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(54) **SUSPENSION AND TRACTION SYSTEM, ELEVATOR USING THE SAME AND FRICTION CONTROL METHOD**

AUFHAENGUNGS- UND TRAKTIONSKONTROLLSYSTEM, AUFZUG MIT SOLCH EINEM SYSTEM SOWIE TRAKTIONSKONTROLLVERFAHREN

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Description

Field of the Art

[0001] The present invention relates to ropes, belts, or other suspension and traction elements used in elevators, overhead cable cars and funicular cars. The invention particularly relates to a suspension and traction element in which the load bearing section is at least partially covered with a sheath, said sheath comprising a paramagnetic polymeric matrix and magnetic particles.

State of the Art

[0002] During normal operation of suspension and traction systems, for example elevators, it is desirable for adhesion between suspension and traction elements and the traction pulleys to be very high, as traction capacity thereby increases. However, there are cases in which minimizing said traction capacity is of interest:

1. To prevent possible winding of the car outside its nominal path, the ropes sliding around the traction pulley is of interest in certain cases. The most well-known case is that mentioned in the standard EN81-1 "Counterweight resting on the buffers". When the car is on the top floor, despite the fact that the traction pulley continues moving in the upward direction of the car, the rope must slide on the pulley so that the car does not go up. Accordingly, in this case it is of interest for adhesion between the traction pulley and the rope to be low so that the rope will slide and thereby prevent accidents.
2. When there is a deflection pulley in the system, alignment of the rope with respect to the grooves of the deflection pulley must be maximum because any fleet angle causes twisting in the rope, which causes unwanted torsional stresses (Figures 1 a and 1 b), especially in the case of ropes covered with a polymer sheath. In practice it is not always possible to completely prevent these deviations. In these cases, as the rope comes into contact with the pulley, it first touches a side of the groove (at a higher or lower point, depending on the fleet angle value) to then, by sliding and twisting, reach the bottom of the groove. Twisting of the rope is unwanted because, if there is twisting, the rope is subjected to stresses for which it has not been designed. As a result, it is advantageous for adhesion between rope and pulley in these cases to be minimum, as explained in EP1657208A1.

[0003] Another problem known in the state of the art is that which occurs in deflection pulleys due to the inequality of stresses between different ropes. This difference in stresses means that the ropes advance in the grooves of the pulley other than tangentially, which can be accentuated due to adhesion between rope and pulley. This phenomenon is particularly undesirable in covered ropes because it causes noise, among other phenomena.
[0004] It is therefore desirable to have systems in which adhesion between suspension and traction elements and pulleys is variable and controllable.
[0005] Magnetorheological materials respond to the application of a magnetic field with a change in its mechanical behavior and they are formed by magnetizable particles in a paramagnetic matrix. This change is due to the magnetic forces generated by interactions between magnetic dipoles caused by the application of an external magnetic field.
[0006] JP H09 210182A is considered to represent the closest prior art discloses a suspension and traction system comprising a traction pulley and a suspension and traction element in the form of a wire rope, the pulley cooperates with an electromagnet capable of producing a variable magnetic field perpendicular to the suspension and traction element.

Object of the Invention

[0007] The object of the present invention is to provide a traction and suspension element the adhesion of which can be actively controlled depending on the type of contact (between suspension or traction element and pulley), area of contact (function of the pulley diameter, geometry of the grooves of the pulley and wrap angle) and on the working conditions of the element (normal operation or winding). To that end, the suspension and traction system of the invention according to claim 1 is provided. Preferably, the proportion of magnetic particles dispersed in said matrix is at least 15%. Preferably, but not necessarily, the particles will be spherical and will have a dimension between 10 and 10^5 nm, and the matrix will be an elastomeric thermoplastic polyurethane matrix. The magnetic particles can be of one or several of the following materials: iron, ferrites, magnetites, garnets, nickel, cobalt, or mixtures thereof. The invention comprises also an elevator and an adhesion control method.

