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(71) Applicant: **NV BEKAERT SA** [BE/BE]; Bekaertstraat 2,
8550 Zwevegem (BE).

(72) Inventors: **ZHANG, Aijun**; Room 302 - Building 5Park
Road, Jiangyin, Jiangsu 214434 (CN). **MA, Haijun**; No.
5 Dong Wai Huan Road Binjiang Economic Development
Zone, Jiangyin, Jiangsu 214434 (CN).

(74) Agent: **MESSELY, Marc**; Bekaertstraat 2, 8550 ZW-
EVEGEM (BE).

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(54) Title: A STEEL CORD FOR RUBBER REINFORCEMENT

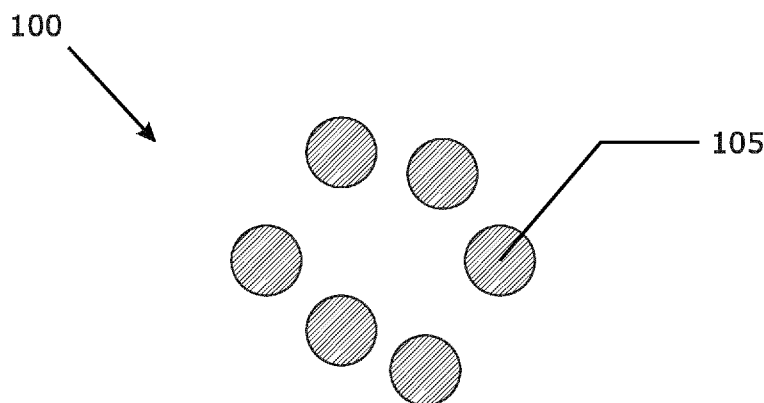


Fig. 1

(57) Abstract: The invention provides a steel cord for rubber reinforcement. The steel cord comprises two or more steel wires, two or more steel wires are twisted to form the steel cord, at least one steel wire has obtained a preforming wherein the preformed steel wire has an elongation at 50N with a preload of 2.5N being larger or equal to 0.7% when being unravelled from said steel cord, the centreline of the preformed steel wire forms a helical line when being unravelled from the steel cord, the projection of the helical line over one twist in a plane perpendicular to the central axis of the helical line shows an ellipse, the ellipse has a major axis and a minor axis, the ellipse has an ellipticity within one twist which is expressed by the ratio of the major axis and the minor axis, the average ellipticity of the at least one preformed steel wire over three consecutive twists is ranging from 1.02 to 1.50. The invention steel cord has full rubber penetration performance.



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Title: A steel cord for rubber reinforcement**Description****Technical Field**

[0001] The invention relates to a steel cord for rubber reinforcement. The
5 invention also relates to a rubber article reinforced by the steel cords.

Background Art

[0002] Steel cord comprising at least two steel wires is used as a reinforcement
for rubber product, such as rubber belt, rubber tire hose and etc. The at
least two steel wires are twisted together to form a steel cord.

10 [0003] It is already known that the steel cord for reinforcing rubber tire is required
to have a certain strength, corrosion resistance, fatigue resistance, rubber
penetration property, rubber adhesion property and etc.. Rubber
penetration property is one property of the steel cord showing in what
extent the rubber can penetrate into the steel cord. The rubber penetrates
15 into the steel cord and fills the gaps among the steel wires and thereby
reduces the cavity inside the steel cord, thereby the moisture is prevented
to enter into the steel cord, and this avoids the steel wires of the steel cord
to be corroded, this ensures the long lifetime of the steel cord. High rubber
penetration property is always desired for a steel cord.

20 [0004] Open steel cord is one type of steel cord which is developed for high
rubber penetration property. Open steel cord means that the steel cord
has quite a lot gaps between the steel wires which make the rubber
penetrating into the steel cord relatively easier.

25 [0005] US4258543 discloses an open steel cord, the open steel cord has 3 to 5
steel wires, and the open steel cord has a diameter greater than the
diameter of the same cord in the compact geometric configuration. The
individual wires are preformed by bending according to a radius of the
curvature of a value which is lower than the value required to maintain the
wires helicoidally wound together in the compact geometric configuration,
30 and this means the open steel cord is realized by giving the individual wire
a bending preforming in a certain value. The value of radius of the
curvature is reached by adjusting the diameter of pre-forming device -

pins. The steel cord has improved rubber penetration compared with compact cord.

[0006] JP2007-92259 discloses an open oval steel cord. The open oval steel cord is consisting of n wires. When detecting the cross-section of the steel cord, wires form a helical oval shape with major axis and minor axis different from each other. By making the steel cord and the steel wires having oval spiral shape, the fatigue resistance of the steel cord is improved.

[0007] US4938015 discloses an open oval steel cord. The open oval steel cord is consisting of n wires, each wire inside the open oval steel cord has a helical oval shape which is realized by zigzag arranged straightening rolls. The steel cord with helical oval shaped steel wires has good rubber penetration performance.

