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Description

Object of the Invention

[0001] A first aspect of the present invention relates to a rope for elevator apparatuses and a second aspect relates to an elevator apparatus comprising said rope, said two aspects having application in the field of lifting, and more specifically in the elevator industry, allowing achieving a rope, the flexural rigidity of which is lowered, that can be used with sheaves having a small diameter with a deterioration level of the rope less than that of the currently existing ropes, which allows extending their useful life.

Background of the Invention

[0002] In the field of lifting, either in the elevator sector or in sectors such as that of cranes, the use of different types of ropes, equally used for different purposes, is known.

[0003] Ropes are used in the lifting industry, among other applications, as suspension elements, i.e., for supporting or hanging loads therefrom, it being frequent for this application that the rope passes through one or several sheaves.

[0004] At least one of said sheaves is usually driven by means of an engine, therefore the rope, in addition to fulfilling the suspension function or application, also fulfills a function in the means for driving the elevator, acting as an element transmitting the torque from the sheave in a traction force which is used for moving the loads comprised in the lifting system.

[0005] Other types of applications which have ropes in lifting systems comprise their use in safety systems, being used to join or link different components of said safety systems, the passage of said ropes through sheaves being equally required in these cases.

[0006] In any case, in all previously mentioned applications, during their passage through a sheave the rope passes from a straight position to a curved position, returning to the straight position when said rope leaves the sheave again, which causes the rope to be subjected to bending stresses, in addition to the tensile stresses due to the weight of the different loads.

[0007] It is also known in the lifting sector that throughout its useful life the rope repeatedly passes a great number of times through the sheave, causing the previously mentioned change between the straight configuration and the curved configuration, and vice versa, whereby the internal stresses occurring in the rope and those occurring between the rope and sheave give rise to mechanical fatigue and wear phenomena both outside and inside the ropes, which over time cause a deterioration of the rope, requiring its replacement.

[0008] In addition to affecting the safety of the lifting systems and means, all these phenomena have to be taken into consideration when designing the elements

and components of an elevator, which implies an increase in the costs of said elevator, for which reason the lifting industry has made several attempts to reduce the effect of these phenomena, among which there is a trend to reduce the diameter of the sheaves and maintain a safety ratio between the diameter of a sheave D and the diameter of a rope d , such that said effects are reduced by means of fulfilling the following expression:

$$D/d \geq 40$$

[0009] With regard to fatigue and wear effects, the use of lubricants is one factor which reduces said effects, although said reduction involves a decrease of the traction capacity of the rope-sheave system, which is counterproductive.

[0010] Ropes coated with polymer materials have been recently used, whereby the coefficient of friction between the rope and the sheave is increased at the same time as the wear effect is decreased. These coatings having implied a considerable improvement in the useful life of these types of elements. For example, in European patents EP 1273695, EP 1517850 and EP 1597183 coated ropes for their use in lifting systems are described.

[0011] In this sense, the recent use of flat ropes, also called belts, implies another significant advancement in suspension and traction means for lifts. European patent EP 1023236 and PCT patent applications WO 99043885 and WO 00037738 describe these types of ropes as suspension and traction systems which have a width or length a significantly greater than their thickness or edge b .

[0012] The advantage which these flat ropes have is that for a single suspension and traction capacity they have a flexural rigidity less than that of a conventional rope. This is due to the fact that the traction capacity of these elements mainly depends on the area of their cross-section A_t , which can be represented by means of the following expression:

$$A_t = a \cdot b$$

[0013] Where a is the width of the rope and b is its thickness.

[0014] In addition the flexural rigidity of the rope depends on the moment of inertia I_x of the cross-section A_t with respect to an x -axis, coinciding with the neutral axis of said cross-section A_t , i.e., in the situation in which the bending occurs as a result of the passage of the rope through a sheave, the x -axis is an axis parallel to the rotating shaft of said sheave, therefore the moment of inertia I_x is obtained with the following expression:

$$I_x = \frac{a \cdot b^3}{12}$$

[0015] It turns out that if the area of a cross-section is kept constant, the following expression is obtained:

$$a = \frac{A_t}{b}$$

[0016] If this formula is replaced in the formula for flexural rigidity, the following expression is obtained:

$$I_x = \frac{A_t \cdot b^2}{12}$$

[0017] This formula indicates that for a constant area, the flexural rigidity of a longitudinal traction element of cross-section A_t decreases when its edge or thickness b decreases and therefore its width a increases.

[0018] A reasoning similar to that previously explained can be carried out without difficulty for the stresses caused inside the rope as a result of the bending upon its passage through the sheave, which are the stresses causing a good part of the deterioration of the traction element, whereby it is concluded that the use of traction elements with a flat shape or configuration is beneficial for achieving more economical, reliable and safer lifting systems.

[0019] However, the use of belts in lifting systems can give rise to several problems and drawbacks.

[0020] First of all, reducing the flexural rigidity of the rope causes vibrations to be generated in the direction perpendicular to the smaller dimension of the belt, given that mechanical systems generally have more tendency to vibrate the more flexible they are, unless elements are incorporated which provide damping, and tend to reduce or absorb said vibrations over time.

[0021] It is also known that the greater the a/b ratio in a section is, i.e., the ratio between the width a of the rope and its thickness b , the less the torsional rigidity is compared with more compact sections, therefore the torsional vibration is also higher in these sections.

[0022] Furthermore, in round sections the torsional vibrations can go unnoticed due to the polar symmetry of the section. In this same sense, some geometric configurations of lifting installations induce a rotational movement on their own shaft of the rope as the loads move vertically. If the section of the rope is circular, the rope can rotate in its contact with the sheave, which rotation allows it to adapt to the configuration of the installation. In ropes with non-circular sections said rotation is not possible and the rope or belt is confined by the sheave, causing additional stresses, generally torsional stresses.