Brief Description of the Drawings

[0008] For the purpose of aiding to better understand the features of the invention according to a preferred practical embodiment thereof, the following description refers to a set of drawings in which the following has been depicted with an illustrative character:

Figure 1 illustrates twisting of a rope in the deflection pulley due to deviations of the rope.
Figure 2 is an implementation of the invention in rope form.
Figure 3 shows different possible sections of the suspension and traction element of the invention.

Detailed Description of the Invention

[0009] As can be seen in Figure 2, the traction and suspension element comprises a load bearing section (1) completely or partially covered with a paramagnetic polymeric material sheath (2) to which magnetic particles are added in a proportion of at least 10% by volume.

[0010] Among polymeric materials, the matrix will be elastomeric because its elasticity allows for an important magnetorheological effect. A TPU (elastomeric thermoplastic polyurethane) matrix is preferably used because it shows good behavior from the point of view of adhesion in rope-pulley systems.

[0011] The load bearing section can include a single wire or a plurality of wires, with the same or different features (material, covering, hardness, rigidity...).

[0012] The particle size is preferably, but not necessarily, between 10 and 10^5 nm. Said particles can be needle-, spherical-, octahedral-, cubic-shaped, or in the form of flakes. In a preferred embodiment, they are preferably spherical-shaped because from the point of view of fatigue of the suspension and traction element this shape shows the best compromise between lifetime and properties.

[0013] Figure 2 shows an implementation in rope form, wherein the sheath surrounds the bearing section. The bearing section is made up of several strands formed by wires. Figure 3 shows other implementations: a rope in which the sheath not only surrounds the bearing section, but is also present between strands, and an implementation in which the suspension and traction element is a belt.

[0014] The suspension and traction element can be manufactured using different processes. The selection will depend on the type of polymeric material used in the matrix:

- Extrusion process with thermoplastic material with magnetic particles.
- Pultrusion process applied to a polymeric matrix with magnetic particles the curing of which is performed with a vulcanizing agent.
- Pultrusion process applied to a polymeric matrix with magnetic particles the curing of which is performed at room temperature.

[0015] The following possibilities exist for the complete system (in reference to ropes, although the same implementations are applicable to suspension and traction elements of any type):

Traction pulley:

[0016] During normal operation of an elevator, it is desirable for there to be good adhesion so that the entire torque of the motor is transmitted to the rope. To that end, a radial magnetic field (with respect to the pulley) will be applied from the inner part of the pulley by means of the use of an electromagnet.

[0017] However, outside the nominal path of the car, low adhesion is required to prevent winding of the car. Electromagnets are placed on the outer part of the pulley along an arc having a length equal to the length of the rope in contact with the pulley in order to control adhesion. The length of rope in contact with the pulley depends on the diameter thereof and on the wrap angle.

Deflection pulley:

[0018] In the case of the deflection pulley, it is always of interest for adhesion to be minimum. The electromagnet will therefore be placed on the outer part of the pulley and will surround the portion of rope in contact with the pulley, such that a magnetic field is applied perpendicular to same (the same configuration as in the case of the traction pulley in winding conditions).

[0019] For both the traction pulley and the deflection pulley, application of a magnetic field greater than 1 mT in the radial direction of the pulley modifies rope-pulley adhesion depending on operating needs.

[0020] Since hardness is a parameter that is much easier to quantify than adhesion is, tests have been conducted in relation to hardness by applying a magnetic field perpendicular to the suspension and traction element from outside the pulley (deflection pulley). Said tests are shown in the following table.

