Metal cord (1), in particular for use in the reinforcing structures of elastomer-based products, especially tyres for vehicle wheels, comprising two basic wires (2A, 2B) which are wound together and at least one of which is flexurally deformed and the other of which is free from torsional deformations. The description also illustrates two methods for producing the abovementioned cord (1) as well as the rubberized fabrics reinforced with the cord (1) according to the invention and the products made with said rubberized fabrics.
FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

| AL | Albania | AM | Armenia | AT | Austria | AU | Australia | AZ | Azerbaijan | BA | Bosnia and Herzegovina | BB | Barbados | BE | Belgium | BF | Burkina Faso | BG | Bulgaria | BJ | Benin | BR | Brazil | BY | Belarus | CA | Canada | CF | Central African Republic | CG | Congo | CH | Switzerland | CI | Côte d'Ivoire | CM | Cameroon | CN | China | CU | Cuba | CZ | Czech Republic | DE | Germany | DK | Denmark | EE | Estonia | ES | Spain | FI | Finland | FR | France | GB | United Kingdom | GE | Georgia | GH | Ghana | GN | Guinea | GR | Greece | HU | Hungary | IE | Ireland | IL | Israel | IS | Iceland | IT | Italy | JP | Japan | KE | Kenya | KG | Kyrgyzstan | KP | Democratic People's Republic of Korea | KR | Republic of Korea | KZ | Kazakhstan | LC | Saint Lucia | LI | Liechtenstein | LK | Sri Lanka | LR | Liberia | LS | Lesotho | LT | Lithuania | LU | Luxembourg | LV | Latvia | MC | Monaco | MD | Republic of Moldova | MG | Madagascar | MK | The former Yugoslavia | ML | Mali | MN | Mongolia | MR | Mauritania | MW | Malawi | MX | Mexico | NB | Niger | NL | Netherlands | NO | Norway | NZ | New Zealand | PL | Poland | PT | Portugal | RO | Romania | RU | Russian Federation | SD | Sudan | SE | Sweden | SG | Singapore | SI | Slovenia | SK | Slovakia | SN | Senegal | SZ | Swaziland | TD | Chad | TG | Togo | TJ | Tajikistan | TM | Turkmenistan | TR | Turkey | TT | Trinidad and Tobago | UA | Ukraine | UG | Uganda | US | United States of America | UZ | Uzbekistan | VN | Viet Nam | YU | Yugoslavia | ZW | Zimbabwe |
METAL CORD FOR REINFORCING ELASTOMERIC PRODUCTS AND METHOD FOR THE MANUFACTURE THEREOF

The present invention relates to the metal cords usually used as reinforcing elements in elastomer-based composite products and, more particularly, relates to a cord comprising a group of two basic wires which are wound together about the axis of longitudinal extension of the cord. The abovementioned cord has a fatigue strength which is decidedly greater than that of cords of the same type known in the art.

It is known that a metal cord consists of a plurality of basic wires which are twisted together in different geometric configurations which are stabilised by means of a suitable permanent deformation, at least of a flexural nature, imparted to the abovementioned wires.

So-called rubberized fabrics which form a basic semi-finished product in the preparation of elastomer-based articles - referred to hereinbelow simply as rubber articles - are also known. These fabrics essentially consist of a sheet of rubber in which reinforcing cords consisting of textile or metallic material are incorporated, being distributed parallel to one another and with predetermined thickness values. Strips of fabric, of varying dimensions and with a predetermined angle of lay of the cords are obtained from this sheet, and these strips form the main reinforcement and/or the auxiliary reinforcing elements of the abovementioned articles: the latter are usually prepared by assembling a plurality of different semi-finished products, some of which consist precisely of the abovementioned strips of rubberized fabric. The metal cords intended to reinforce said articles are required to posses a good penetrability of the rubber between the constituent wires, as well as a high structural strength so as to ensure optimum performance of the article during use.
The cord according to the invention is particularly suitable for use in the manufacture of tyre components for motor vehicles, such as for example carcass and/or belt plies, but may also be advantageously used in the manufacture of other products, such as for example pipes for high-pressure fluids, belts, conveyor belts or any other article consisting of an elastomer-based composite material.

