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(71) Applicants: **thyssenkrupp Elevator AG** [DE/DE]; ThyssenKrupp Allee 1, 45143 Essen (DE). **THYSSENKRUPP AG** [DE/DE]; ThyssenKrupp Allee 1, 45143 Essen (DE).

(72) Inventors: **XINHONG, Wang**; Rm.101. No.156, lane 1799, Yinchun Rd.Minhang District, Shanghai (CN). **ZHONG, Yue**; Rm.201, No. 12, Rd. Chunshen, Minhang District, Shanghai (CN).

(74) Agent: **THYSSENKRUPP INTELLECTUAL PROPERTY GMBH**; ThyssenKrupp Allee 1, 45143 Essen (DE).

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(54) **Title:** A TRACTION BELT OF ELEVATOR SYSTEM AND A PULLEY THEREOF, AND AN ELEVATOR WITH THE TRACTION BELT AND THE PULLEY

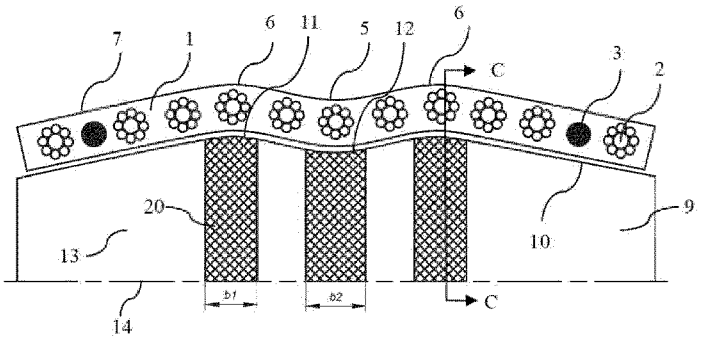

FIG.2A

(57) **Abstract:** The invention provides a traction belt of elevator system and a pulley thereof, and an elevator with the traction belt and the pulley. The traction belt of the elevator system comprises: bearing units that extend along the length of the whole traction belt; an early warning unit that extends parallel to the bearing units along the length of the whole traction belt, and the bending fatigue life thereof is shorter than that of the bearing units; and a coating layer that wraps outside the bearing units and the early warning unit, wherein the traction belt is in a strip shape with a uniform thickness, and has at least one continuously fluctuating contour in the width direction, so that a concave section and a convex section are formed on A-side that matches with the traction sheave and on B-side that matches with the guiding pulley, respectively. The pulley comprises a traction sheave and a guiding pulley, and the surface of the traction sheave has two different friction coefficients. Through cooperation of the continuously fluctuating contours, axial movement of the traction belt when passing through the gear train is prevented.

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A TRACTION BELT OF ELEVATOR SYSTEM AND A PULLEY THEREOF, AND AN ELEVATOR WITH THE TRACTION BELT AND THE PULLEY

Field of the Invention

The present invention relates to a driving device of elevator system, and more particularly, to a traction belt of elevator and a pulley thereof.

Background of the Invention

Traction belt has been used in elevator industry for many years, and it has the advantages of having longer service life, lower noise, lower maintenance cost, and more compact structure and the like comparing with the traction way of traditional wire rope.

In the traction belt of an elevator system in the prior art, a flat belt is most commonly used as the traction belt. In order to prevent the belt from moving in the axial direction along the wheel train in the process of working, the belt pulley is designed to be of a convex crown profile along the cross section of a rotating shaft, as shown in FIG. 8. By means of such design, although the problem of axial movement when the traction belt passes through the wheel train is solved, the pulley in the convex crown shape causes the deformation of the engaged traction belt in the width direction, thereby increasing internal stress, and reducing the service life of the traction belt.

In order to solve the problem of axial movement when the traction belt passes through the wheel train, a multi-wedge belt is used as the traction belt in some elevator systems, and the problem that the belt moves along the axial direction of the wheel train can be solved to a certain degree through the multi-wedge belt pulley that engages with the multi-contour. One side of the multi-wedge belt is provided with belt wedges, while the other side is a plane. Therefore, in practical application of elevator, especially in an elevator with a traction ratio of 2:1, the side that is a plane will be in contact with a guiding pulley when the belt passes through a car guiding pulley; therefore, the problem that the belt moves along the axial direction of the wheel train cannot be completely avoided. Although the turnover of the belt can be realized by an auxiliary device, the cost will be increased, and the reliability of the system will be reduced. This problem can also be solved by arranging a wheel train; however, the wrap angle of the belt on a traction sheave will be greatly reduced thereby, and the problem of insufficient traction capability may be caused.