[0023] In addition, the use of irregular geometries, as reflected for example in PCT patent application WO

2002064883, different from a circular configuration, gives rise to permanent deformations of different types which do not occur in the case of circular sections, and even if they do occur, they go completely unnoticed. The causes generating or causing said permanent deformations are similar to those set forth for the case of vibrations. These permanent deformations are often due to several reasons, such as manufacturing processes, storage processes, assembly operations or the actual way of using the belts.

[0024] Currently belts or flat ropes with a configuration different from the circular configuration, can only be supported on the channels of the sheave only on one of their two faces, which further restricts the type of geometric configuration which can be adopted by an installation using these types of traction and suspension means. With regard to this requirement, which is inherent to the configuration of a belt, there is the drawback that belts usually have constructive defects or manufacturing errors preventing their correct use, such as not being flat or parallelism errors between the faces.

[0025] United States Patent No. US-5,566,786-A discloses a synthetic fiber cable as suspension means for lifts, with a synthetic material sheathing, surrounding an outermost cable strand layer. The cable strands are twisted or laid up of individual aramide fibers, wherein a friction-reducing intermediate sheathing is interposed between the outermost strand layer and the inner strand layer, and in order to obtain an almost circularly shaped strand layer and increase the degree of filling of the strands, any gaps therein is augmented by filler strands.

[0026] On the other hand, European Patent Application No. EP-1748104-A1 discloses a belt for a speed governor for elevators, which cluster at least two metallic ropes comprising high-strength steel wires completely coated with a polymeric material. The sheaves designed for said belt have a low aggression and reduced diameter and high level of adherence, determining a high coefficient of friction between the belt and the sheave, and a high strength against fatigue due to bending and wear.

Description of the Invention

[0027] A first aspect of the present invention relates to a rope for elevator apparatuses the flexural rigidity of which is less than that of the currently existing ropes, allowing its use with sheaves having a reduced diameter, which achieves maintaining a deterioration level less than that of said conventional ropes during an extended useful life, with the subsequent increase in safety and savings in the costs of maintaining the elevator apparatus.

[0028] The rope for elevator apparatuses proposed by the invention comprises at least two linear resistant elements parallel to one another along the entire length of the rope.

[0029] Said resistant elements provide rigidity to the rope and are located on a central axis of a cross-section

A_t of the rope. Each resistant element has a cross-section a_t , such that the cross-sections a_t of the resistant elements are located in an alignment.

[0030] The cross-section A_t of the rope of the invention has a width a and a thickness b , the ratio between said width a and said thickness b being substantially equal to one along the entire rope.

[0031] Magnitude or width a of the section of the rope is understood in the description as the measurement of the rope at an axis passing through the geometric centers of the resistant elements inserted in the rope, whereas the magnitude or thickness b of the section of the rope is understood in the description as the measurement of the rope at an axis perpendicular to the axis traversing the geometric centers of the resistant elements inserted in the rope, and which in turn passes through the geometric center of the section of the rope.

[0032] In the present description of the invention it is understood that the term substantially relates to the ratio between the width a divided by the thickness b of the rope which is not less than 0.8 or greater than 1.2, therefore it is obvious that with these dimensional ranges small variations are included in said aspect ratio due to the fact for example that the rope is in a load and/or curved position due to the effect of its passage through a sheave.

[0033] It is provided in a not claimed embodiment that the rope comprises at least two alignments of cross-sections a_t of resistant elements aligned close to the central axis of the cross-section A_t of the rope.

[0034] The resistant elements provide most of the rigidity to the rope and are located in the cross-section of the rope in positions close to the central axis, preferably coinciding with a neutral horizontal plane of bending of the rope when said rope is subjected to bending as a consequence of its passage through a sheave.

[0035] In the case in which the resistant elements of the rope, as well as its cross-section A_t , have a symmetrical arrangement, the neutral horizontal plane of bending of the rope will coincide with the horizontal geometrical plane of symmetry thereof.

[0036] When the rope object of the invention undergoes bending stresses due to its passage through a sheave or through any other means, and due to the fact that its rigidity is much lower in the plane defined by the resistant elements, the rope will bend taking the central axis around which said resistant elements are distributed as a neutral axis, whereby the axial deformation, i.e., the compression and/or tensile stresses to which the resistant elements are subjected will be minimal, therefore the bending stresses in the rope are reduced to a great extent.

[0037] In the event that the resistant elements are formed by a plurality of intertwined wires, the relative movement between said wires, an effect causing internal abrasion phenomena, is equally reduced.

[0038] Therefore, due to the fact that these two factors are those generating fatigue and wear, the degradation of the rope of the invention is greatly reduced, which al-

lows extending the useful life of the rope, maintaining the required safety levels during such useful life.

[0039] The possibility is also provided that the rope of the invention comprises at least one linear damping element, having a cross-section a'_t which is located in an area of the cross-section A_t of the rope which is away from the central axis of said cross-section A_t of the rope, having a function and purpose different from that of the resistant elements consisting of damping the damaging vibrations occurring in the thin configuration of said resistant elements, as previously explained.

[0040] It is likewise provided that the rope comprises at least two damping elements located on both sides of the central axis of the cross-section A_t of the rope, whereby it would have a symmetrical rope configuration with respect to the central axis.

[0041] As in the case of the arrangement of the resistant elements, the possibility is provided that the rope comprises a plurality of damping elements the cross-sections a'_t of which are aligned parallel to the central axis of the cross-section A_t of the rope, therefore being arranged parallel to the cross-sections a_t of the resistant elements, all of them being parallel to a rotating shaft of a sheave through which the rope passes.

[0042] This set of damping elements, which also occupy the entire length of the rope, but which are located or distributed in areas of the section away from the central axis, is preferably constructed with geometric configurations and/or materials providing little rigidity but having a high internal dissipation or damping capacity due to friction.

[0043] The damping elements can be formed using polymer materials, or any other material having a high internal damping coefficient. It is provided that the damping elements are made with twisted wires, such that the energy is dissipated due to rubbing the wires with each other.