Normally the cords of this type are produced using a stranding machine of the so-called double-twist type, provided with a rotor which is operationally coupled to a support structure and rotatable by motor means, as well as with a so-called "cradle", which is fastened to the rotor in an oscillating manner along an axis coinciding with the axis of rotation of the rotor. The cradle carries a plurality of supply reels onto which the basic wires are wound beforehand, said wires, by means, of suitable supply and guiding means, being grouped together and guided through the stranding machine along a predetermined stranding path during which the wires undergo the permanent deformations necessary for providing the final cord with properties of stability and compactness.

Recently, tyre technology has undergone significant changes in accordance with the present-day requirements of the market where there is a demand for increasingly lighter tyres which are capable of a very good handling performance and at the same time have a very low rolling resistance, so as to minimize the fuel consumption of the vehicle.

The rolling resistance remarkably depends on the flexibility of the tyre, which conditions the way in which it is deformed during travel in the impression area underneath.

In this context metal reinforcing cords consisting of a very small number of basic wires twisted together have become of fundamental importance since they allow the production of rubberized fabrics which are extremely
flexible and very light both owing to the reduced weight of the metal and owing to the smaller quantity of rubber which is required for incorporation of the reinforcing cords into the rubber sheet, in view of the smaller diameter of these cords. The cords, moreover, owing to their structural simplicity, can be easily penetrated by the rubber which is thus able to cover almost entirely the constituent wires, thus providing them with long-lasting protection from corrosion.

Obviously, with a reduction in the number of wires of the cord, the importance of the mechanical strength properties of the individual wires and the cord as a whole correspondingly increases, so as to ensure that the cord has the necessary structural strength and the finished product has a high fatigue strength.

These characteristics have been mainly sought after through the use of stronger materials among which the most commonly used are high-strength steels which are identified in the art by the abbreviations HT, SHT and UHT (High Tensile, Super High Tensile and Ultra High Tensile), i.e. steels with a very high carbon content, greater than 0.9%.

Cords composed of more than four wires which are wound together in configurations known in the art as 1x4, 2+2, 1+2, 2x, 3x have thus become available in the tyre industry. The simplest of these cords is the well-known cord 2x0.30 HT, i.e. a cord consisting of two basic wires which are twisted together, each with a diameter equal to 0.30 mm and made of HT steel.

The patents US 4,022,009, US 4,408,444 and EP 225,055 provide a substantially complete and reliable illustration of the state of the art attained in this sector.

The drawback of this type of cord consists in a drop in the mechanical fatigue strength values due to temporary and permanent deformations imparted to the wires of the cord by the stranding process, with a consequent
reduction in the qualitative level of the finished product, in particular the tyre.

The Applicants have noticed that there was the possibility of remedying this drawback, by further improving the already high performance of the known cord 1x2 by simply modifying the process of preparation of the abovementioned cord.

The object of the present invention is therefore that of providing steel cords which have a very high fatigue strength, in particular flexural fatigue strength, and within this context that of providing cords which are less costly than those which are currently commercially available.

According to a first aspect thereof, the invention relates to a metal cord, in particular for reinforcing composite products made of elastomeric material, comprising two basic wires which have a diameter preferably of between 0.10 and 0.50 mm and which are wound together and around the axis of longitudinal extension of the cord, characterized in that one of said basic wires is deformed at least flexurally along a generatrix of its external lateral surface, while the other wire is free from torsional deformations.

Preferably, the basic wires of said metal cord are wires with the same diameter, said diameter being preferably between 0.12 mm and 0.38 mm and even more preferably between 0.22 mm and 0.38 mm.

In a different embodiment the winding pitch of said wires in the cord is preferably between 3 mm and 50 mm and even more preferably between 6 mm and 30 mm.

In an alternative embodiment, the cord comprises two wires with different diameters, the difference in said diameters being preferably between 0.01 and 0.03 mm.

In yet another version, the torsion-free wire of the cord is flexurally deformed permanently.