Material	Magnetic field	ShA 1	ShA 2	ShA 3	Mean Sh A
0% particles	0 mT	33	33	34	33.33
15% particles	0 mT	48	48	45	47.00
15% particles	130 mT	55	55	57	55.67
15% particles	0 mT (after removing preceding one)	50	48	48	48.67
15% particles	180 mT	55	57	57	56.33
15% particles	0 mT (after removing preceding one)	50	47	45	47.33

[0021] The tests were conducted with a suspension and traction element without magnetic particles (first row of the table) and then an element according to the invention, with 15% magnetic particles by volume, was used. The hardness measurement according to the Shore A scale was taken three times, obtaining a mean to minimize errors. The matrix used was a WACKER Elastosil® M 4644 silicone consisting of two components: silicone (WACKER Elastosil® M 4644 A) and vulcanizing agent (WACKER Elastosil® M 4644 B). The vulcanizing agent to matrix ratio is 1:10, respectively. This matrix is selected because curing is performed at room temperature, and furthermore, the start of said process is controlled with the vulcanizing agent.

[0022] The magnetic particles used were iron, CIP (Carbonyl Iron Powder), particles having a mean size of 1.27 ± 0.54 μm and spherical shape.

[0023] First, hardness was studied according to the Shore A scale for an element to which no magnetic field (0 mT) was applied. Then a perpendicular field of 130 mT was applied to the element. After removing said field, a measurement was taken again. In a fourth step, a field, this time of 180 mT, was applied again. Finally, the field was removed again and a final measurement was taken. As can be seen, after removing the magnetic field the hardness returns to values that were very close to initial values. Hardness increases with the application of a field. As any person skilled in the art will understand, a change in hardness entails a change in rigidity and adhesion.

Claims

1. Suspension and traction system with a traction and/or deflection pulley and a suspension and traction element with active adhesion control comprising a load bearing section (1) provided with at least one wire and a sheath (2) at least partially covering the bearing section, the sheath comprises a paramagnetic and polymeric material matrix and magnetic particles dispersed in said matrix in a proportion of at least 10% by volume and wherein the pulley or pulleys are provided on their outer and/or inner part with electromagnets capable of producing a variable magnetic field perpendicular to the suspension and traction element along the entire length of the suspension and traction element in contact with the pulley.

2. Suspension and traction system according to claim 1, wherein the magnetic field produced by the electromagnets is at least 1 mT.

3. Suspension and traction system according to claims 1 or 2, wherein the proportion of magnetic particles is at least 15% by volume.

4. Suspension and traction system according to claims 1-3, wherein the particles are spherical.

5. Suspension and traction system according to claims 1-4, wherein the particles have a dimension between 10 and 10^5 nm.

6. Suspension and traction system according to any of the preceding claims, wherein the matrix is an elastomeric thermoplastic polyurethane matrix.

7. Suspension and traction system according to any of the preceding claims, wherein the magnetic particles are of one or several of the following materials: iron, ferrites, magnetites, garnets, nickel, cobalt, or mixtures thereof.

8. Adhesion control method for controlling adhesion to the pulley of a suspension and traction system according to the

preceding claims, wherein a controllable magnetic field is applied perpendicularly to the suspension and traction element.

9. Elevator comprising a suspension and traction system according to any of claims 1-7.

Patentansprüche

1. Aufhängungs- und Traktionssystem mit einer Zug- und/oder Umlenkrolle und einem Aufhänge- und Zugelement mit aktiver Adhäsionskontrolle, umfassend einen Lastlagerabschnitt (1) aufweisend mindestens einen Draht und eine den Lagerabschnitt zumindest teilweise bedeckende Hülle (2), wobei die Hülle eine paramagnetische und polymere Materialmatrix und magnetische Partikel, die in der Matrix in einem Anteil von mindestens 10 Vol.-% verteilt sind, umfasst, und wobei die Rolle oder Rollen an ihrem Außen- und / oder Innenteil mit Elektromagneten versehen sind, die ein variables Magnetfeld erzeugen können, das senkrecht zum Aufhänge- und Zugelement entlang der gesamten Länge des Aufhänge- und Zugelements mit der Rolle in Berührung steht.

2. Aufhängungs- und Traktionssystem gemäß Anspruch 1, wobei das durch die Elektromagneten erzeugte Magnetfeld mindestens 1 mT ist.