The information disclosed in this Background of the Invention section is only for enhancement of understanding of the general background of the invention and should not be taken as an acknowledgement or any form of suggestion that this information forms the prior art already known to a person skilled in the art.

Brief Summary

The invention aims to provide a traction belt of an elevator system and a pulley thereof in order to solve the problem that the traction belt moves along the axial direction of a wheel train in an elevator system in the prior art, and there is no deformation of the traction belt in the width direction.

In particular, the invention provides a traction belt of an elevator system, which is connected with and drives an elevator car and a counterweight, and comprises: bearing units extending along the length of the whole traction belt; an early warning unit extending parallel to the bearing units along the length of the whole traction belt, and having a bending fatigue life shorter than that of the bearing units; and a coating layer wrapping outside the bearing units and the early warning unit, wherein the traction belt is in a strip shape with a uniform thickness, and has at least one continuously fluctuating contour in the width direction, so that a concave section and a convex section are formed on A-side that engages the traction sheave and on B-side that engages the guiding pulley, respectively.

In the traction belt of the elevator system according to the invention, preferably, the traction belt further comprises a straight section in the width direction of the section thereof.

In the traction belt of the elevator system according to the invention, preferably, the bearing units are arranged at equidistant or non-equidistant intervals with the fluctuation of the traction belt along the width direction of the traction belt, but they are symmetric relative to the center of the section of the traction belt.

In the traction belt of the elevator system according to the invention, preferably, the bearing units are composed of a plurality of wire ropes or a plurality of separate rope strands; the plurality of wire ropes are of the same structure, and each wire rope is formed by twisting a plurality of rope strands around a rope core; and the plurality of separate rope strands are of the same structure, and each rope strand is formed by twisting a plurality of wires.

In the traction belt of the elevator system according to the invention, preferably, the early warning unit is composed of a rope strand that is different from the rope strand used in the bearing units or a single separate steel wire that is different from the steel wire used in the bearing units.

The invention further provides a pulley of an elevator system, which is used in cooperation with the traction belt of the above elevator system, and comprises a traction sheave and a guiding pulley which are made of metallic materials. The traction sheave has a continuous fluctuating contour that matches with the A-side of the traction belt of the elevator system in the axial direction, and the guiding pulley

has a continuous fluctuating contour that matches with the B-side of the traction belt of the elevator system in the axial direction.

In the pulley of the elevator system according the invention, preferably, the surface of the traction sheave at least has two different friction coefficients, particularly when used with the same traction belt. More preferably, the traction sheave further comprises one or more non-metallic embedment(s) embedded therein. Preferably, the non-metallic embedment(s) surround the traction sheave in the circumferential direction, and form a part of the continuous fluctuating contour of the traction sheave. Preferably the non-metallic embedment(s have same or different width in the axial direction, but are symmetric relative to the center of the section of the traction belt. Advantageously the surface of the traction sheave further comprises one or more surface treatment band(s) surrounding the traction sheave in the circumferential direction, and preferably having same or different width in the axial direction, but they are symmetric relative to the center of the section of the traction belt.

The invention further provides an elevator, which comprises the traction belt of the elevator system, and the pulley of the elevator system.

The traction belt of the elevator system according to the invention is cooperated with the pulley of the elevator system according to the invention, which at least has the following beneficial effect:

Through the cooperation between the traction sheave and continuous fluctuating contour on A-side of the traction belt for the elevator system, the traction belt is prevented from moving in the axial direction when it passes through the traction sheave; and through the cooperation between the guiding pulley and continuous fluctuating contour on B-side of the traction belt for the elevator system, the traction belt is prevented from moving in the axial direction when it passes through the guiding pulley. The friction coefficient on the surface of the traction sheave is changed by embedding one or more non-metallic embedment(s) in the traction sheave, or by changing the surface roughness on local surface of the traction sheave; therefore, the adjustment or control to the traction force is achieved, so as to meet different requirements to the traction force.

In addition, by means of the bending fatigue life of the early warning unit being shorter than that of the bearing units, alarm for prompting maintenance or replacement can be given out when the traction belt is damaged.