According to a second aspect thereof, the invention also relates to a method for the manufacture of
a metal cord, in particular for reinforcing composite products made of elastomeric material, comprising two basic wires which have a diameter preferably of between 0.10 and 0.50 mm and which are wound together and around the axis of longitudinal extension of the cord, said method comprising the steps of deforming one of said basic wires at least flexurally along a generatrix of its external lateral surface and leaving the other wire torsionally undeformed.

An alternative method of preparing said cord envisages permanently deforming flexurally the torsionally undeformed wire, imparting said permanent flexural deformation along a cylindrical helix extending over the external lateral surface of said wire.

According to a different aspect thereof, the invention also relates to a rubberized fabric for use as a structural component of composite products made of elastomeric material, said fabric essentially consisting of a rubber sheet incorporating, distributed parallel to one another in accordance with a predetermined thickness value, metal reinforcing cords comprising two basic wires which are helically wound together and around the axis of longitudinal extension of the cord (1), characterized in that in said cords one of said basic wires is permanently deformed at least flexurally along a generatrix of its external lateral surface, while the other wire, which is wound around the first of said wires, is substantially free from torsional deformations about its axis.

According to another alternative aspect thereof, the invention relates to a tyre for vehicle wheels which comprises a torus-shaped carcass, a tread located on the periphery of said carcass, a pair of axially facing sidewalls terminating in beads reinforced with bead wires and associated bead filling elements, for fixing said tyre to a corresponding mounting rim, said tyre comprising rubberized fabrics reinforced with metal reinforcing cords comprising two basic wires which are helically wound
together and around the axis of longitudinal extension of the cord, characterized in that in said cords one of said basic wires is deformed permanently, at least flexurally, along a generatrix of its external lateral surface, while the other wire, which is wound around the first wire, is substantially free from torsional deformations about its axis.

Further characteristic features and advantages will emerge more clearly from the detailed description of a few preferred, but not exclusive, embodiments of a metal reinforcing cord, to be used particularly in elastomer-based composite products, as well as a few methods and an apparatus intended for the manufacture of said cord, in accordance with the present invention.

This description will be provided hereinbelow with reference to the accompanying drawings, provided only by way of example and therefore in a non-limiting manner, in which:

Figure 1 is a side view of a section of cord in accordance with the present invention;

Figure 2 shows a side view of a known stranding device set up for production of the cord according to Figure 1 in accordance with a first preferred mode of implementation of the method according to the invention;

Figure 3 shows a side view of the stranding device according to Figure 2 set up for the production of the cord according to Figure 1 in accordance with a second preferred mode of implementation of the method according to the invention;

Figure 4 shows a partial, right-angled section through a tyre provided with constituent parts comprising reinforcing cords according to the invention.

With reference to the said figures, numeral reference 1 denotes in its entirety a metal reinforcing cord to be used in particular in elastomer-based composite products, especially motor vehicle tyres, in accordance with the present invention.
In a manner known per se, the cord 1 comprises a first basic wire 2a, which is wound helically onto a second basic wire 2b and around the axis of longitudinal extension of the cord itself. Preferably the abovementioned wires are made of steel with a carbon content of between 0.65% and 0.98% and have a diameter of between 0.10 mm and 0.50 mm, which is not necessarily the same. In this case, however, the difference in diameter between the larger-diameter wire and the smaller-diameter wire is preferably between 0.01 mm and 0.20 mm, but is more preferably limited to between 0.01 mm and 0.05 mm and even more preferably contained between 0.02 and 0.03 mm.

In a first embodiment of the present invention, the two basic wires have different diameters, respectively of between 0.20 mm and 0.40 mm in the first wire and between 0.12 mm and 0.38 mm in the second wire, with a difference between said diameters of the wires lying between 0.02 and 0.08 mm.

In a different preferred embodiment, the wires instead have the same diameter, preferably of between 0.25 mm and 0.32 mm and more preferably equal to 0.30 mm.

In accordance with the invention, in any embodiment, one of said wires (2a) is permanently deformed both flexurally and torsionally while the other wire is free from torsional deformation and, at the most, is deformed exclusively flexurally.