[0008] Recently, to satisfy the requirement of the lightweight tire for saving energy, the high tensile strength steel wires are more and more used for making an open steel cord. However, the rubber penetration performance of the open steel cord is not good when the steel wires have a ST class tensile strength or above which means the tensile strength is higher than (4100-2000xD) MPa.

Disclosure of Invention

[0009] The primary object of the invention is to solve the problem mentioned above.

[0010] Another object of the invention is to provide an open steel cord with high rubber penetration performance.

[0011] A third object of the invention is to provide a tire reinforced by the open steel cord.

[0012] According to the first aspect of the invention a steel cord is provided. The steel cord comprises two or more steel wires, two or more steel wires are twisted to form the steel cord, at least one steel wire has obtained a preforming wherein the preformed steel wire having an elongation at 50N with a preload of 2.5N being larger or equal to 0.7% when being unravelled from said steel cord, and the centreline of the preformed steel wire forms a helical line when being unravelled from the steel cord, the projection of the helical line over one twist in a plane perpendicular to the

central axis of the helical line shows an ellipse, the ellipse has a major axis and a minor axis, the ellipse has a ellipticity within one twist which is expressed by the ratio of the major axis and the minor axis, the average ellipticity of the at least one preformed steel wire over three consecutive twists is ranging from 1.02 to 1.50.

[0013] The steel cord according to the invention is an open cord and has full rubber penetration performance, even when the steel wire for forming the steel cord has a super tensile strength, i.e. higher than 4100-2000xD MPa. Full rubber penetration means rubber can penetrate into every gap of the steel cord and thereby there is no cavity inside the steel cord when the steel cord is embedded into the rubber ply. The inventors found that the less the ellipticity of the preformed steel wire brings better rubber penetration to the steel cord, particularly when the ellipticity of the preformed steel wire is in above mentioned certain value range.

[0014] According to the present invention, "preforming" means the steel wire is deformed prior to being twisted to form a steel cord.

[0015] According to the present invention, the helical line of the preformed steel wire is measured when the preformed steel wire is unravelled from the steel cord. This is different from the prior arts wherein the shape of the steel wire is measured when the steel wire is still kept within the steel cord. The helical line of the preformed steel wire detected when the steel wire is unravelled from the steel cord is different from the helical line of the preformed steel wire when the steel wire is kept within the steel cord. The elliptical shape of the steel wire after unravelling is changed due to the elastic stressrelease, and this makes the helical line of the unravelled steel wire being different from the helical line of the steel wire which is still inside a steel cord.

[0016] The helical line of the preformed steel wire unravelled from the steel cord is measured by an axial scanning apparatus as descried in WO95/16816. The apparatus comprises two axially aligned chucks, 100mm apart, for holding the steel wire ends under test. A controlled tension of $3N \pm 1\%$ is applied to the steel wire for example by means of weight. A linear scanning apparatus, such as KEYENCE LS 7001 which comprises the scan system and the process unit integrally designed or KEYENCE LS

3034 laser scan system in combination with a KEYENCE LS 3100 processing unit, is made to travel parallel to the central axis of the helical line of the preformed steel wire by means of an encoding high precision linear drive (accuracy is better than $\pm 10\mu\text{m}$ at a step side of $50\mu\text{m}$). The axis of the steel wire will be called the Z-axis. The measurement plane of the laser scan system is perpendicular to the Z-axis. The laser scan system can scan the outer edges of the wire up to a precision of $\pm 0.5\mu\text{m}$.

[0017] In a first scan at the equidistant discrete measuring positions ' z_j ', ' Δz ' apart, the lower and upper edges of the wire are determined and the average of both is used as the position of the centreline along the axis perpendicular to the Z-axis, i.e. the X-axis. In this way the positions ' $x(z_j)$ ' are measured and stored in a computer. The index ' j ' is the sequential number of the sampled point and counts up to the number of measuring points ' M '.

[0018] Then the chucks are turned 90° and the scan is repeated. Now, the values ' $y(z_j)$ ' along the Y-axis, perpendicular to X and Z-axis are measured and stored. In this way the triplets ' $(x(z_j), y(z_j), z_j)$ ' are obtained that determine the shape of the centreline of the preformed steel wire.

[0019] An alternative way to record ' $(x(z_j), y(z_j), z_j)$ ' is to have two, mutual perpendicular laser scan systems that record both $x(z_j)$ and $y(z_j)$ in one single pass. The procedures for analysing the data remain the same.

[0020] When looking at the X-Y plane being perpendicular to Z-axis which is also the central axis of the helical line of the preformed steel wire unravelled from the steel cord, the shape of the helical line over one twist on the X-Y plane shows elliptical but close to a round circle. "Feret diameter" of the elliptical shape is measured to know the major axis and the minor axis. By rotating the data every 0.5° over 180° to 360° Feret diameters are obtained for one twist, from these 360 Feret diameters the minimum value is the minor axis and maximum value is the major axis of the elliptical shape. For ensuring the data accuracy, the three consecutive twists within 10mm-90mm of the tested wire sample is calculated while the rest data are left out. Three consecutive twists of each preformed steel wire unravelled from the steel cord are tested to get three major axis

and three minor axis, and thereby three ellipticity value are obtained by calculating the ratio of major axis and minor axis. So for one preformed steel wire there are three tested ellipticity values. The average ellipticity of the at least one preformed steel wire is the average value of all the tested ellipticity values of all the preformed steel wire of one steel cord but not the average value of three ellipticity of one individual preformed steel wire.

