Title: A BELT FOR LIFTING

Abstract: A steel cord (105) for reinforcement of rubber products, like belts (100) for lifting, having a structure of 7x7+7x19 Warrington. Additionally a belt (100) comprising at least one steel cord (105), the steel cord (105) has a structure of 7 x 7 + n x 19, while n is ranging from 6 to 8, is disclosed. The belt (100) has an improved flexibility, breaking load and fatigue resistance. The belt (100) can be used for lifting in various applications, i.e. lifting in a harbour crane and can be coiled on a reel onto itself.
before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))
A belt for lifting

Description

Technical Field

[1] The invention relates to a belt for lifting. The present invention also relates to a steel cord for reinforcing the belt. The present invention also relates to harbour crane lifted by the belt.

Background Art

[2] Harbor crane is a machine in harbor for lifting and moving heavy load which can be more than 50 ton. Generally, the harbour crane lifts and moves the heavy load by rope. The rope for lifting in a harbor crane has a big diameter of more than 25 mm for big breaking load, but the rope with so big diameter performs not so well on fatigue resistance and fatigue resistance. Because the rope lifts and moves heavy load by being coiled by a reel, the rope breaks easily because of its poor performance on fatigue resistance and fatigue resistance. And the reel for paying-off and taking-up the rope is required to have a big size and be hard enough. All these make the cost of a harbour crane to be high.

[3] A belt comprising one or more elongated elements as reinforcement and a polymer surrounding the one or more elongated elements is known in the art of elevators. For example, US6739433 discloses a flat belt for lifting elevator; US2004216958 discloses a belt having a running surface facing the drive pulley with a plurality of ribs and grooves extending in parallel in a longitudinal direction of the belt. In elevators, these belts have the great advantage of allowing a compact design of the elevator and enable the saving of an additional floor for the machine room of the elevator. The belt in elevator have a limited breaking load and can afford a limited load of less than 1.5 ton, and it has a width lower than 50mm and a thickness lower than 4mm, and the steel cord in the belt has a diameter lower than 2mm.

[4] However, up to now these belts have been limited to elevators and have not found extensive application elsewhere.
Disclosure of Invention

[5] The primary object of the invention is to provide a belt for lifting having a high flexibility, high breaking load and high fatigue resistance.

[6] Another object of the invention is to provide a steel cord for reinforcing the belt.

[7] A third object of the invention is to provide an use of the belt in harbour crane.

[8] A fourth object of the invention is to provide a harbour crane with low cost.

[9] A fifth object of the invention is to provide a reel and a belt for the application of harbour crane.

[10] According a first aspect of the invention a belt is claimed. A belt for lifting comprises at least one steel cord, the steel cord has a structure of $7 \chi 7 + n \chi 19$, while $n$ is ranging from 6 to 8.

[11] The inventor is surprised to find that the invention belt provides a good performance on flexibility, breaking load and fatigue resistance, and the belt also achieves a proper balance between the breaking load and fatigue resistance. So the belt can be suitable for lifting and being coiled layer upon layer. Normally, to a belt, it is hard to achieve a balance between the breaking load and fatigue resistance, the increase of the breaking load normally brings a decrease of fatigue resistance. The invention belt solves the problem, and it achieves a perfect balance between the breaking load and fatigue resistance. The breaking load of the belt is improved; in the meantime the fatigue resistance is also improved.

[12] The structure of '$7 \chi 7 + n \chi 19$' means the steel cord comprises seven strands being twisted as a core and $n$ strands being twisted around the core, each of the seven strands comprises seven filaments and each of the $n$ strands comprises nineteen filaments. Preferably $n$ strands have a Warrington (hereafter W) structure, 'Warrington (W)' means a two layered construction with uniform-sized wires in the inner layer, and two diameters of wire alternating large and small in the outer layer, the larger outer-layer wires rest in the valleys, and the smaller ones on the crowns, of the inner layer. More preferably, the steel cord has a structure of $7 \chi 7 + 7 \chi 19W$. 
The belt has a layer covering the at least one steel cord, and it means the at least one steel cord is embedded into the layer to form a belt. The layer may be a polymer or elastomer layer. The polymer layer may be made of plastic, and the elastomer layer may be made of rubber.

In case of plastic, this plastic can be selected from the group of thermal polyurethane (TPU), polyurethane (PU), polyethylene (PE), polytetrafluoroethylene (PTFE), polypropylene (PP) and polystyrene.

Preferably, the polymer or elastomer layer is transparent or comprises a colouring pigment. The colouring pigment can be any one known in the art, such as black pigment or white pigment.

According to the present invention, the belt comprises a plurality of steel cords aligning in parallel with a distance between each other. Preferably, the distance between the steel cords in the belt has a value being 0.2 to 0.6 times the diameter of the steel cord.