Preferably the flexural deformation of the first wire extends along a generatrix of the radially external surface of the wire, parallel to the axis of said wire, while the flexural deformation of the second wire, when present, extends along a cylindrical helix on the radially external surface of the wire.

The particular features and constructional characteristics of the cord 1 according to the invention will be easily understood on the basis of the following description, both of the apparatus used and of the method
followed for manufacture thereof.

With particular reference to Figure 2, the machine for the production of the metal reinforcing cord 1 comprises, in a manner known per se, a supporting structure 4 which is fixed to the ground and on which a so-called rotor 5 is rotatably engaged, said rotor being driven in rotation by means of a motor 8 or equivalent means which allow rotation of the rotor about its horizontally arranged axis. The rotor 5 has mounted internally, coaxial with its axis of rotation, a so-called cradle 6 which is freely rotating with respect to said rotor and on which at least one wire supply reel 7 having wound on it one of the abovementioned basic wires, for example the wire 2a, is operationally engaged.

The rotor 5 essentially consists of a pair of bell members 51, 52 which are arranged coaxially, locked together in rotation and each mounted by means of hollow hubs 53, 54 on a corresponding support 41 of the supporting structure 4.

Suitable wire-guiding means are mounted both on the cradle 6 and on the rotor 5, said means essentially consisting of a plurality of drive rolls 55, 56, 57, 58, 30, 31, 32, 33, 34, 35, 36 which are only partially indicated in schematic form since they are known per se and conventional, so as to guide in a suitable manner the basic wires through the machine, along a specific stranding path.

Preferably, a pre-forming device 37, which comprises essentially an idle roll arranged along an axis perpendicular to the direction of feeding of the wires 2a, 2b, is also mounted on the cradle. The basic wire, being wound onto the pre-forming device 37 at an angle of between 10° and 180°, preferably equal to about 60°, undergoes permanent flexural deformation which is intended to assist the subsequent operations involving stranding together with the other wire.

More particularly, the pre-forming device consists
of a roller provided with a plurality of pre-forming seats consisting of circumferential grooves which are formed in positions arranged parallel alongside one another on the cylindrical surface of the pre-forming roller and which are each designed to engage operationally with a respective basic wire.

In order to ensure that pre-forming is performed correctly on the individual basic wires 2a, 2b also in the case of a difference in their diameters, each of said circumferential grooves is shaped and dimensioned in accordance with only one of the basic wires themselves and in particular has a width substantially equivalent to the diameter of the corresponding basic wire, a bottom portion with a semi-circular profile having an axis coplanar with that of the bottom portions of the other circumferential grooves and a depth related to the diameter of the corresponding basic wire 2a, 2b so that the latter is deviated along a radius of curvature which is specifically chosen in relation to the diameter of the wire itself.

The degree of pre-forming may be controlled both by varying the abovementioned radius of curvature and (preferably) by varying the tension applied to the wire, i.e. the pulling force exerted by the capstan, for the same radius of curvature, as moreover is already known.

The machine also comprises two external rolls, i.e. an output roll A and an input roll B and a support (not shown) for an external supply reel which is arranged upstream of the roll B with respect to the direction of feeding of the wire and which supplies the second wire 2b, in accordance with a constructional method according to the invention.

Finally, the machine also comprises a pulling device (the already mentioned capstan) and a device for storing the finished cord which is located downstream of the roll A and which may comprise the usual wire-straightening devices, such as the dummy twister for eliminating the residual tensions in the finished cord,
all of which are not illustrated since they are known and conventional and not particularly relevant for the purposes of the present invention.

As regards the drive rolls 55, 56, 57, 58 located on the rotor it should be noted that they are mounted on the said hollow hubs so that their surface of rotation is substantially tangential to the common axis of rotation of the cradle and the rotor.

As for the drive rolls 31 and 35, they are mounted on the cradle so that the common tangent to their surface of rotation, which represents the path of a wire passing directly from one roll to another, does not have points which interfere with the pre-forming roller 37, but is at the most tangential thereto.