[0044] Given their arrangement, the damping elements are located in areas away from the neutral horizontal plane of bending of the rope, i.e., the central axis.

[0045] When the rope is subjected to bending due to its passage through a sheave, the axial deformation occurring in the damping elements is much higher than the case of the resistant elements due to the fact that they are further from the central axis, i.e., from the neutral axis of the cross-section A_t of the rope, whereby the energy dissipated by said damping elements is greater, such that the vibrations caused by the dynamics of the installation are damped in less time, i.e., quicker.

[0046] It is provided as a possibility that the rope of the invention comprises a sheath containing the resistant elements, said sheath being made of a material having a high coefficient of friction, said sheath being configured to be in contact with at least one sheave, a traction or deviation sheave. It is provided that the resistant elements are completely or partially embedded in said sheath, being able to even penetrate between said resistant elements, or they are simply contained or encap-

sulated therein.

[0047] It is likewise provided that the rope comprises a sheath containing the resistant elements and said at least one damping element, the sheath being made of a material having a high coefficient of friction, and being configured to be in contact with at least one sheave.

[0048] As in the case of the resistant elements, the sheath can contain or encapsulate the resistant elements and the damping elements, or penetrate between said damping and resistant elements, in which they would be completely or partially embedded.

[0049] The sheath, or coating, can be made with a polymer material, or any other material with a low rigidity level and a high coefficient of friction with the sheave, in addition to a high level of adherence with respect to the resistant elements and to the damping elements.

[0050] It is provided that the sheath is made with polymer materials similar to those used in belts or ropes which are currently used in lifting installations. This sheath has a dual function, first of all it is useful for joining all elements comprised by the rope, and secondly it is useful for ensuring a good grip between the rope and a sheave. The use of this type of coating with a high coefficient of friction ensures that the rope is not going to slide through the sheave. This allows using the sheave with non-aggressive grooves, such as grooves with a U-shaped section, such that the damage produced in the rope by contact with the sheave is considerably reduced.

[0051] The materials which are considered for making the sheath are natural polymers, such as rubber or resins, synthetic polymers, such as nylon, as well as elastomers, plastics or fibers, i.e., all types of either thermoplastic or thermosetting polymers.

[0052] According to a preferred embodiment, the sheath is made of polyurethane, this material being the most used as a coating, being able to incorporate additive elements and/or agents for the purpose of providing it with certain properties, such as for example a fire-resistant or fire-retarding character.

[0053] It is likewise provided that the damping elements are made of the same material as the sheath, i.e., the sheath is made of the actual material of the damping elements.

[0054] In addition to covering all the elements comprised in the rope, the sheath is useful for keeping them in their relative position in the section of the rope. Furthermore, the sheath provides adherence so that all elements of the rope move in an integral manner both longitudinal and transversally. Finally, this sheath acts as an interface between the elements of the rope and the sheave, providing adherence between the rope object of the invention and the sheave and homogenizing the contact stresses which could occur between said rope and said sheave.

[0055] The cross-sections a_i of the resistant elements are preferably operatively spaced from one another in the cross-section A_t of the rope, i.e., having a relative distance between the centers of contiguous elements

which is comprised between 1.75 mm and 8 mm, although it can be outside said range, being related to the transverse dimensions or the diameter of said resistant elements.

5 **[0056]** By way of an example, for a rope comprising three resistant elements, the diameters of each of the resistant elements being 2 mm, a minimum breaking load (MBL) value of approximately 12000 N is obtained. In the event that the resistant elements have a diameter of 2.5 mm, a minimum breaking load (MBL) value of approximately 19000 N is obtained. For resistant elements having a diameter of 3 mm, a minimum breaking load (MBL) value of approximately 27000 N is obtained.

10 **[0057]** The possibility is provided that the cross-section A_t has any configuration, provided that it keeps the previously defined ratio between the width a and the thickness b , being able to be circular, in which case the outer geometry of the rope will be circular, or the cross-section A_t of the rope is not circular.

15 **[0058]** In the event that the cross-section A_t of the rope is not circular, said cross-section A_t is configured to be housed in a groove of a sheave, the cross-section A_t having a shape complementary to that of said groove, the central axis being in a position parallel to a rotating shaft of the sheave, i.e., parallel to a neutral bending axis of the cross-section A_t of the rope and parallel to the direction of the width a of the rope.

20 **[0059]** With regard to the geometry of the rope, it is necessary to consider that since there is a great different between the bending moments of inertia of each axis of the cross-section A_t of the rope, this causes the rope to always bend along one plane, and this effect always determines the position of the rope upon its passage through a sheave.

25 **[0060]** As has been previously mentioned, the possibility of using ropes with a cross-section different from the circular one, is subject to the fact that the width a of the cross-section A_t of the rope is similar or of the same order of magnitude as the edge or thickness b and to the fact that the resistant elements are located around the entire central axis or neutral axis, and in the event of comprising damping elements, these are placed in areas away from said central axis. The main reasons for using these alternative sections are improving the uniformity of the thickness of the layer which is around the damping and resistant elements, which allows working with grooves different from semicircular grooves, adapting to different configurations of sheaves and grooves. The use of grooves different from semicircular grooves further ensures that the rope will not torsionally rotate upon its passage through said grooves. Furthermore, the use of non-circular ropes allows an operator to visually check during the installation of the rope that the rope is not twisted at any of the pulling sections between sheaves.

30 **[0061]** According to a preferred embodiment, the resistant elements comprise steel wires preferably having a strength of not less than 2000 N/mm² and a diameter of less than 0.5 mm. Said steel wires can be twisted,

forming strands, the resistant elements can likewise comprise twisted ropes with strands.

[0062] In addition, it is provided that the resistant elements comprise wires made of synthetic material, which can be equally twisted, forming strands, providing the possibility that the resistant elements comprise twisted ropes with strands of wires made of synthetic material, which can consist of aramid fibers, preferably Kevlar.