The diameter of the steel cord can be any one of the diameter known in the art. Preferably, the diameter of the steel cord is in the range of 5 to 8 mm. Thus the belt comprising such steel cords can provide a stronger performance on breaking load and fatigue resistance. The belt can be used for lifting heavy load, and it is suitable for lifting in harbour crane.

According to the present invention, the steel cord may be filled with a polymer or elastomer in advance. For example, during the production of steel cord, the seven strands each of which comprising seven filaments are twisted with each other as a core first, and then the core is covered with a polymer or elastomer, and finally the polymer or elastomer covered core is twisted around by seven strands each of which comprising nineteen filaments. The belt comprising such steel cords provides a better fatigue resistance performance and a longer lifetime.

The steel filaments in the steel cord may be coated with non-metallic coating or metallic coating for better corrosion resistance and better adhesion to the polymer or elastomer layer.

In one embodiment, the belt is a flat belt or a rectangular belt which has two parallel flat wide sides and two narrow sides along the longitudinal direction. The flat belt has a flat cross-section, and its two narrow sides have surfaces with a natural arc. The rectangular belt has a rectangular
cross-section, and its two narrow sides are flat sides. The biggest distance between the two narrow sides is the width of the belt, and the distance between the two flat sides is the thickness of the belt.

[21] In an alternative embodiment, the belt comprises an upper side and a down side along its longitudinal direction, the upper side and the down side are set with grooves and/or teeth along the longitudinal direction and/or transverse direction of said belt. Preferably, the upper side is set with grooves and the down side is set with teeth, wherein the grooves and the teeth are engaging with each other when the belt is coiled. The groove or the tooth has a cross-section preferably selected from the group consisting of triangle, trapezoid, rectangle, square, semicircle or semi-oval. The belt with such a structure provides a good anchoring while being coiled, and the good anchoring helps the belt to avoid moving while being coiled. In this embodiment, the belt also has a long axis and a short axis in its cross-section, the biggest distance in the long axis is the width of belt, and the shortest distance in the short axis is the thickness of belt.

[22] Preferably, the belt has a thickness in the range of 6 to 13 mm and a width in the range of 100 to 130 mm.

[23] This preferable width and thickness provide a high strength, breaking load and fatigue resistance to the belt to make the belt being suitable for lifting heavy load, i.e. more than 50 ton, and being coiled layer upon layer.

[24] In a preferable embodiment, the belt has a thickness in the range of 6 to 13 mm and a width in the range of 100 to 130 mm, and the steel cords in the belt have a diameter in the range of 5 to 8 mm, the distance between the steel cords in the belt has a value being 0.2 to 0.6 times the diameter of steel cord. The belt performs quite well on flexibility, breaking load and fatigue resistance; and it solves the problem of balance between the breaking load of belt and fatigue resistance of belt which means both of breaking load of belt and fatigue resistance of belt are improved. The belt can meet the requirement of being coiled layer upon layer and the requirement of lifting heavy load of even more than 50 ton. The belt can be applied for lifting in a harbour crane.

[25] While applying the belt for lifting in a harbour crane, compared with the prior art rope for lifting in a harbour crane, the invention belt has a similar
breaking load and an improved fatigue resistance, thus the invention belt has a longer lifetime, and the invention belt also makes the cost of the harbour crane lower. Firstly, the invention belt has a better fatigue resistance performance than the prior art rope, so the invention belt has a longer lifetime than the prior art rope. Secondly, the prior art rope is coiled along the length of the reel in one layer, and that requires the reel to have a length long enough; the belt is coiled upon the length of the reel layer upon layer, and that doesn't require the reel to have a long length as before, the reel for the belt is much smaller than the prior art reel for the rope, so the invention belt can help to reduce the size of the reel therefore reduce the cost of reel and the cost of harbour crane.

[26] According to the second aspect of the present invention, a steel cord with a structure of $7 \times 7 + 7 \times 19$ is provided. This steel cord presents an improved flexibility, breaking load and fatigue resistance. Preferably, the steel cord has a diameter in the range of 5 to 8 mm. The steel cord is suitable for the application of belt for lifting heavy load, i.e. a load of more than 50 ton.

[27] The belt can be used for lifting, especially for lifting in elevator, mining and crane.

[28] According to third aspect of the present invention, the application of the belt for lifting in a harbour crane is provided. The belt with high flexibility, high breaking load and high fatigue resistance can be used for lifting in a harbour crane.