Finally, it should be remembered that, during operation of the machine, the rotor rotates about its axis, while the cradle, which is mounted freely rotating - and hence is idle - on the hubs of the rotor, does not rotate, but at the most performs a few oscillations about its axis during the start-up and stop transients of the machine.

As a result, the axes of the rolls 55, 56, 57, 58 also rotate together with the rotor, while the axes of all the rolls mounted on the cradle, in particular the axes of the rolls 30 and 36 as well as, obviously, the axes of the rolls A and B, remain stationary.

Having become familiar with the machine, it is now possible to describe the method for preparing the cord: according to the invention, this method envisages that one of the wires forming the cord is supplied no longer from the inside but from the outside of the cording machine, thus envisaging a different method of preparation of the cords and at the same time providing cords with a new configuration, even though having an already known structure (i.e. two component wires).

The wire 2a supplied by the reel 7, via a series of drive rolls 33, 32 and 34, is conveyed onto the pre-
forming roller 37 where it undergoes a permanent flexural deformation along a line parallel to the axis of the wire, i.e. along a generatrix of its external lateral surface.

The wire 2a is coupled to the wire 2b which is supplied from the outside of the cabling machine, on the roll 34 or on the roll 35, depending on the method used, as will be seen further below, and the two wires are conveyed first onto the roll 36 and then onto the roll 52 and from here, via the hollow hub 54, onto the external surface of the bell members 52 and 51, reversing their direction of feeding. Finally, via the hollow hub 53, they reach the roll 55 and from here pass onto the roll A so as to reach the reel for storing the finished cord.

Recalling what has already been said regarding the relative rotation of the axes of the drive rolls it can be easily understood that, in the section between the rolls 36 and 57, the two wires undergo a first twisting action as a result of which they are wound together so as to produce a cord.

The cord thus formed runs on the outside of the bell members towards the roll 55 which deviates it onto the roll A. It is obvious that, along the section between these two rolls, the cord undergoes additional twisting in the same direction as the previous twisting operation, owing to the relative rotation between the axis of the roll 55, rotating about the axis of the stranding machine, and the axis of the roll A, which is stationary. It can be easily understood that the wire 2a, owing to the processing undergone while passing through the stranding machine, upon leaving the said machine, in addition to the flexural deformation received on the pre-forming device, also has a torsional deformation about its own axis.

If we now consider processing of the wire 2b supplied by the external reel, said wire passes from the roll B onto the roll 58, via the hollow hub 54, and from here is brought outside the rotor and along the latter to its opposite end where it enters into the hollow hub 53,
passing onto the roll 56 so as to arrive inside the rotor onto the drive roll 30 and from here onto the roll 31.

Along the abovementioned path this wire obviously undergoes a first twisting action between the rolls B and 58 and a second twisting action in the same direction between the rolls 56 and 30, as can be easily understood from the fact that the rolls B and 30 have a stationary axis, while the rolls 58 and 56 have a rotating axis.

From the roll 31, in accordance (Fig. 2) with a first method of preparation, the twisted cord 2b is conveyed onto the roll 38, where it is coupled to with the wire 2a supplied by the reel 7, and then passes together with the latter wire onto the pre-forming device 37.

It is therefore obvious that, owing to the said twisting actions previously undergone, the permanent flexural deformation along a line parallel to the direction of feeding of the wire, imparted on the pre-forming device, will extend along the wire in the manner of a cylindrical helix lying on the external lateral surface thereof and rotating about the axis of the wire in the untwisted condition.

The method described is particularly advantageous in the case of cords which have wires with different diameters.

In accordance with a different method of preparation (Fig. 3), the wire 2b which reaches the roll 31 twisted is instead conveyed directly onto the roll 35 where it is coupled to the wire 2a supplied by the pre-forming device 37, and then passes together with the latter wire onto the roll 36.

In this case the wire 2b does not undergo obviously any flexural deformation.