[0063] With regard to the damping elements, it is provided that they are made of polymer material, both natural and synthetic, being able to be any plastic material, elastomer, rubber, neoprene or resin, provided that it fulfills the condition of damping and resisting compression without undergoing excessive deformation.

[0064] The possibility is provided that the rope comprises a visual mark configured to allow identifying the position of the central axis of the cross-section A_t of the rope at any time from outside, for the purpose of allowing identifying the arrangement of the resistant elements and the damping elements during the operations for assembling the rope for a correct positioning thereof in a sheave.

[0065] A visual check that the rope is not twisted in any of the sections for pulling between sheaves is thus allowed. Said visual mark can consist of a longitudinal mark in an outer visible part of the rope, so that the person assembling it, ensures that the rope is not twisted after the assembly process. The visual mark is equally useful for checking that it has been correctly assembled and the rope is supported in the groove of the sheave in the correct position.

[0066] A second aspect of the invention relates to an elevator apparatus comprising at least one rope such as any of those previously described, such that said rope is in contact with a traction sheave, the central axis of the rope being located in a position parallel to the direction of the width a of the rope and parallel to a rotating shaft of said sheave 5, i.e., parallel to a neutral bending axis of the cross-section A_t of the rope when said rope is in contact with a sheave.

[0067] The possibility is provided that the traction sheave of the elevator apparatus of the invention has a pitch diameter of less than 160 mm.

[0068] In the case of a gear, pitch diameter is understood to be the diameter of a circumference which would define a surface on which said gear would run without sliding. In the case of the sheave of the elevator apparatus of the invention, pitch diameter is understood to be the distance between the groove centers of the sheave, passing of course through the center of said sheave.

[0069] The possibility is likewise provided that the pitch diameter of the traction sheave is less than 40 times the diameter of a circle completely circumscribing the resistant elements of the rope.

[0070] Obviously the rope comprised in the elevator apparatus of the invention, which the first aspect of the invention relates to, can be a suspension and traction rope or a speed governing rope of the lifting system.

Description of the Drawings

[0071] To complement the description being made and for the purpose of aiding to better understand the features of the invention according to a preferred practical embodiment thereof, a set of drawings is attached as an integral part of said description, in which the following has been shown with an illustrative and non-limiting character:

Figure 1 shows a cross-section of an embodiment with a circular section of the rope of the invention, in which the rope has three resistant elements located on the central axis and two damping elements located at points away from said central axis.

Figure 2 shows a cross-section of a not claimed embodiment of the rope comprising a plurality of alignments both of resistant elements, located near the central axis, and dampers, away from said central axis.

Figure 3 shows a cross-section of another variant of the embodiment with a rhomboid section of the rope proposed by the invention.

Figure 4 shows a cross-section of another variant of the embodiment of the rope of the invention in this case with a cross-shaped section, in which it can be seen how the thickness of an outer layer of the sheath is more constant than in the variants shown in the previous figures.

Preferred Embodiment of the Invention

[0072] In view of the indicated figures it can be observed how in one of the possible embodiments of the invention, a first aspect thereof relates to a rope for elevator apparatuses comprising at least two linear resistant metal elements (1) parallel to one another along the entire length of the rope.

[0073] According to a preferred embodiment of the invention, shown in Figure 1, the rope comprises three resistant elements (1) located on a central axis (4) of a circular cross-section A_t of the rope.

[0074] The resistant elements (1) are formed by a plurality of intertwined steel wires having a strength of not less than 2000 N/mm² and a diameter of less than 0.5 mm.

[0075] Each resistant element (1) has a cross-section a_t , such that the cross-sections a_t of the resistant elements (1) are aligned on said central axis (4) of the rope.

[0076] The cross-section A_t of the rope of the invention has a width a and a thickness b , the ratio between said width a and said thickness b being substantially equal to one, along the entire rope.

[0077] Magnitude or width a of the section of the rope is understood in the description as the measurement of the rope at an axis passing through the geometric centers of the resistant elements inserted in the rope, whereas the magnitude or thickness b of the section of the rope

is understood in the description as the measurement of the rope at an axis perpendicular to the axis traversing the geometric centers of the resistant elements inserted in the rope, and which in turn passes through the geometric center of the section of the rope.

[0078] The figures attached to the following description specify which is the magnitude a and the magnitude b of each of the ropes which will be referenced in the mentioned invention.

[0079] According to the preferred embodiment shown in Figure 1, the rope comprises two linear damping elements (2) made of polymer material, symmetrically arranged one on each side of the central axis (4), each of which has a cross-section a_t which is located in an area of the cross-section A_t of the rope which is away from the central axis (4) of said cross-section A_t of the rope.

[0080] The rope comprises a sheath (3) made of polyurethane completely embedding the resistant elements (1) and the damping elements (2), said sheath (3) being configured to be in contact with a traction sheave (5).

[0081] The cross-sections (a_t) of the resistant elements (1) are operatively spaced from one another in the cross-section (A_t) of the rope.

[0082] The rope likewise comprises a visual mark, not depicted, which is configured in order to allow identifying the position of the central axis (4) of the cross-section A_t of the rope at any time from outside for the purpose of allowing identifying the arrangement of the resistant elements (1) and the damping elements (2) during the operations for assembling the rope for a correct positioning thereof in a traction sheave (5).

[0083] According to the not claimed variant of the embodiment shown in Figure 2, the rope has a circular cross-section A_t and comprises an alignment of cross-sections a_t of resistant elements (1) aligned on the central axis (4) and two other alignments of cross-sections a_t of resistant elements (1) aligned close to said central axis (4) of the cross-section A_t of the rope.

[0084] The rope comprises a plurality of damping elements (2) the cross-sections a_t of which are aligned parallel to the central axis (4) of the cross-section A_t of the rope, therefore being arranged parallel to the cross-sections a_t of the resistant elements (1).