The methods and apparatuses of the present invention have other features and advantages which will be apparent from or are set forth in more detail in the accompanying drawings, which are incorporated herein, and the following Detailed Description, which together serve to explain certain principles of the present invention.

Brief Description of the Drawings

FIG. 1A is a cross-sectional schematic view illustrating a traction belt of the elevator system according to an embodiment of the present invention.

FIG. 2A is a schematic view illustrating the cooperation between the traction belt and the traction sheave of the elevator system according to the present invention.

FIG. 2B is a cross-sectional view of the traction sheave taken from C-C section in FIG. 2A.

FIG. 3 is a schematic view illustrating the cooperation between the traction belt and the guiding pulley of the elevator system according to the present invention.

FIG. 4 shows another embodiment of the traction belt of the elevator system according to the present invention.

FIG. 5 is a structural schematic view illustrating the bearing unit of the traction belt of the elevator system according to the present invention.

FIG. 6 is another structural schematic view illustrating the bearing unit of the traction belt of the elevator system according to the present invention.

FIG. 7A is a structural schematic view illustrating the early warning unit having the structure of rope strands of the traction belt of the elevator system according to the present invention.

FIG. 7B is a structural schematic view illustrating the early warning unit having the structure of single separate steel wire of the traction belt of the elevator system according to the present invention.

FIG. 8 is a schematic view illustrating the traction belt of the elevator system in the prior art, wherein the flat-belt traction belt deforms when it passes through the pulley in a convex crown shape.

Wherein, reference numbers shown in the drawings are illustrated as follows:

1- traction belt; 2- bearing unit; 3- early warning unit; 4- coating layer; 5- concave section; 6- convex section; 7- straight section; 8- center; 9- traction sheave; 10- tapered surface section of the traction sheave; 11- convex of the traction sheave; 12- concave of the traction sheave; 13- metallic section of the traction sheave; 14- axis of rotation of the traction sheave; 15- guiding pulley; 16- tapered surface section of the guiding pulley; 17- concave of the guiding pulley; 18- convex of the guiding pulley;

19- axis of rotation of the guiding pulley; 20- embedment of the traction sheave; 21- wire rope; 22- rope strand; 23- steel wire; 24- rope core; 25- rope strand; 26- steel wire; 27- steel wire; 28- rope strand; 29- steel wire; 30- steel wire.

It should be understood that the appended drawings are not necessarily to scale, presenting a somewhat simplified representation of various features illustrative of the basic principles of the invention. The specific design features of the present invention as disclosed herein, including, for example, specific dimensions, orientations, locations, and shapes will be determined in part by the particular intended application and use environment.

Detailed Description

Reference will now be made in detail to various embodiments of the present invention, examples of which are illustrated in the accompanying drawings and described below. While the invention will be described in conjunction with exemplary embodiments, it will be understood that the present description is not intended to limit the invention to those exemplary embodiments. On the contrary, the invention is intended to cover not only the exemplary embodiments, but also various alternatives, modifications, equivalents and other embodiments, which may be included within the spirit and scope of the invention as defined by the appended claims.

Hereinafter, the present invention will be described in detail with reference to FIG. 1A to FIG.8.

FIG. 1A shows a traction belt 1 of an elevator system, which is connected with and drives an elevator car and a counterweight. The traction belt 1 comprises bearing units 2 that extend along the length of the whole traction belt 1; an early warning unit 3 that extends parallel to the bearing units 2 along the length of the whole traction belt 1, and it has a bending fatigue life shorter than that of the bearing units 2; and a coating layer 4 that wraps outside the bearing units 2 and the early warning unit 3, wherein the traction belt 1 is in a strip shape with a uniform thickness, and it has at least one continuously fluctuating contour in the width direction, so that a concave section 5 and a convex section 6 are formed on A-side that engages the traction sheave and on B-side that engages the guiding pulley, respectively.

In addition to the concave section 5 and the convex section 6, the traction belt 1 further comprises a straight section 7 in the width direction of the section thereof so as to meet particular requirement in structure.

The bearing units 2 are arranged with the fluctuation of the traction belt 1 along the width direction of the traction belt. They can be arranged at equidistant or non-equidistant intervals, but are symmetric relative to the center 8 of the section of the

traction belt 1, thereby guaranteeing the whole section of the traction belt 1 to have uniform bearing capability.

The bearing units 2 can be composed of a plurality of wire ropes 21 or a plurality of separate rope strands 25.