From the roll 35 the two wires follow the path already illustrated above, undergoing the abovementioned twisting operations between the pairs of rolls 36, 57 and 55, A, being wound helically together so as to form the desired cord.
It must be noted, however, that, whereas for the wire 2a supplied by the reel 7, the last two said twisting operations are final twisting operations, in the case of the wire 2b, supplied by the external reel and previously twisted between the rolls B, 58 and 56, 30, these subsequent twisting operations are in reality untwisting operations which bring the wire back into the untwisted state, therefore leaving it torsionally undeformed.

The relationship existing between the speed of rotation of the rotor 5, which is preferably between 2000 and 6000 revs/minute, and the speed of feeding of the cord 1, and hence of the basic wires 2a, 2b, which is preferably between 60 and 250 m/minute, determines the value of the winding pitch, namely the pitch with which the basic wires 2a, 2b are helically wound together in the finished cord 1.

In a preferred solution of the invention, this stranding pitch has a value of between 3 mm and 50 mm, preferably between 6 mm and 30 mm, and even more preferably limited between 14 mm and 16 mm.

The cord according to the invention has proved to have a very high fatigue resistance, in particular if compared to the known cords. More specifically, the Applicants have subjected to a flexural fatigue test, known to persons skilled in the art as FFF (Firestone Flexion Fatigue) test or Wallace test, the cord according to the invention (0.30+0.30 HT) compared with the known cord 2x0.30 HT.

The test is carried out on a strip of rubberized fabric by subjecting the strip to a series of cyclical flexing movements caused by moving alternatively the fabric strip in both directions about a roller of suitable dimensions, using a predefined load which has been suitably chosen in relation to the dimensions of the reinforcing cords of the fabric sample.

The abovementioned test was carried out on a strip of rubberized fabric reinforced with metal cords arranged
with a thickness equivalent to 100 cords/decimetre, applying a predefined load of 150 pounds to the ends of the strip and using a roller with a diameter equal to 32 mm.

The results are shown in the following table:

<table>
<thead>
<tr>
<th>Cord structure</th>
<th>Pitch</th>
<th>Duration of test</th>
</tr>
</thead>
<tbody>
<tr>
<td>2x0.30 HT</td>
<td>14/s</td>
<td>3500 kilocycles (test interrupted owing to breakage of cords)</td>
</tr>
<tr>
<td>0.30+0.30 HT</td>
<td>14/s</td>
<td>13500 kilocycles (test interrupted without breakage of cords)</td>
</tr>
</tbody>
</table>

The cord according to the invention has proved to be particularly useful for reinforcing elastomer-based composite products and more specifically for the production of rubberized fabrics for use in tyres.

The cords according to the invention are distributed in the abovementioned fabrics with a thickness preferably of between 70 and 180 cords/decimetre.

Figure 4 shows a generic tyre comprising rubberized fabrics provided with reinforcing cords according to the invention.

With reference to this Figure, the tyre to which the invention relates preferably comprises a carcass 100 which is internally lined with an airproof rubber sheet 110, a tread 120 which is located on the periphery of said carcass, a pair of axially facing side-walls 130 terminating in beads 140 reinforced with bead wires 150 and associated bead filling elements 160, for fixing said tyre to a corresponding mounting rim. The tyre may further comprise reinforcing edges 190 and, in the case of radial-carcass tyres, also a belt structure 210 arranged between carcass and tread.

The carcass 100 comprises one or more carcass
plies which are fixed to said bead wires 150, for example are folded around the abovementioned bead wires from the inside towards the outside. The carcass ply or plies are formed by sections of rubberized fabric reinforced with textile or metal cords 220 embedded in the rubber of the fabric and shown in schematic form.

The belt structure 210 comprises two belt strips 230 and 240, which are radially arranged on top of one another, and a third belt strip in a radially outermost position.

The belt strips 230 and 240 are formed by sections of rubberized fabric incorporating, preferably according to the invention, metal cords which are parallel to one another in each strip and intersect with those of the adjacent strips and are inclined preferably in a symmetrical manner with respect to the equatorial plane of the tyre 100, while the belt strip 250 is provided with cords which are oriented circumferentially, i.e. at zero degrees with respect to the abovementioned equatorial plane.