[29] According to the forth aspect of the present invention, a harbour crane lifted by the belt is provided. The harbour crane with a bridge structure for lifting heavy load comprises a lifting structure for vertical movement and a car movement organization along the bridge structure for horizontal movement, the lifting structure comprising a reel and a belt, the reel is for paying-off and taking-up the belt, the reel pays-off and takes-up the belt layer by layer, wherein the belt comprises at least one steel cord and a polymer or elastomer layer, at least one steel cord is embedded in the polymer or elastomer layer, the steel cord has a structure of $7 \times 7 + \eta \times 19$, while $\eta$ is ranging from 6 to 8. Compared with the prior art harbour crane
lifted by rope, harbour crane costs lower because of the longer lifetime of the belt and the lower cost of the reel.

According to the fifth aspect of the present invention, a reel and a belt is provided, wherein the reel has a groove to fix the end of the belt, and the belt is coiled on the reel layer upon layer. The reel has a width bigger than the width of the belt to make sure that the belt can be coiled on the reel. Preferably, the belt has a thickness in the range of 6 to 13 mm and a width in the range of 100 to 130 mm.

Brief Description of Figures in the Drawings

Figure 1 describes a cross-section view of belt comprising steel cord of 7x7+7x1 9W.

Figure 2 describes a cross-section view of steel cord of 7x7+7x1 9W.

Figure 3 shows a cross-section view of belt comprising steel cord of 7x7+7x1 9.

Figure 4 shows a cross-section view of steel cord of 7x7+7x1 9.

Mode(s) for Carrying Out the Invention

Figure 1 illustrates a first embodiment of the present invention. The rectangular belt 100 comprising steel cords 105 and a TPU layer 110. The belt 100 has a rectangular cross-section in which the width W is 110 mm and the thickness T is 9 mm. S1, the distance between the adjacent steel cords, is 2.5mm; S2, the closest distance between the steel cord and the surface of the belt, is 1.2mm. The steel cords 105 have a structure of 7x7+7x1 9W. The diameter of the steel cord 105 is 6.5mm. Figure 2 illustrates the steel cord 105. The steel cord 105 comprises seven strands 120 each of which comprises 7 filaments and seven strands 115 each of which comprises 19 filaments. The strands 115 are Warrington strands.

The belt 100 is made as follows:
1) provide steel cords 105, and arrange the steel cords 105 in parallel;
2) cover the steel cords 105 with a TPU layer 110 by extruding;
3) cool the belt.
The belt 100 has a stiffness being lower than 35,000 N\text{mm}^2, a breaking load being more than 480KN, a fatigue resistance being more than 1,000,000 cycles. The lower stiffness shows that the belt 100 is very flexible, and the higher breaking load shows that the belt 100 has can lift a heavy load, even more than 50 ton, and the high fatigue resistance show that the belt 100 can meet the requirement of being coiled layer upon layer. The belt is up to the requirement of lifting in a harbour crane.

Compared with the prior art rope for lifting in a harbour crane, the belt 100 has a similar breaking load and an improved fatigue resistance, thus the belt 100 has a longer lifetime. Additionally, the reel for coiling the belt has a smaller size, so the belt 100 also makes the cost of the reel and the harbour crane lower.

The steel cord 105 presents a good performance on flexibility, breaking load and fatigue resistance. Compared with other steel cord, steel cord 105 is much more suitable for reinforcing the belt. The following table shows the advantages of the steel cord 105.

<table>
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<tr>
<th>Properties</th>
<th>Prior art steel cord 7×19</th>
<th>Invention steel cord 105</th>
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<tbody>
<tr>
<td>Cord diameter (mm)</td>
<td>6.9</td>
<td>6.5</td>
</tr>
<tr>
<td>Stiffness (N×mm²)</td>
<td>50088</td>
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<td>Fatigue resistance (cycles)</td>
<td>842689</td>
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<td>Breaking load (KN)</td>
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Compared with the prior art steel cord 7×19, the invention steel cord 105 has a smaller diameter, but a bigger breaking load and a bigger fatigue resistance. And the lower stiffness of steel cord 105 shows that the steel cord 105 is much more flexible. The invention steel cord is more suitable for reinforcing a belt for lifting than the prior art steel cord.

Figure 3 illustrates a second embodiment of the present invention. The rectangular belt 125 comprises steel cords 130 and a PU layer 135 covering the steel cord 130. The width of the belt 125 is 120mm, and the thickness of the belt 125 is 10mm. The diameter of the steel cord 130 is 7.5mm. Figure 4 illustrates the steel cord 130. The steel cord 130 has a
structure of 7x7+7x19, and it comprises seven strands each of which comprises 7 filaments and seven strands 140 each of which comprises 19 filaments.

A third embodiment of the present invention is a flat belt comprises steel cords of 7x7+6x19 and a TPU layer, and the steel cords are arranged parallel and embedded into the TPU layer.

A forth embodiment of the present invention is a flat belt comprises steel cords of 7x7+6x19W and a TPU layer, and the steel cords are arranged parallel and embedded into the TPU layer.

