(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 621 368 A1**

(12) **EUROPEAN PATENT APPLICATION**

(21) Application number: **94100757.7**

(51) Int. Cl.[5]: **D07B 1/06**

(22) Date of filing: **20.01.94**

(30) Priority: **23.04.93 RU 93021503**

(43) Date of publication of application:
26.10.94 Bulletin 94/43

(84) Designated Contracting States:
AT BE DE FR GB IT

(71) Applicant: **BELARUSSIAN STEEL WORKS**
Zhlobin Gomelskoi obl.,
ul Shosseinaya 149
Belarus 247210 (RU)

(72) Inventor: **Valerianovich, Baglai Gennady**
Zhlobinh Gomelskoi obl. 16 mkrn.,D.36/45
Belarus (SU)
Inventor: **Alexandrovich, Birjukov Boris**
Zhloblin Gomelskoi obl.,16 mkrn., 15/48
Belarus (SU)
Inventor: **Iosifovich, Dashevsky Lev**
ul. Krasnaya Presnya 38/23
Moscow 123022 (SU)
Inventor: **Ivanovich, Kupry Evgeny**
Bulv. Pobedy, 25/38
Ukraine 256400, Belaya Tserkov (SU)
Inventor: **Vladimirovich, Nenashev Alexandr**
Zhlobin Gomelskoi obl.,16 mkrn., 387187
Belarus 24/210 (SU)
Inventor: **Pavlovich, Fetisov Vasily**
Zhlobin Gomelskoi obl., 16 mkrn., 35/22
Belarus 247210 (SU)

(74) Representative: **Gramm, Werner, Prof. Dipl.-Ing.**
Patentanwälte Gramm + Lins
Theodor-Heuss-Strasse 1
D-38122 Braunschweig (DE)

(54) **Twisted-wire product.**

(57) The present invention relates to production of metal cord for reinforcing of tyres and other mechanical rubber goods.

The essence of the present invention resides in that in a twisted-wire product, comprising strands (1) wound together spirally and laid of spirally wound wires (2), the ratio between the diameter (8) of wires (2) and the diameter (D) of the product itself is within 0.135 and 0.206. In addition, the ratio between the number of wires (2) in each strand (1) to the number of strands (1) in the product is so selected that the ratio between the perimeter (P) of the exposed outer surface of the cross-sectional area equal to unity and a sum moment (W) of bending resistance is in excess of 215.

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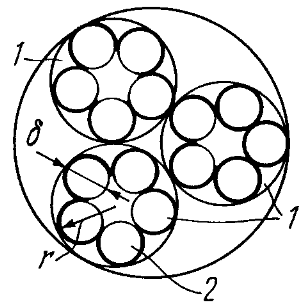
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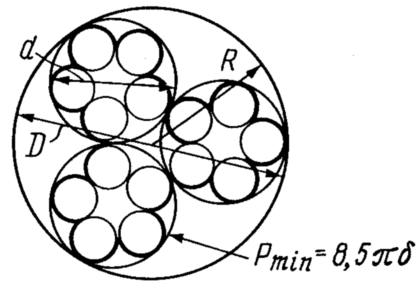
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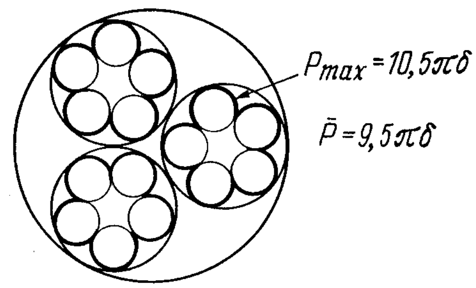
$P_{min} = 8,5\pi\delta$


$P_{max} = 10,5\pi\delta$
$\bar{P} = 9,5\pi\delta$

The present invention relates in general to production of metal cord for reinforcing of tyres and other mechanical rubber goods and more specifically to twisted-wire products.

The principal aim of twisted-wire products made use of for reinforcing of tyres and other mechanical rubber goods is to increase the strength of a rubber-cord component in the finished product, its high flexibility remaining unaffected. Provision of a required flexibility and hence service durability is attained due to a reduced diameter of the wire the product is twisted of, which results in a decreased moment of bending resistance of the product according to the following commonly known relation:

$$W = \sum_{i=1}^{k} 0{,}1\, n_i \cdot \delta_i^3 \qquad (1)$$

where

n_i - the number of wires having the diameter of 'i';

δ_i - the diameter of 'i' wire.