Similarly other component elements of the tyre may be formed by sections of rubberized fabric with reinforcing cords which are suitably inclined with respect to the axial, radial and/or circumferential direction of the tyre in accordance with requirements: for example, the said reinforcing edge 190 has cords which are inclined at an angle of between 30° and 60° with respect to the radial direction.

All the abovementioned reinforcing cords may be made of any suitable material, in particular textile or metal material; with regard to the functional characteristics required in the tyre, the invention relates in particular to the use of metal cords consisting of two wires which are wound together in accordance with the invention, as per the description above.

The invention thus achieves the preset objects.

The cord obtained has excellent rubberization
properties owing to its structural simplicity as well as its considerable mechanical strength, high flexibility and high fatigue strength.

Since the basic wires 2a, 2b are fully lined with the elastomeric material, the risk of premature corrosion of the cord wires owing to exposure of the metal to moisture is drastically reduced. The complete rubberization of the wires 2a, 2b moreover effectively prevents undesired phenomena of friction between the wires themselves which tend to occur in particular in the case of cords used in the manufacture of tyres.

The cord of the preceding example, which is made with the geometrical and dimensional parameters and in accordance with the methods specified during the course of the description, has a breaking load of between 400 N and 490 N and an ultimate elongation of between 1.5% and 2.5%, these being standard values for cord produced with steel wires having a carbon content equal to 0.8%.

It has thus been shown how the stranding method according to the invention has not adversely affected in any way the mechanical strength of the cord compared to the best cords of the known art.

The cord according to the invention is also very suitable for forming a reinforcing element for more complex cords, for example the central element of a layered cord having a core of two wires or one of the elements of a stranded cord with one or more of the component strands being formed by a cord with two or more wires.

Finally, the cord according to the invention, as a result of the constructional method used, is more economical than the cords with an equivalent configuration according to the state of the art.
CLAIMS

1. Tyre for vehicle wheels which comprises a torus-shaped carcass 100, a tread 120 located on the periphery of said carcass, a pair of axially facing sidewalls 130 terminating in beads 140 reinforced with bead wires 150 and associated bead filling elements 160, for fixing said tyre to a corresponding mounting rim, said tyre comprising rubberized fabrics reinforced with metal reinforcing cords comprising two basic wires which are helically wound together and around the axis of longitudinal extension of the cord (1), characterized in that in said cords one of said basic wires is deformed permanently, at least flexurally, along a generatrix of its external lateral surface, while the other wire is substantially free from torsional deformations about its axis.

2. Rubberized fabric for use as a structural component of composite products made of elastomeric material, said fabric essentially consisting of a rubber sheet incorporating, distributed parallel to one another in accordance with a predetermined thickness value, metal reinforcing cords comprising two basic wires which are helically wound together and around the axis of longitudinal extension of the cord (1), characterized in that in said cords one of said basic wires is permanently deformed at least flexurally along a generatrix of its external lateral surface, while the other wire is substantially free from torsional deformations about its axis.

3. Method for the manufacture of a metal cord, in particular for reinforcing composite products made of elastomeric material, comprising two basic wires which have a diameter preferably of between 0.10 and 0.50 mm and which are wound together and around the axis of longitudinal extension of the cord, said method comprising the steps of deforming permanently one of said basic wires
(2a) at least flexurally along a generatrix of its external lateral surface, leaving the other wire torsionally undeformed.

4. Method according to Claim 3, characterized by the fact of permanently deforming flexurally the torsionally undeformed wire, imparting said permanent flexural deformation along a cylindrical helix extending over the external lateral surface of said wire.

5. Metal cord, in particular for reinforcing composite products made of elastomeric material, comprising two basic wires (2a, 2b) which have a diameter of between 0.10 and 0.50 mm and which are wound together and around the axis of longitudinal extension of the cord (1), characterized in that one of said basic wires is permanently deformed at least flexurally along a generatrix of its external lateral surface, while the other wire is substantially free from torsional deformations about its axis.