FIG. 5 shows the bearing unit 2 composed of wire ropes 21. The wire rope 21 is composed of rope strands 22 and a rope core 24, and the rope strands 22 surround the rope core 24 by twisting. FIG. 6 shows the bearing unit 2 composed of a separate rope strand 25, which is formed by twisting a plurality of wires 26 around the wire 27 at the core.

The structures of the bearing units 2 shown in FIG. 5 and FIG. 6 are only exemplary, and the invention is not limited to this. The bearing unit 2 of the invention can be made of any elements that can satisfy the bearing capability required by the traction belt 1.

The early warning unit 3 can be composed of a rope strand which is different from the rope strand used in the bearing unit 2, or a single separate steel wire which is different from the steel wire used in the bearing unit 2.

FIG. 7A is structural schematic view illustrating the early warning unit 3 having the structure of rope strands. A rope strand 28 forming the early warning unit 3 is composed of a plurality of wires 29 (3 wires are shown, but not limited to this). FIG. 7B is a structural schematic view illustrating the early warning unit 3 having the structure of single separate steel wire 30 (oval shown in this figure, but not limited to this).

The early warning unit 3 shown in FIG. 7A and FIG. 7B are only exemplary, and the invention is not limited to this, provided that the bending fatigue life is shorter than that of the bearing unit, so as to guarantee generating fatigue break prior to the bearing unit 2 and thereby guaranteeing the reliability of the traction belt 1.

FIG. 2A is a schematic view illustrating the cooperation between the traction belt 1 and the traction sheave 9 of the elevator system according to the present invention.

As shown in FIG. 2A, the traction sheave 9 has a continuous fluctuating contour that matches with A-side of the traction belt 1 of the elevator system in the axial direction. The traction sheave 9 further comprises a plurality of non-metallic embedments 20 embedded therein, and the non-metallic embedments 20 surround the traction sheave 9 in the circumferential direction to form a part of the continuous fluctuating contour of the traction sheave 9.

FIG. 2B is a cross-sectional view of the traction sheave taken from C-C section in

FIG. 2A. It shows the structure of the non-metallic embedment 20 surrounding the traction sheave 9 in the circumferential direction and embedding therein.

The friction coefficient of the traction sheave 9 can be changed or adjusted on different locations by the non-metallic embedment 20, so as to achieve the object of changing or adjusting the traction force of the traction sheave 9.

It should be noted that the control to the friction force on the surface of the traction sheave 9 can be performed by other methods. For example, the non-metallic embedment 20 is not used, while special surface machining or processing is carried out on corresponding positions of the traction sheave 9, so as to form one or more surface treatment band(s); therefore, the friction coefficient is changed by changing the surface roughness of the local surface of the traction wheel 9.

FIG. 3 is a schematic view illustrating the cooperation between the traction belt 1 and the guiding pulley 15 of the elevator system according to the present invention. As shown in FIG. 3, the guiding pulley 15 has a continuous fluctuating contour that matches with B-side of the traction belt of the elevator system in the axial direction.

In the application, through the cooperation between the traction sheave and continuous fluctuating contour on A-side of the traction belt for the elevator system, the traction belt is prevented from moving in the axial direction when it passes through the traction sheave; and through the cooperation between the guiding pulley and continuous fluctuating contour on B-side of the traction belt for the elevator system, the traction belt is prevented from moving in the axial direction when it passes through the guiding pulley.

The friction coefficient on the surface of the traction sheave is changed by embedding one or more non-metallic embedment(s) in the traction sheave, or by changing the surface roughness on local surface of the traction sheave; therefore, the adjustment or control to the traction force is achieved, so as to meet different requirements to the traction force.

In addition, by means of the bending fatigue life of the early warning unit being shorter than that of the bearing units, alarm for prompting maintenance or replacement can be given out when the traction belt is damaged.

The foregoing descriptions of specific exemplary embodiments of the present invention have been presented for purposes of illustration and description. They are not intended to be exhaustive or to limit the invention to the precise forms disclosed, and obviously many modifications and variations are possible in light of the above teachings. The exemplary embodiments were chosen and described in order to explain certain principles of the invention and their practical application, to thereby enable others skilled in the art to make and utilize various exemplary embodiments of

the present invention, as well as various alternatives and modifications thereof. It is intended that the scope of the invention be defined by the Claims appended hereto and their equivalents.