An indispensable prerequisite for producing a rubber-metal composite having high performance characteristics is reliable adhesion of its components. Adhesive power of metal reinforcer is directly proportional to the area open for contact with rubber surface:

$S = P \cdot l$,

where

P - perimeter of the outer exposed surface;

l - length of the twisted-wire product.

With the value of 'l' being invariable the adhesive power is a function of the perimeter of the outer surface of the cross-sectional area of the twisted-wire product, which is found from the following relation:

$$P = \sum_{i=1}^{n} k_i\, \pi \cdot \delta_i \qquad (2)$$

where

k_i - part of the cross-sectional area of the 'i' wire open for contact with rubber;

δ_i - wire diameter.

For comparative assessment of the various constructions of twisted-wire products as to adhesive parameters and flexibility a generalized index I is used, equal to the ratio between the perimeter P of the outer surface of the metallic component, said perimeter determining the adhesive power of the product, and the moment W of resistance to bending, since fatigue strength and flexibility are inversely proportional to said ratio.

Known in the art are multiwire helically twisted wire constructions featuring small-diameter wires, such as 3+9+15 (Be, A, 0,176,139; Fr, A, 0,260,556) and 4+10+20 (cf. The Catalog of metal cord constructions of Pirelli, Italy), characterized by low values of the moment W of bending resistance and of the perimeter P of the exposed outer surface of the metallic component.

The value of the index I for such constructions is rather high. However, such products are highly labor-consuming due to a great number of components they consist of, whereas a reduced number of such components in, e.g., 3+6 or +x5 constructions lead to a higher value of the moment W of bending resistance with a nearly the same value of P and hence to a reduced value of I. Moreover, the presence of a central element in such constructions, e.g., of the 3+6 type, decreases the value of the index I to still higher degree.

Known at present is a prior-art twisted-wire product (Wo, 85/02210) containing strands spirally wound together and consisying of twisted wires having a structure of 3x3, 3x4, 4x4. These rope-lay constructions consisting of a low number of wires meet the requirements of high adhesion because the perimeter P of their outer exposed surface exceeds that in the aforedescribed multiwire compact constructions. However, they have a lower index I due to high moment W of bending resistance.

It is therefore a primary and essential object of the present invention to provide a twisted-wire product featuring such a ratio between its diameter and the diameter of the wires the strands are twisted of, that ensures higher performance characteristics as to flexibility, fatigue strength, and adhesion.

The foregoing object is accomplished due to the fact that a twisted-wire product, comprising strands spirally wound together and laid of spirally wound wires, according to the invention, features a ratio between the diameter of the wires laid into strands and that of the product itself is within 0.135 and 0.206, and the ratio between the number of wires per strand and the number of strands per product is so selected that the minimum ratio between the perimeter of an exposed outer surface of the cross-sectional area equal to unit and a sum moment of bending resistance is 215.

Selection, within the aforesaid range, of the ratio between the diameter of individual wires and that of the product which comprises three or more strands of the rope lay, each of the strands consisting of five wires, that is, having the 3x5, 4x5, and 5x5 constructions provides for high value of the perimeter of the exposed outer surface, said value determining their adequate adhesive power. In addition, this makes it possible to reduce the momend W of bending resistance in the proposed constructions and hence to increase the generalized index I characteristic of the adhesive power and fatigue strength of the proposed construction.

In what follows the proposed invention will now be illustrated in a detailed description of a specific exemplary embodiment thereof with reference to the accompanying drawing, wherein the construction of the herein-proposed twisted product is shown with the various possible combinations of mutual arrangement of wires in the strands.

The twisted-wire product, according to the invention, has three spirally laid strands 1, each consisting of five wires 2 twisted spirally and having a lay radius r which can be found from the relation:

$$r = \frac{d - \delta}{2} = \frac{t \cdot tg\,\alpha}{2\pi} \qquad (3)$$

where

d and δ - diameters of the strand 1 and the wire 2, respectively;

t and α - pitch and lay angle of the wire 2 being wound.

The strands 1 are wound together by a spiral lay having a radius R:

$$R = \frac{D - d}{2} = \frac{T \cdot tg\,\beta}{2\pi} \qquad (4)$$

where

D - diameter of the twisted-wire product;

T and β - pitch and lay angle of the strands 1 being laid.

In this case the ratio between a mean diameter of the wires 2 and the metal-cord diameter is as follows: K = δ/D = 0.196 and ranges within 0.185 and 0.206, and within 0.135 and 0.150 for the 5x5 structure, depending on the wire gauge tolerance of ±0.01 mm.