[0085] In addition, according to the variants of the preferred embodiment shown in Figures 3 and 4, the cross-section A_t of the rope has non-circular configurations, being rhomboid and cross-shaped respectively in the depicted sheaths.

[0086] In these cases the cross-section A_t is configured to be housed in a groove (6) of the sheave (5), the cross-section A_t having a shape complementary to that of said groove (6), the central axis (4) being in a position parallel to a rotating shaft of the sheave (5), i.e., parallel to a neutral bending axis of the cross-section A_t of the rope and parallel to the direction of the width a of the rope.

[0087] A second aspect of the invention relates to an elevator apparatus comprising a rope such as any of those previously described, such that said rope is in con-

tact with a traction sheave (5), the central axis (4) of the rope being located in a position parallel to the direction of the width (a) of the rope and parallel to a rotating shaft of said sheave (5).

5 [0088] The traction sheave (5) of the elevator apparatus of the invention has a pitch diameter less than 40 times the diameter of a circle completely circumscribing the resistant elements (1) of the rope.

10 [0089] In view of this description and set of figures, a person skilled in the art could understand that the embodiments of the invention which has been described can be combined in multiple ways within the object of the invention. The invention has been described according to several preferred embodiments thereof, but for a person skilled in the art it will be obvious that multiple variations can be introduced in said preferred embodiments without departing from the object of the claimed invention.

20 Claims

1. Elevator apparatus comprising at least one rope configured to be in contact with a traction sheave (5), wherein said at least one rope comprises at least two linear resistant elements (1), **characterized in that** all of the resistant elements (1) are parallel along the entire length of the rope and located on a central axis (4) of a cross-section A_t of the rope, wherein all of the resistant elements (1) have cross-sections a_t located in an alignment, said cross-section A_t having a width a and a thickness b , the ratio between said width a and said thickness b being substantially equal to one.
2. Elevator apparatus according to claim 1, wherein at least one rope comprises at least one linear damping element (2) having a cross-section a_t which is located in an area of the cross-section A_t of the rope which is away from the central axis (4) of said cross-section A_t of the rope.
3. Elevator apparatus according to claim 2, wherein at least one rope comprises at least two damping elements (2) located on both sides of the central axis (4) of the cross-section A_t of the rope.
4. Elevator apparatus according to any of the previous claims, wherein at least one rope comprises a sheath (3) containing the resistant elements (1), said sheath (3) being made of a material which has a high coefficient of friction, said sheath (3) being configured to be in contact with at least one sheave (5).
5. Elevator apparatus according to any of claims 2 and 3, wherein at least one rope comprises a sheath (3) containing the resistant elements (1) and said at least one damping element (2), said sheath (3) being

made of a material having a high coefficient of friction, said sheath (3) being configured to be in contact with at least one sheave (5).

6. Elevator apparatus according to any of the previous claims, wherein the cross-sections a_t of the resistant elements (1) are operatively spaced from one another in the cross-section A_t of a rope or in contact. 5
7. Elevator apparatus according to any of the previous claims, wherein the cross-section A_t of at least one rope is circular. 10
8. Elevator apparatus according to any of claims 1 to 6 wherein cross-section A_t of at least one rope is not circular, said cross-section A_t being configured to be housed in a groove (6) of a sheave (5), the cross-section A_t having a shape complementary to that of said groove (6), the central axis (4) being in a position parallel to a rotating shaft of the sheave (5), when said at least one rope and said sheave (5) are in contact. 15
9. Elevator apparatus according to any of the previous claims, wherein the resistant elements (1) comprise steel wires having a strength of not less than 2000 N/mm² and a diameter of less than 0.5 mm. 20
10. Elevator apparatus according to any of the previous claims, wherein the resistant elements (1) comprise wires made of synthetic material. 25
11. Elevator apparatus according to any of claims 4 to 10, wherein a sheath (3) is made of polymer material. 30
12. Elevator apparatus according to any of the previous claims, wherein at least one rope comprises a visual mark configured to allow identifying the position of the central axis (4) of the cross-section A_t of the rope. 35
13. Elevator apparatus according to any of the previous claims, wherein a traction sheave (5) has a pitch diameter of less than 160 mm. 40
14. Elevator apparatus according to any of the previous claims, wherein the pitch diameter of a traction sheave (5) is less than 40 times the diameter of a circle completely circumscribing the resistant elements (1) of a rope. 45

Patentansprüche

1. Aufzugvorrichtung, die zumindest ein Seil aufweist, das ausgebildet ist, um in Kontakt mit einer Treibscheibe (5) zu stehen, wobei das zumindest eine Seil zumindest zwei lineare widerstandsfähige Elemente (1) aufweist, **dadurch gekennzeichnet**, 55

dass alle widerstandsfähigen Elemente (1) entlang der gesamten Länge des Seils parallel sind und auf einer Mittelachse (4) eines Querschnitts (A_t) des Seils angeordnet sind, wobei alle widerstandsfähigen Elemente (1) Querschnitte a_t aufweisen, die sich in Ausrichtung befinden, wobei der Querschnitt A_t eine Breite a und eine Dicke b aufweist, wobei das Verhältnis zwischen der Breite a und der Dicke b im Wesentlichen gleich eins ist.