Claims:

1. A traction belt of an elevator system which is connected with and drives an elevator car and a counterweight, characterized in comprising:

bearing units (2) extending along the length of the whole traction belt (1);

an early warning unit (3) extending parallel to the bearing units (2) along the length of the whole traction belt (1), and having a bending fatigue life shorter than that of the bearing units (2); and

a coating layer (4) wrapping outside the bearing units (2) and the early warning unit (3),

wherein the traction belt (1) is in a strip shape with a uniform thickness, and has at least one continuously fluctuating contour in the width direction, so that a concave section (5) and a convex section (6) are formed on A-side that engages the traction sheave and on B-side that engages the guiding pulley, respectively.

2. The traction belt of the elevator system according to claim 1, characterized in that: the traction belt further comprises a straight section (7) in the width direction of the section thereof.

3. The traction belt of the elevator system according to claim 1 or claim 2, characterized in that: the bearing units (2) are arranged at equidistant or non-equidistant intervals with the fluctuation of the traction belt (1) along the width direction of the traction belt (1), but are symmetric relative to the center of the section of the traction belt (1).

4. The traction belt of the elevator system according to one of the preceding claims, characterized in that: the bearing units (2) are composed of a plurality of wire ropes or a plurality of separate rope strands, the wire ropes are of the same structure each formed by twisting a plurality of rope strands around a rope core; the plurality of separate rope strands are of the same structure each formed by twisting a plurality of wires.

5. The traction belt of the elevator system according to one of the preceding claims, characterized in that: the early warning unit (3) is composed of a rope strand that is different from the rope strand used in the bearing units (2) or a single separate steel wire that is different from the steel wire used in the bearing units (2).

6. A pulley of an elevator system used in cooperation with the traction belt of the elevator system according to claims 1-5, comprising a traction sheave (9) and a guiding pulley (15) which are made of metallic materials, and characterized in that:

the traction sheave (9) has a continuous fluctuating contour that matches with A-side of the traction belt of the elevator system in the axial direction, and the guiding pulley (15) has a continuous fluctuating contour that matches with B-side of the traction belt of the elevator system in the axial direction.

7. The pulley of the elevator system according to claim 6, characterized in that: the surface of the traction sheave (9) at least has two different friction coefficients.

8. The pulley of the elevator system according to claim 6 or claim 7, characterized in that: the traction sheave (9) further comprises one or more non-metallic embedment(s) (20) embedded therein.

9. The pulley of the elevator system according to claim 8, characterized in that the non-metallic embedment (20) surrounds the traction sheave (9) in the circumferential direction, and forms a part of the continuous fluctuating contour of the traction sheave (9).

10. The pulley of the elevator system according to claim 8 or claim 9, characterized in that the non-metallic embedment(s) (20) has same or different width in the axial direction, but are symmetric relative to the center of the section of the traction belt.

11. The pulley of the elevator system according to one of claims 6 to 10, characterized in that: the surface of the traction sheave (9) further comprises one or more surface treatment band(s) surrounding the traction sheave (9) in the circumferential direction.

12. The pulley of the elevator system according to claim 11,characterized in that the surface treatment band(s) has same or different width in the axial direction, but are symmetric relative to the center of the section of the traction belt.

13. An elevator is characterized by comprising the traction belt of the elevator system according to claims 1-5, and the pulley of the elevator system according to claims 6-12.