Table 1

Nos	Construction	Wire diameter*	Perimeter P of exposed surface, mm	Sum moment W of bending resistance	Ratio I = P/W	Percent of Ref. No.1
1	2	3	4	5	6	7
1	3 x 5	$(0,267/\pi)^{0,5}$	8,50	0,0370	229,7	100
2	4 x 5	$(0,20/\pi)^{0,5}$	6,87	0,0320	214,7	93,5
3	5x5	$(0,16/\pi)^{0,5}$	7,62	0,0287	265,5	115,6
4	1x5	$(0,8/\pi)^{0,5}$	5,55	0,0643	86,3	37,6
5	3 + 6	$(0,691/\pi)^{0,5}$	5,30	0,0512	103,5	45,0
6	3 + 9 + 15	$(0,143/\pi)^{0,5}$	5,70	0,0270	211,1	91,9
7	3x3	$(0,444/\pi)^{0,5}$	9,80	0,0480	204,2	88,9
8	3x4	$(0,333/\pi)^{0,5}$	8,57	0,0415	206,5	89,9
9	4x4	$(0,25/\pi)^{0,5}$	7,30	0,0360	202,8	88,3

*Note: Numerical data on wire diameter are obtained proceeding from the assumption that the index I is equal to the area of the metallic component of the twisted-wire product, which rules out the scaling factor.

Table 1 contains comparative data of the proposed construction of a twisted-wire product and of the heretofore-known constructions as for the parameters P, W, and I. An analysis into said data demonstrates that it is due to the use of the five-wire coreless strand 1 as the component of a three- or multistrand rope construction, that is, 3x5, 4x5, 5x5 that the proposed technical solution is advantageous over the heretofore-known ones in that it provides the maximum value of the generalized index I characteristic of the adhesive and fatigue strength characteristics of the proposed construction.

Considered hereinafter as an exemplary practical embodiment of the herein-proposed construction of a twisted-wire product are the geometric and physicomechanical characteristics of the 3x5 metal cord featuring the diameter of the wire 2 equal to 0.18 mm as compared to construction of the 7x3 and 3x0.15 + 0.265 types featuring the wire diameter of 0.15 and 0.265 mm, respectively, both of said constructions having the same breaking strength characteristics and the same ultimate breaking strength value (x = 2800 N/mm^2) of the wires. These data are tabulated in Table 2 below.

Table 2

Nos	Wire diameter and construction	Diameter D of twisted-wire product, mm	Perimeter P of exposed surface, mm	Moment W of bending resistance, mm^3	P/W, mm^{-2}
1	2	3	4	5	6
1	3x5x0.18 mm	0.92	4.8	0.00875	548.6
2	7x3x0.15 mm	1.2	4.0	0.00709	564.2
3	3x0.15+6x0.265	0.83	3.3	0.01218	270.9

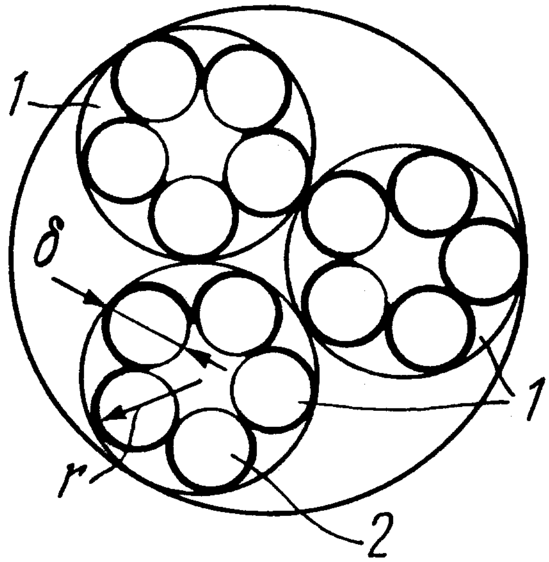
Nos	Ratio between outer wire diameter and diameter D	Brass-plated rope adhesion to rubber according to BISFA, N/mm	Bending endurance to GOST 2387-85 on dia.25 mm roller, thsd of cycles	Total breaking force, N
1	7	8	9	10
	0,185-0.206	380	10.0	890
	0.117-0.133	325	10.0	890
	0.307-0.331	309	4.0	900

Note: The 7x3x0.15 and 3x0.15+6x0.265 constructions comply with GOST 14311-85 and Std. Specs. TU 14-4-1460-87.

