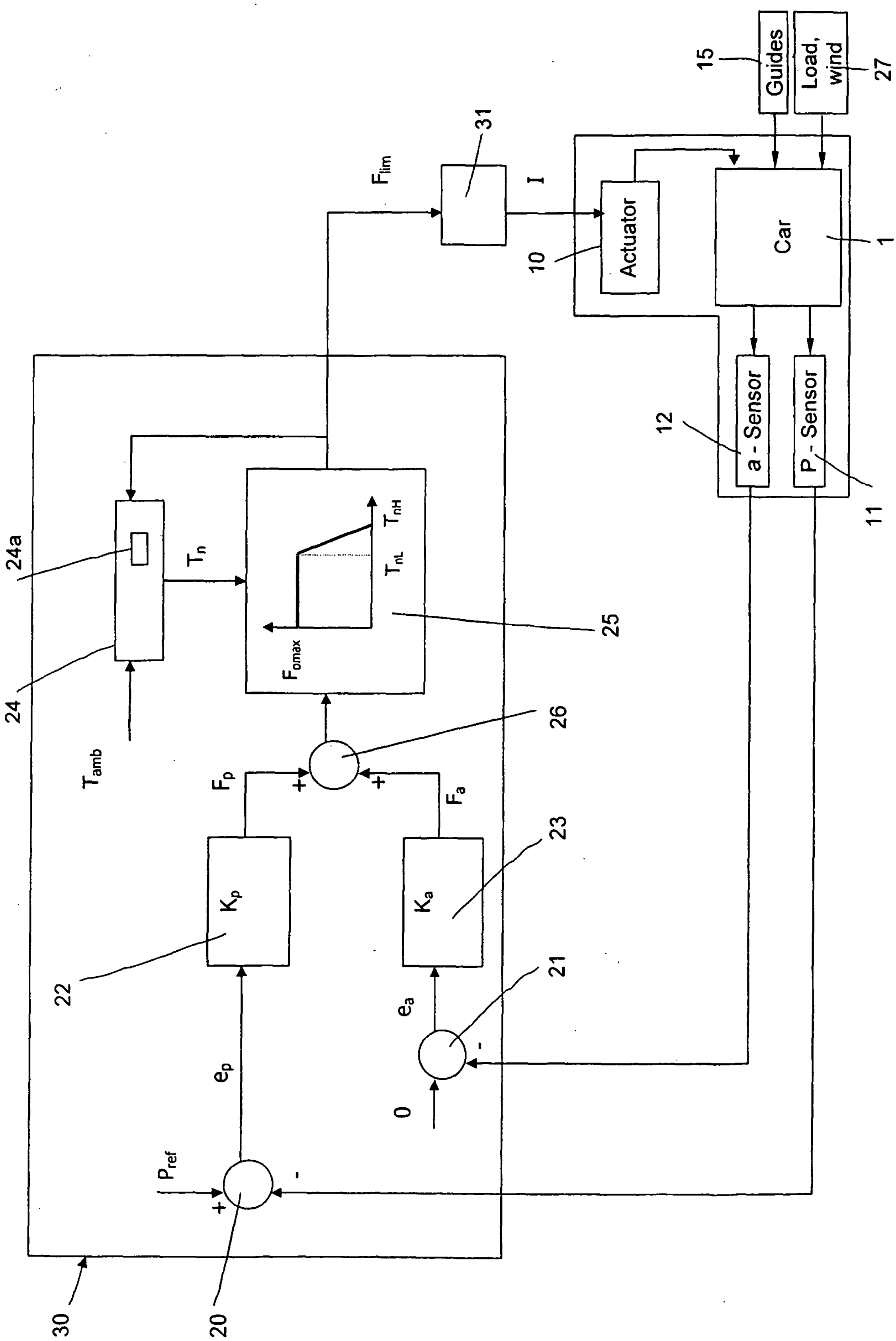
Guides
Load, wind
Car
Actuator
a - Sensor
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T_{nH}
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Fig. 7