3. Aufhängungs- und Traktionssystem gemäß Anspruch 1 oder 2, wobei der Anteil der magnetischen Partikel mindestens 15 Vol.-% beträgt.

4. Aufhängungs- und Traktionssystem gemäß Anspruch 1 bis 3, wobei die Partikel kugelförmig sind.

5. Aufhängungs- und Traktionssystem gemäß Anspruch 1 bis 4, wobei die Partikel eine Abmessung zwischen 10 und 10^5 nm aufweisen.

6. Aufhängungs- und Traktionssystem gemäß einem der vorhergehenden Ansprüche, wobei die Matrix eine elastomere thermoplastische Polyurethanmatrix ist.

7. Aufhängungs- und Traktionssystem gemäß einem der vorhergehenden Ansprüche, wobei die magnetischen Partikel aus einem oder mehreren der folgenden Materialien bestehen: Eisen, Ferrite, Magnetite, Granate, Nickel, Kobalt oder Mischungen davon.

8. Adhäsionskontrollverfahren zur Steuerung der Adhäsion eines Aufhängungsund Traktionssystems gemäß den vorhergehenden Ansprüchen zu der Rolle, wobei ein steuerbares Magnetfeld senkrecht zum Aufhänge- und Zugelement aufgebracht wird.

9. Aufzug mit einem Aufhängungs- und Traktionssystem nach einem der Ansprüche 1-7.

Revendications

1. Système de suspension et de traction comprenant une poulie de traction et/ou de déflection et un élément de suspension et de traction, ayant un contrôle d'adhérence actif, comprenant une partie (1) porteuse de charge pourvue d'au moins un fil et une gaine (2) recouvrant au moins partiellement la partie porteuse, la gaine comprenant une matrice en matière paramagnétique et polymère et des particules magnétiques dispersées dans la matrice en une proportion d'au moins 10% en volume et dans lequel la poulie ou les poulies sont pourvues, sur leur partie extérieure et/ou intérieure, d'électroaimants aptes à produire un champ magnétique variable perpendiculaire à l'élément de suspension et de traction le long de toute la longueur de l'élément de suspension et de traction en contact avec la poulie.

2. Système de suspension et de traction suivant la revendication 1, dans lequel le champ magnétique produit par les électroaimants est d'au moins 1 Mt.

3. Système de suspension et de traction suivant la revendication 1 ou 2, dans lequel la proportion de particules magnétiques est d'au moins 15% en volume.

4. Système de suspension et de traction suivant l'une des revendications 1 à 3, dans lequel les particules sont sphériques.

5. Système de suspension et de traction suivant l'une des revendications 1 à 4, dans lequel les particules ont une dimension comprise entre 10 et 10^5 nm.

6. Système de suspension et de traction suivant l'une quelconque des revendications précédentes, dans lequel la matrice est une matrice élastomère thermoplastique de polyuréthane.

7. Système de suspension et de traction suivant l'une quelconque des revendications précédentes, dans lequel les particules magnétiques sont en l'une ou en plusieurs des matières suivantes : fer, ferrites, magnétites, grenats, nickel, cobalt ou leurs mélanges.

8. Procédé pour se rendre maître de l'adhérence de la poulie d'un système de suspension et de traction suivant les revendications précédentes, dans lequel on applique, perpendiculairement à la suspension à l'élément de traction, un champ magnétique réglable.