A fifth embodiment of the present invention is a rectangular belt comprises steel cords of 7x7+8x19W and a PE layer, and the steel cords are arranged parallel and embedded into the PE layer.

A sixth embodiment of the present invention is a belt comprises steel cords of 7x7+8x19 and a PP layer, and the steel cords are arranged parallel and embedded into the PP layer. The belt comprises an upper side and a down side along its longitudinal direction, wherein the upper side is set with grooves and the down side is set with teeth along the longitudinal direction of the belt, and the upper side and the down side are engaging with each other when the belt is coiled.

The invention belt has a higher flexibility, higher breaking load and higher fatigue resistance, and it is suitable for lifting, especially for lifting in elevator, harbour crane and mining.

A harbour crane lifted by the invention belt is provided. The harbour crane has a bridge structure for lifting heavy load, and it comprises a lifting structure for vertical movement and a car movement organization along the bridge structure for horizontal movement, the lifting structure comprising a reel and a belt, the reel is for paying-off and taking-up the belt, the belt, and the reel pays-off and takes-up the belt layer upon layer, the belt is belt 100 in the first embodiment. Compared with the prior art harbour crane lifted by rope, the invention harbour crane lifted by the belt has a lower cost because of the longer lifetime of the belt and the smaller size of the reel.
Claims

1. A belt for lifting comprising at least one steel cord, characterized in that said steel cord has a structure of $7^x 7^y 19$, while $n$ is ranging from 6 to 8.

2. A belt as claimed in claim 1, characterized in that said steel cord has a structure of $7^x 7^y 19W$.

3. A belt as claimed in claim 1 or 2, characterized in that said belt has a layer covering said at least one steel cord, said layer is a polymer or elastomer layer.

4. A belt as claimed in claim 3, characterized in that said polymer layer is made of plastic selecting from the group consisting of thermal polyurethane, polyurethane, polyethylene, polytetrafluorethylene, polypropylene and polystyrene.

5. A belt as claimed in any one of claims 1 to 4, characterized in that said belt comprises a plurality of said steel cords aligning in parallel with a distance between each other, said distance has a value being 0.2 to 0.6 times the diameter of said steel cord.

6. A belt as claimed in any one of claims 1 to 5, characterized in that said steel cord has a diameter in the range of 5 to 8 mm.

7. A belt as claimed in any one of claims 1 to 6, characterized in that said belt has a flat or rectangular cross-section.

8. A belt as claimed in claim 7, characterized in that said belt has a thickness in the range of 6 to 13 mm and a width in the range of 100 to 130 mm.

9. A belt as claimed in any one of claims 1 to 6, characterized in that said belt comprises an upper side and a down side along its longitudinal direction, said upper side and said down side are set with grooves and/or teeth along the longitudinal direction and/or transverse direction of said belt.
10. A belt as claimed in claim 9, characterized in that said upper side is set with grooves and said down side is set with teeth, said grooves and said teeth are engaging with each other when said belt is coiled.

11. A belt as claimed in any one of claims 1 to 10, characterized in that said polymer or elastomer layer further comprises a colouring pigment.

12. A use of the belt as claimed in any one of claims 1 to 11 is for lifting in a crane, mining or an elevator.

13. A steel cord for reinforcement, characterized in that said steel cord has a structure of 7x7x19W.

14. A harbour crane with a bridge structure for lifting heavy load comprising a lifting structure for vertical movement and a car movement organization along the bridge structure for horizontal movement, said lifting structure comprising a reel and a belt, the reel being for paying-off and taking-up the belt, the reel paying-off and taking-up the belt layer by layer, characterized in that said belt is a belt claimed in any one of claims 1 to 11.

15. A reel and a belt, characterized in that said reel has a groove to fix the end of said belt, said belt is coiled on said reel layer upon layer, and said belt is a belt claimed in any one of claims 1 to 11.
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER
INV. B66B7/06 F16G1/12 D07B1/06
ADD.

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F16G D07B B66B B66D B66C

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

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<td>WOLF E ET AL: &quot;ALTERNATIVE KONSTRUKTIONEN VON STAHLZUGTRAGERN IN FORDERGURTE&quot;, KAUTSCHUK UND GUMMI - KUNSTSTOFFE, HUTHIG VERLAG, HEIDELBERG, DE, vol. 46, no. 9, 1 September 1993 (1993-09-01), pages 727-731, XP000397379, ISSN: 0948-3276</td>
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Further documents are listed in the continuation of Box C. See patent family annex.

Date of the actual completion of the international search
1 April 2014

Date of mailing of the international search report
09/04/2014

Name and mailing address of the ISA
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Authorized officer
Uhlig, Robert
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