2. Aufzugvorrichtung gemäß Anspruch 1, bei der zumindest ein Seil zumindest ein lineares Dämpfungselement (2) mit einem Querschnitt a'_t aufweist, das sich in einem Bereich des Querschnitts A_t des Seils befindet, der entfernt von der Mittelachse (4) des Querschnitts A_t des Seils ist.
3. Aufzugvorrichtung gemäß Anspruch 2, bei der zumindest ein Seil zumindest zwei Dämpfungselemente (2) aufweist, die sich auf beiden Seiten der Mittelachse (4) des Querschnitts A_t des Seils befinden.
4. Aufzugvorrichtung gemäß einem der vorherigen Ansprüche, bei der zumindest ein Seil eine Hülle (3) aufweist, die die widerstandsfähigen Elemente (1) beinhaltet, wobei die Hülle (3) aus einem Material hergestellt ist, das einen hohen Reibungskoeffizienten aufweist, wobei die Hülle (3) ausgelegt ist, um in Kontakt mit zumindest einer Scheibe (5) zu stehen.
5. Aufzugvorrichtung gemäß einem der Ansprüche 2 und 3, bei der zumindest ein Seil eine Hülle (3) aufweist, die die widerstandsfähigen Elemente (1) und das zumindest eine Dämpfungselement (2) beinhaltet, wobei die Hülle (3) aus einem Material hergestellt ist, das einen hohen Reibungskoeffizienten aufweist, wobei die Hülle (3) ausgelegt ist, um in Kontakt mit zumindest einer Scheibe (5) zu stehen.
6. Aufzugvorrichtung gemäß einem der vorherigen Ansprüche, bei der die Querschnitte a_t der widerstandsfähigen Elemente (1) wirksam in dem Querschnitt A_t eines Seils voneinander beabstandet sind oder in Kontakt stehen.
7. Aufzugvorrichtung gemäß einem der vorherigen Ansprüche, bei der der Querschnitt A_t zumindest eines Seils kreisförmig ist.
8. Aufzugvorrichtung gemäß einem der Ansprüche 1 bis 6, bei der der Querschnitt A_t zumindest eines Seils nicht kreisförmig ist, wobei der Querschnitt A_t ausgebildet ist, um in einer Rille (6) einer Scheibe (5) untergebracht zu sein, wobei der Querschnitt A_t eine Form besitzt, die komplementär zu derjenigen der Rille (6) ist, wobei die Mittelachse (4) in einer Position parallel zu einer Rotationswelle der Scheibe (5) ist, wenn das zumindest eine Seil und die Scheibe

(5) in Kontakt stehen.

9. Aufzugvorrichtung gemäß einem der vorherigen Ansprüche, bei der die widerstandsfähigen Elemente (1) Stahldrähte mit einer Stärke von nicht weniger als 2000 N/mm² und einem Durchmesser von weniger als 0,5 mm aufweisen.
10. Aufzugvorrichtung gemäß einem der vorherigen Ansprüche, bei der die widerstandsfähigen Elemente (1) Drähte aufweisen, die aus einem synthetischen Material hergestellt sind.
11. Aufzugvorrichtung gemäß einem der Ansprüche 4 bis 10, bei der eine Hülle (3) aus einem Polymer-Material hergestellt ist.
12. Aufzugvorrichtung gemäß einem der vorherigen Ansprüche, bei der zumindest ein Seil eine sichtbare Markierung aufweist, die ausgebildet ist, um ein Identifizieren der Position der Mittelachse (4) des Querschnitts A_t des Seils zu erlauben.
13. Aufzugvorrichtung gemäß einem der vorherigen Ansprüche, bei der eine Treibscheibe (5) einen Flankendurchmesser von weniger als 160 mm aufweist.
14. Aufzugvorrichtung gemäß einem der vorherigen Ansprüche, bei der der Flankendurchmesser einer Treibscheibe (5) weniger als 40 mal der Durchmesser eines Kreises ist, der die widerstandsfähigen Elemente (1) eines Seils vollständig umzieht.

Revendications

1. Appareil élévateur comprenant au moins un câble configuré pour être en contact avec une poulie d'entraînement (5), dans lequel ledit au moins un câble comprend au moins deux éléments résistants linéaires (1), **caractérisé en ce que** tous les éléments résistants (1) sont parallèles le long de l'ensemble du câble et situés sur un axe central (4) d'une section transversale A_t du câble, dans lequel tous les éléments résistants (1) présentent des sections transversales a_t situées dans un alignement, ladite section transversale A_t présentant une largeur a et une épaisseur b , le rapport entre ladite largeur a et ladite épaisseur b étant sensiblement égal à un.
2. Appareil élévateur selon la revendication 1, dans lequel au moins un câble comprend au moins un élément d'amortissement linéaire (2) présentant une section transversale a_t' qui est située dans une zone de la section transversale A_t du câble qui est éloignée de l'axe central (4) de ladite section transversale A_t du câble.

3. Appareil élévateur selon la revendication 2, dans lequel au moins un câble comprend au moins deux éléments d'amortissement (2) situés sur les deux côtés de l'axe central (4) de la section transversale A_t du câble.
4. Appareil élévateur selon l'une quelconque des revendications précédentes, dans lequel au moins un câble comprend une gaine (3) contenant les éléments résistants (1), ladite gaine (3) étant fabriquée en un matériau qui présente un coefficient de friction élevé, ladite gaine (3) étant configurée pour être en contact avec au moins une poulie (5).
5. Appareil élévateur selon l'une quelconque des revendications 2 et 3, dans lequel au moins un câble comprend une gaine (3) contenant les éléments résistants (1) et ledit au moins un élément d'amortissement (2), ladite gaine (3) étant fabriquée en un matériau présentant un coefficient de friction élevé, ladite gaine (3) étant configurée pour être en contact avec au moins une poulie (5).
6. Appareil élévateur selon l'une quelconque des revendications précédentes, dans lequel les sections transversales a_t des éléments résistants (1) sont espacées en fonctionnement l'une de l'autre dans la section transversale A_t d'un câble ou en contact.
7. Appareil élévateur selon l'une quelconque des revendications précédentes, dans lequel la section transversale A_t d'au moins un câble est circulaire.
8. Appareil élévateur selon l'une quelconque des revendications 1 à 6, dans lequel la section transversale A_t d'au moins un câble n'est pas circulaire, ladite section transversale A_t étant configurée pour être logée dans une rainure (6) d'une poulie (5), la section transversale A_t présentant une forme complémentaire à celle de ladite rainure (6), l'axe central (4) étant dans une position parallèle à un arbre de rotation de la poulie (5), lorsque ledit au moins un câble et ladite poulie (5) sont en contact.
9. Appareil élévateur selon l'une quelconque des revendications précédentes, dans lequel les éléments résistants (1) comprennent des fils en acier dont la résistance n'est pas inférieure à 2 000 N/mm² et le diamètre est inférieur à 0,5 mm.
10. Appareil élévateur selon l'une quelconque des revendications précédentes, dans lequel les éléments résistants (1) comprennent des fils en matériau synthétique.
11. Appareil élévateur selon l'une quelconque des revendications 4 à 10, dans lequel une gaine (3) est en matériau polymère.