9. Ascenseur comprenant un système de suspension et de traction suivant l'une quelconque des revendications 1 à 7.

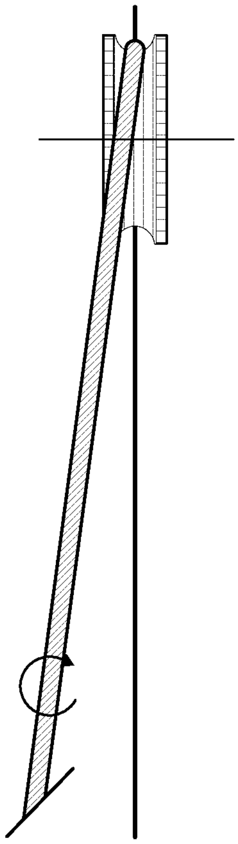

FIG. 1a

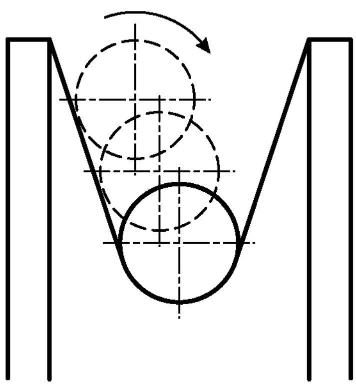

FIG. 1b

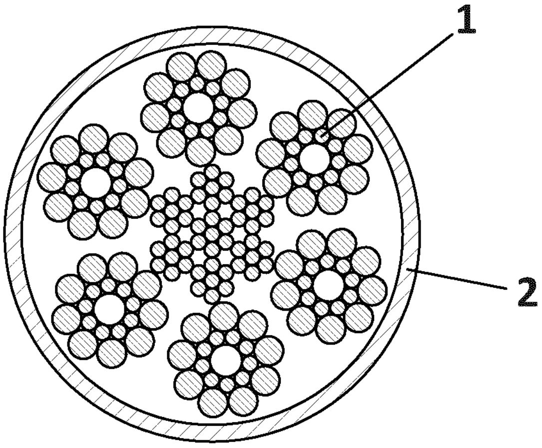

FIG. 2

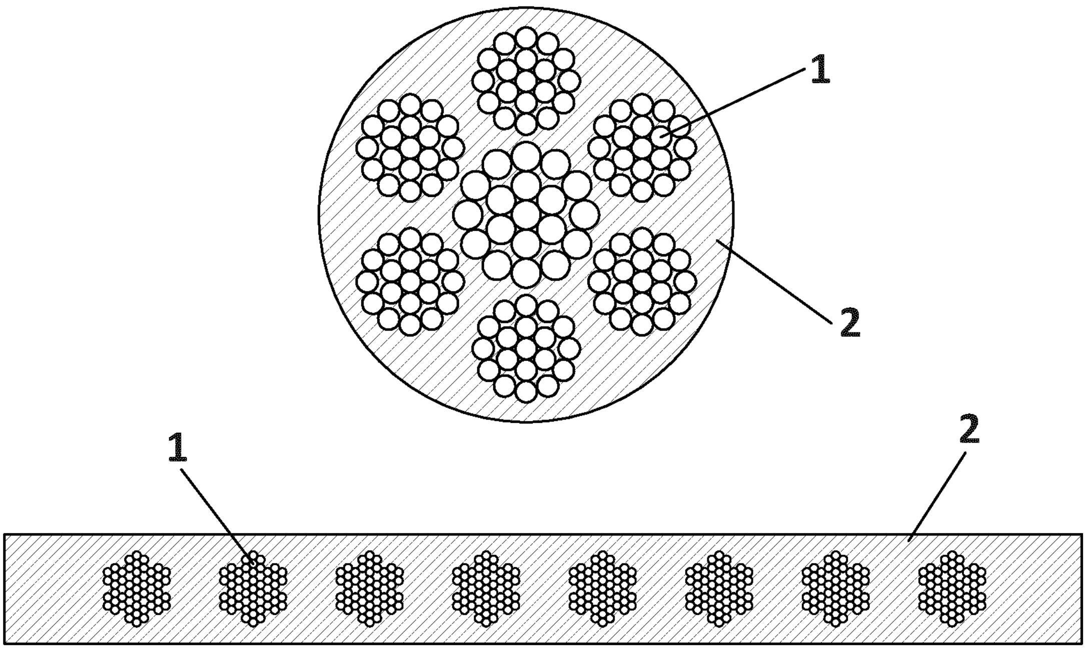

FIG. 3

REFERENCES CITED IN THE DESCRIPTION

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- JP H09210182 A **[0006]**