It ensues from the data contained in Table 2 that the perimeter P of the exposed outer surface of the product exceeds that in the heretofore-known products of the same character and agrees with the index of rubber adhesion strength. The sum moment W of bending resistance of the herein-proposed construction approximates, as to value, that of the multiwire construction 7x3x0.15 mm which also agrees well with their endurance factor.

Claims

1. A twisted-wire product, comprising strands wound together spirally and laid of spirally wound wires, CHARACTERIZED in that the ratio between the diameter of the wires laid into strands and the diameter of the product itself is within 0.135 and 0.206, and the ratio between the number of wires in each strand and the number of strands in the product is so selected that the minimum ratio between the perimeter of an exposed outer surface of the cross-sectional area equal to unity and a sum moment of bending resistance is 215.


1
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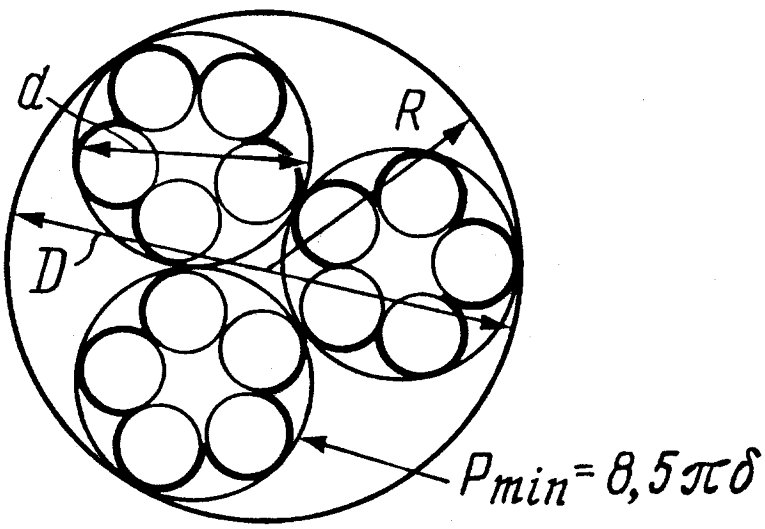
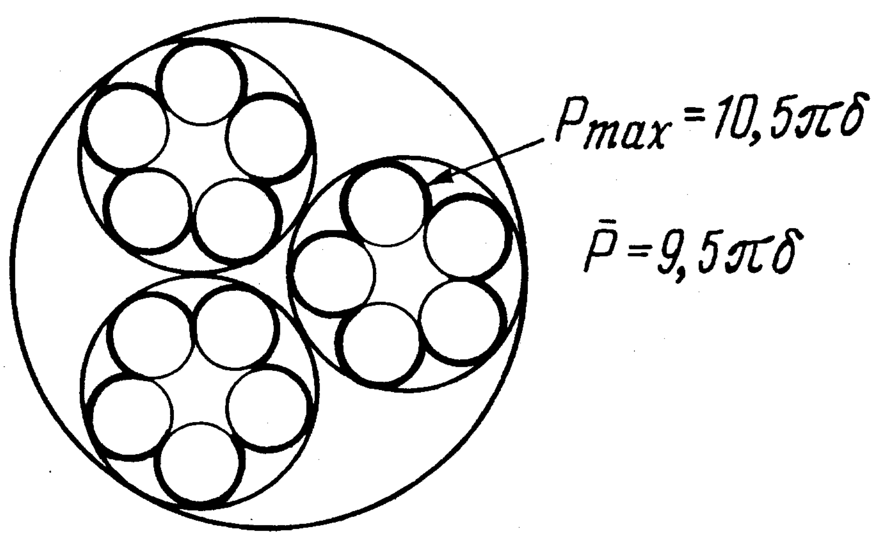

d
R
D
$P_{min} = 8,5\pi\delta$


$P_{max} = 10,5\pi\delta$
$\bar{P} = 9,5\pi\delta$

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EUROPEAN SEARCH REPORT

Application Number
EP 94 10 0757

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.5)
A	EP-A-0 376 272 (SUMITOMO ELECTRIC INDUSTRIES LTD.) * figure 4 * ---	1	D07B1/06
A	BE-A-622 904 (NATIONAL-STANDARD COMPANY) * claims 1-3; figure 1 * -----	1	
			TECHNICAL FIELDS SEARCHED (Int.Cl.5)
			D07B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	12 July 1994	Goodall, C

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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