12. Appareil élévateur selon l'une quelconque des revendications précédentes, dans lequel au moins un câble comprend une marque visuelle configurée pour permettre l'identification de la position de l'axe central (4) de la section transversale A_t du câble. 5
13. Appareil élévateur selon l'une quelconque des revendications précédentes, dans lequel une poulie d'entraînement du câble tracteur (5) présente un diamètre de pas inférieur à 160 mm. 10
14. Appareil élévateur selon l'une quelconque des revendications précédentes, dans lequel le diamètre de pas d'une poulie d'entraînement du câble tracteur (5) est inférieur à 40 fois le diamètre d'un cercle entourant complètement les éléments résistants (1) d'un câble. 15

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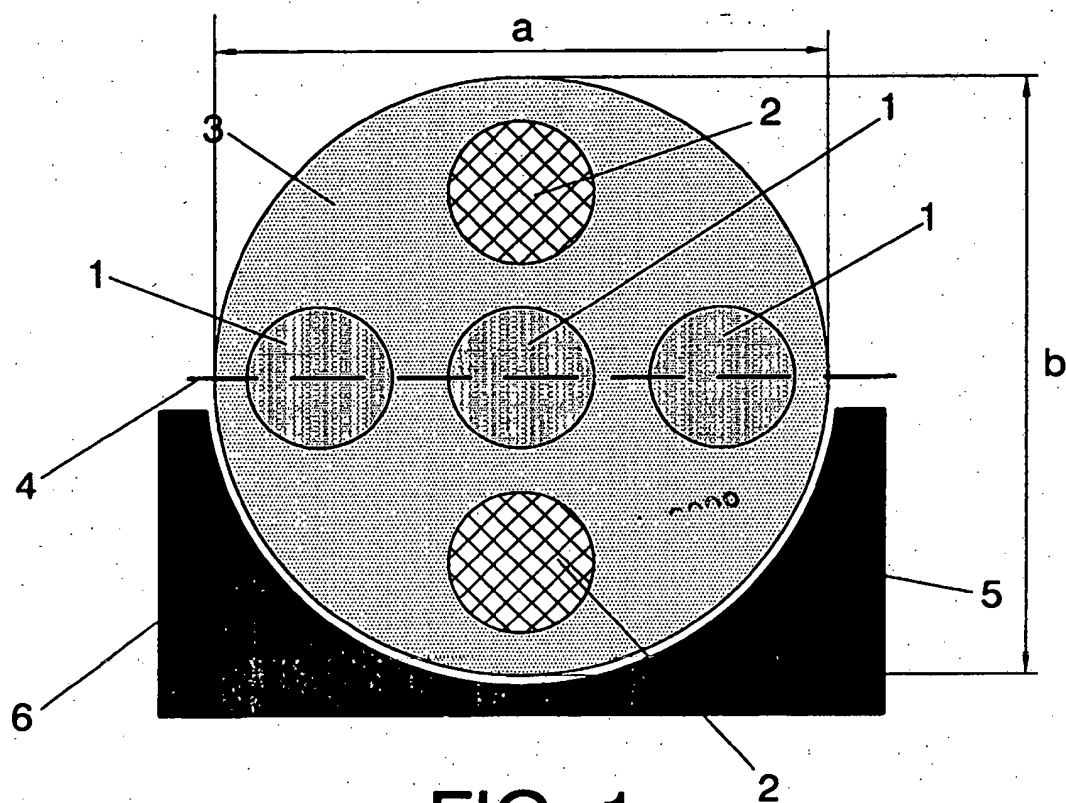