Drawings

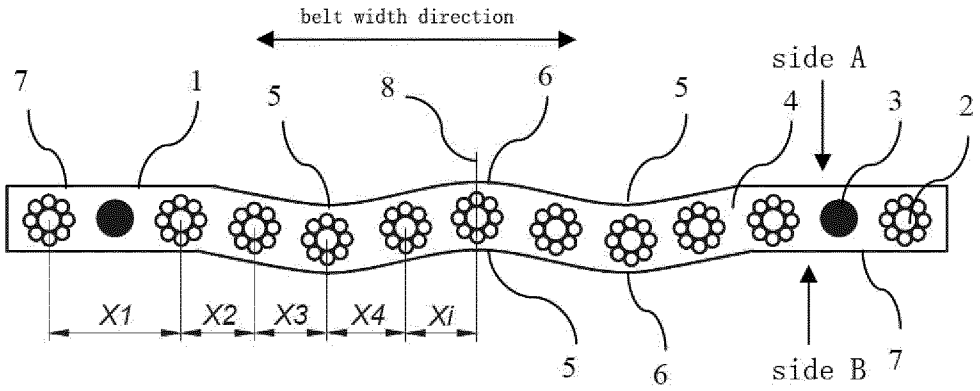

FIG.1

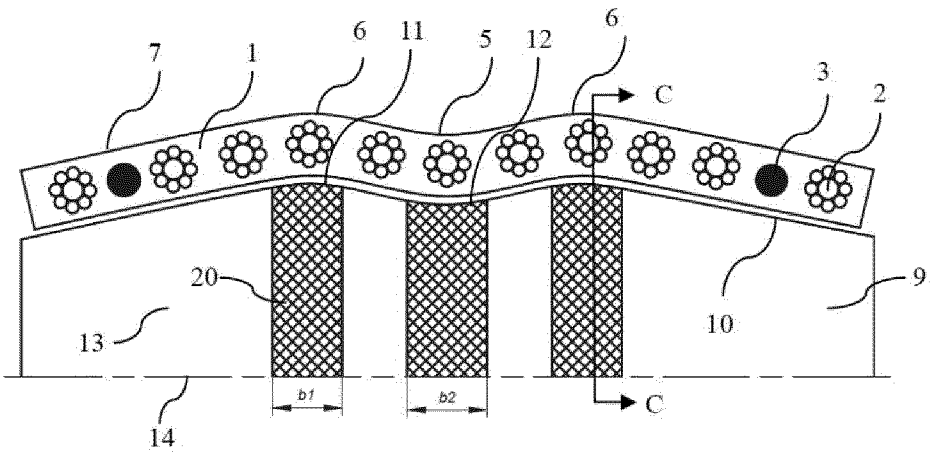

FIG.2A

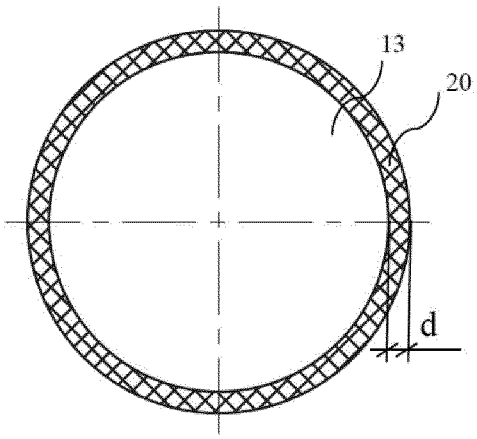

FIG.2B

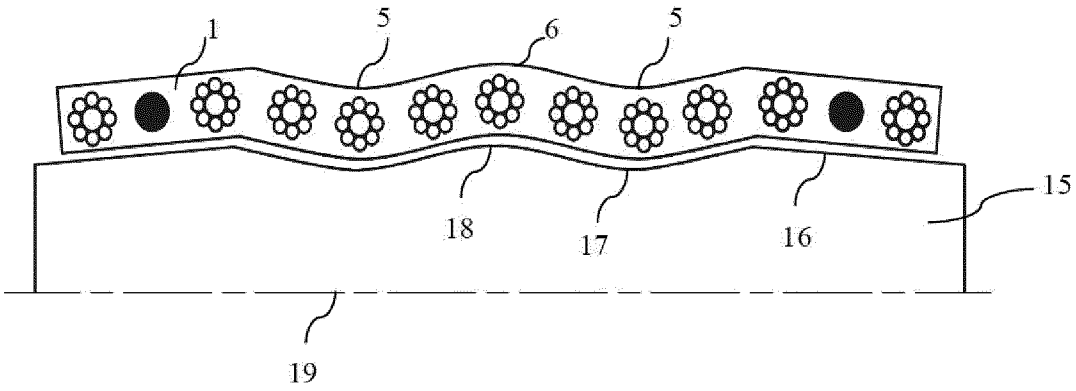

FIG.3

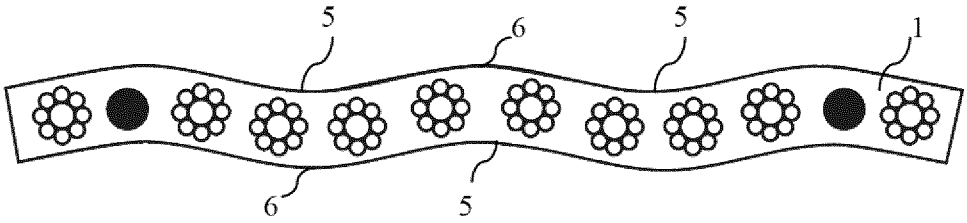

FIG.4

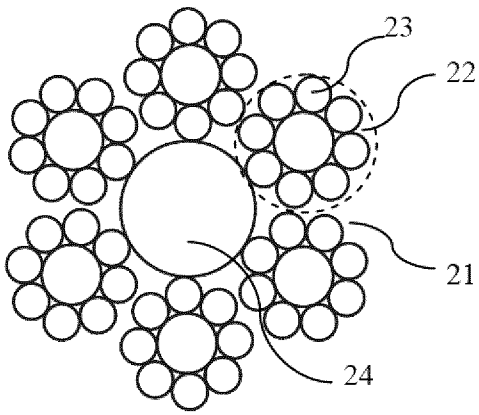

FIG.5

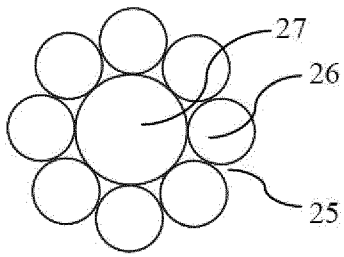

FIG.6

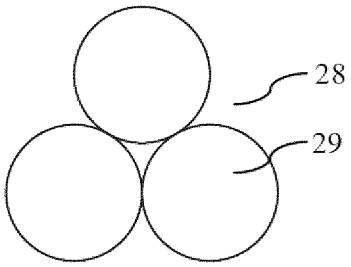

FIG.7A

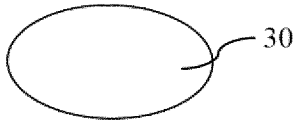

FIG.7B

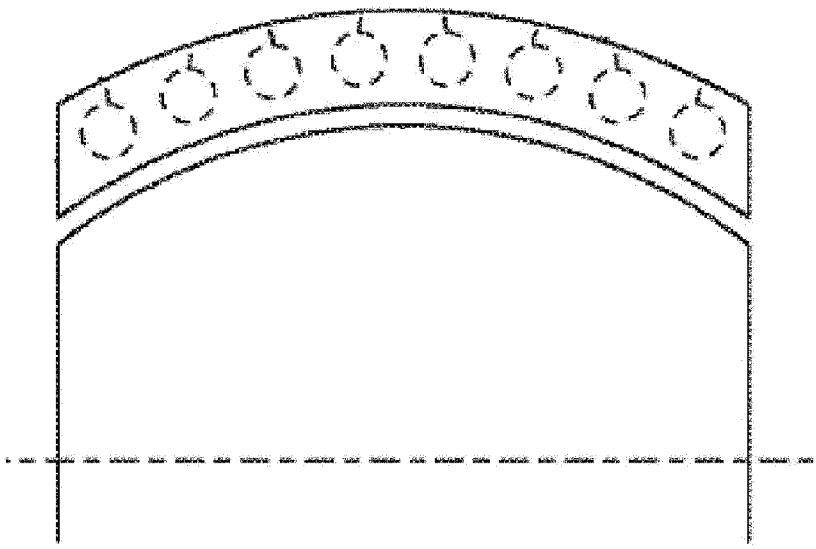

FIG.8

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2018/062235

A. CLASSIFICATION OF SUBJECT MATTER
INV. B66B7/06
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B66B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2015/015280 A1 (GUILANI BRAD [US] ET AL) 15 January 2015 (2015-01-15)	1-7
A	paragraph [0046]; figures 2-7	8-13
Y	CN 106 081 793 A (SJEC CORP) 9 November 2016 (2016-11-09)	1-7
A	figures 6-8	8-13
A	US 2005/245338 A1 (EICHHORN ROLAND [CH] ET AL) 3 November 2005 (2005-11-03) paragraph [0030]	1-13
A	WO 2011/133872 A2 (THYSSENKRUPP ELEVATOR AG [DE]; DUDDE FRANK P [US]; FELDHUSEN PETER P [] 27 October 2011 (2011-10-27) paragraph [0183] - paragraph [0185]	1-13

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

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"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

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Date of the actual completion of the international search	Date of mailing of the international search report
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Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Szován, Levente

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