6. Metal reinforcing cord according to Claim 5, characterized in that the basic wires (2a, 2b) of said pair are wires with the same diameter.

7. Metal reinforcing cord according to Claim 5, characterized in that the wires (2a, 2b) of said pair have a diameter of between 0.12 and 0.38 mm.

8. Metal reinforcing cord according to Claim 5, characterized in that said wire substantially free from torsional deformations is permanently deformed flexurally along a cylindrical helix extending over its external lateral surface.

9. Metal reinforcing cord according to Claim 5, characterized in that the winding pitch of said wires (2a, 2b) is preferably between 3 mm and 50 mm.

10. Metal reinforcing cord according to Claim 5, characterized in that the wires (2a, 2b) of said pair have different diameters, the difference in said diameters being preferably between 0.01 mm and 0.28 mm.
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 D07B1/06 D07B3/02

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)
IPC 7 D07B

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 practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>EP 0 225 055 A (GENCORP INC.) 10 June 1987 (1987-06-10) cited in the application column 2, line 31 - line 51</td>
<td>1,2,5,6</td>
</tr>
<tr>
<td>A</td>
<td>WO 97 34043 A (N.V. BEKAERT S.A.) 18 September 1997 (1997-09-18) claims 1,10 page 5, line 23 - page 6, line 14 page 7, line 15 - line 26</td>
<td>3-6,8</td>
</tr>
</tbody>
</table>

Further documents are listed in the continuation of box C. Patent family members are listed in annex.

* Special categories of cited documents:
  "A" document defining the general state of the art which is not considered to be of particular relevance
  "E" earlier document but published on or after the international filing date
  "L" document which may throw doubt 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 reason
  "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
  "X" document of particular relevance; the claimed invention cannot be considered the invention
  "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is taken alone
  "Z" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
  "M" document member of the same patent family

Date of the actual completion of the international search: 29 March 2000

Date of mailing of the international search report: 06/04/2000

Name and mailing address of the ISA
European Patent Office, P.B. 5818 Patenten 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epos nl, Fax (+31-70) 340-3018

Authorized officer: Goodall, C
<table>
<thead>
<tr>
<th>Patent document cited in search report</th>
<th>Publication date</th>
<th>Patent family member(s)</th>
<th>Publication date</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>ES 2003924 A</td>
<td>01-12-1988</td>
</tr>
<tr>
<td></td>
<td></td>
<td>JP 62117893 A</td>
<td>29-05-1987</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PT 83736 A</td>
<td>17-06-1987</td>
</tr>
<tr>
<td>WO 9734043 A</td>
<td>18-09-1997</td>
<td>AU 1879197 A</td>
<td>01-10-1997</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EP 0886693 A</td>
<td>30-12-1998</td>
</tr>
<tr>
<td></td>
<td></td>
<td>US 5743078 A</td>
<td>28-04-1998</td>
</tr>
<tr>
<td></td>
<td></td>
<td>AT 183785 T</td>
<td>15-09-1999</td>
</tr>
<tr>
<td></td>
<td></td>
<td>AU 710949 B</td>
<td>30-09-1999</td>
</tr>
<tr>
<td></td>
<td></td>
<td>AU 7403696 A</td>
<td>26-06-1997</td>
</tr>
<tr>
<td></td>
<td></td>
<td>BR 9604739 A</td>
<td>21-01-1998</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CA 2193616 A</td>
<td>22-06-1997</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CZ 9603786 A</td>
<td>16-07-1997</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DE 69603940 D</td>
<td>30-09-1999</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DE 69603940 T</td>
<td>17-02-2000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>JP 9193606 A</td>
<td>29-07-1997</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PL 317561 A</td>
<td>23-06-1997</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SK 164296 A</td>
<td>09-07-1997</td>
</tr>
<tr>
<td></td>
<td></td>
<td>TR 970546 A</td>
<td>21-07-1997</td>
</tr>
<tr>
<td></td>
<td></td>
<td>US 6021633 A</td>
<td>08-02-2000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>US 5797257 A</td>
<td>25-08-1998</td>
</tr>
</tbody>
</table>