FIG. 1

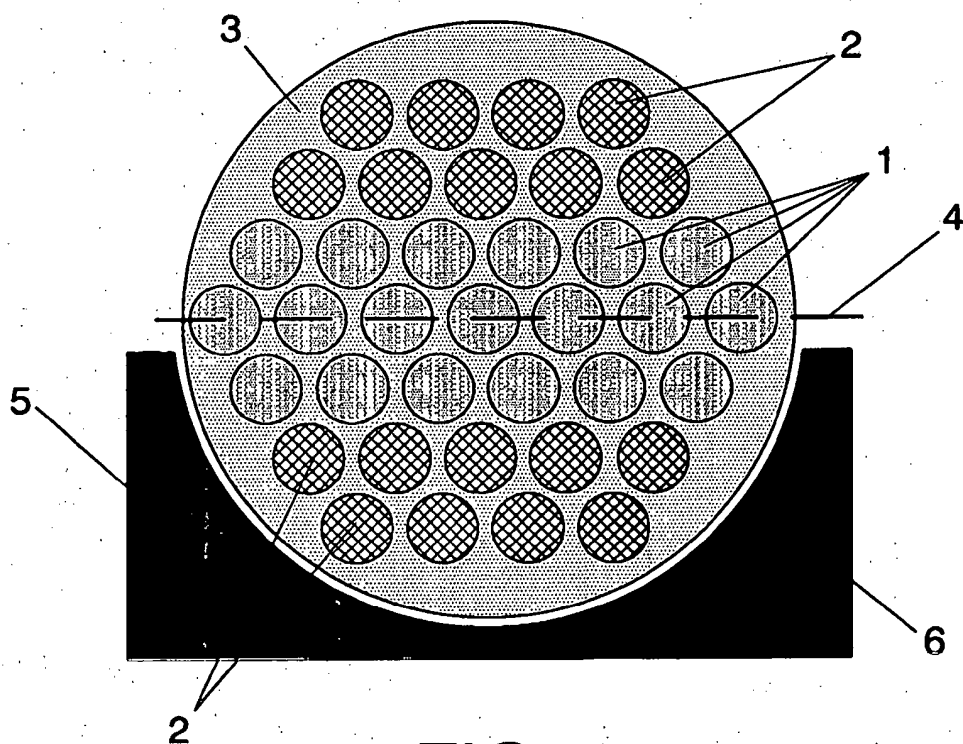


FIG. 2

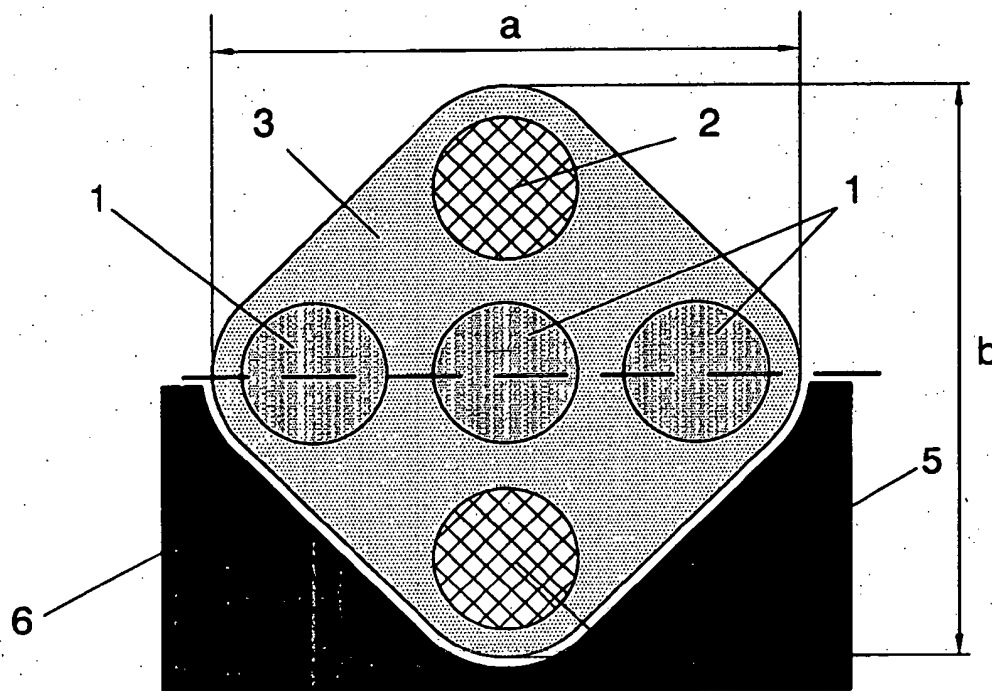


FIG. 3

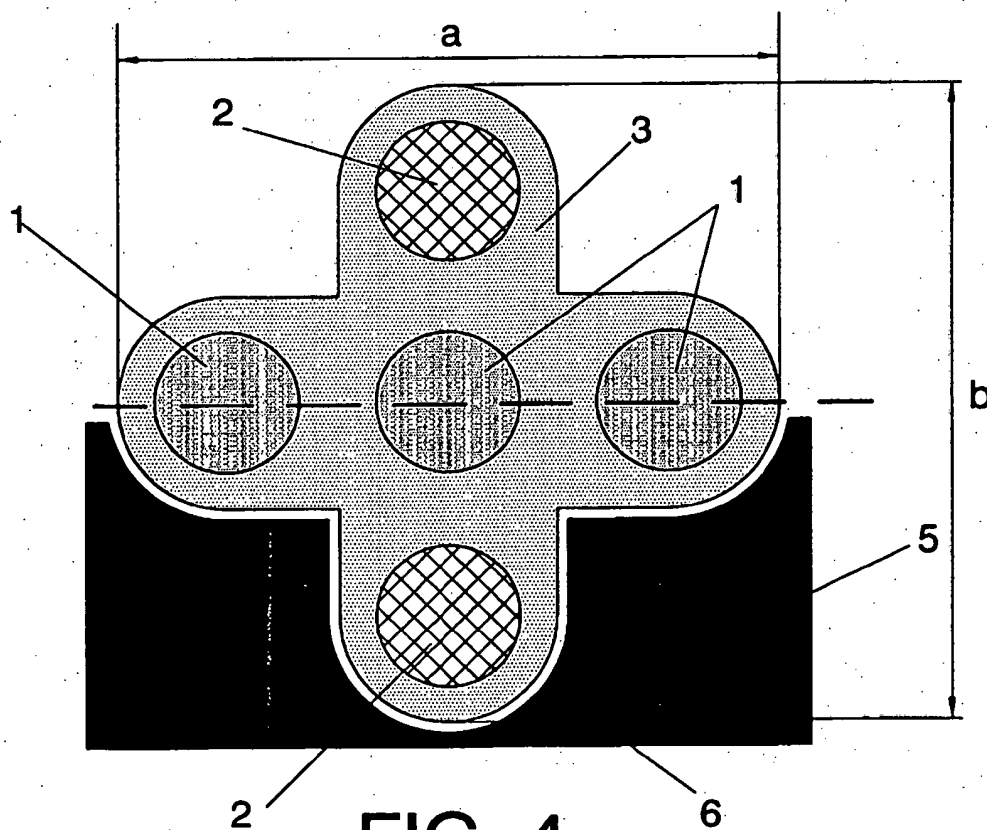


FIG. 4

REFERENCES CITED IN THE DESCRIPTION

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