[0021] According to the invention, the central axis of the helical line of the preformed steel wire over one twist is measured based on the preformed steel wire which is unravelled from a steel cord and has a length of 100mm when it is being given with $3N \pm 1\%$ tension, this means the central axis of the helical line of the preformed steel wire which is unravelled from a steel cord and has a length of 100mm when it is being given with $3N \pm 1\%$ tension is presenting as the central axis of the helical line over one twist. They are the same.

[0022] Preferably the average ellipticity of the at least one preformed steel wire is ranging from 1.08 to 1.38. More preferably the average ellipticity of the at least one preformed steel wire is ranging from 1.10 to 1.27. Most preferably the average ellipticity of the at least one preformed steel wire is ranging from 1.10 to 1.22. This means the preformed steel wire unravelled from the steel cord forms a more round helical shape rather than oval helical shape, and this leads to better rubber penetration of the steel cord.

[0023] Preferably all steel wire of the steel cord are preformed, the average ellipticity of all preformed steel wire is ranging from 1.02 to 1.50.

[0024] The steel cord could have a construction already known in the field. Preferably, the steel cord has a construction of $n \times 1$. And n is preferably to be 3, 4, 5, 6, 7 or 8.

[0025] The present invention is highly adapted for a steel cord comprising steel wires with super tensile strength. According to the invention, the preformed steel wire has a tensile strength being more than $(3890 - 2000 \times D)$ when being unravelled from the steel cord, D is the diameter of preformed steel wire. Preferably the preformed steel wire has a tensile strength being more than $(4130 - 2100 \times D)$ when being unravelled from the steel cord. For a steel wire with super tensile strength, it is difficult to have uniform deformation since the steel wire with super tensile strength is

relatively difficult to have plastic deformation, however, the present invention solves the problem and makes the open steel cord formed by steel wires with super tensile strength being practicable.

[0026] The invention steel cord has an elongation at 50N with a preload of 2.5N being larger than or equal to 0.65% and lower than or equal to 1.1%, the steel cord is an open type steel cord.

[0027] The invention steel cord has an elongation at break being larger than or equal to 3.0% and lower than or equal to 6.0%.

[0028] According to the present invention, at least one steel wire is preformed before being twisted to form a steel cord, and the preforming process makes the elongation of the preformed steel wire increasing, i.e. elongation at 50N with a preload of 2.5N being larger or equal to 0.7% when being unravelled from the steel cord. A non-preformed steel wire has a elongation at 50N with a preload of 2.5N being less than 0.5% when being unravelled from the steel cord. This means the preformed steel wire has an elongation at 50N with a preload of 2.5N higher than the non-preformed steel wire. Preferably the preformed steel wire has an elongation at 50N with a preload of 2.5N being larger or equal to 0.9% when being unravelled from the steel cord. According to the present invention, the elongation at 50N with a preload of 2.5N of one preformed steel wire is tested by the following method, first get the three consecutive sections from one preformed steel wire as three samples, secondly test every sample, and finally calculate the average value of the three tested samples, and the average value of the three tested samples is the elongation at 50N with a preload of 2.5N of one preformed steel wire.

[0029] According to the third object of the invention, a tire is provided. The tire comprises the belt layer, the carcass layer, the tread layer and a pair of bead portions, the belt layer is embedded with the steel cords, at least one of the steel cords comprises two or more steel wires, two or more steel wires are twisted to form the steel cord, at least one steel wire has obtained a preforming wherein the preformed steel wire has an elongation at 50N with a preload of 2.5N being larger or equal to 0.7% when being unravelled from said steel cord, the centreline of the preformed steel wire forms a helical line when being unravelled from the steel cord, the

projection of the helical line over one twist in a plane perpendicular to the central axis of the helical line shows an ellipse, the ellipse has a major axis and a minor axis, the ellipse has an ellipticity within one twist which is expressed by the ratio of the major axis and the minor axis, the average ellipticity of the at least one preformed steel wire over three consecutive twists is ranging from 1.02 to 1.50.

[0030] Glossary

One twist – the rotation period of steel wire in which the steel wire rotates or turns 360° around its axis.

Feret diameter – the distance between the two parallel tangential lines restricting the object.

Brief Description of Figures in the Drawings

[0031] Figure 1 shows the first embodiment with a construction of 6x1.

[0032] Figure 2 shows the method of producing the first embodiment.

[0033] Figure 3a-3b shows the view of one preformed steel wire of the first embodiment in X-Z plane and Y-Z plane. Figure 3c shows the elliptical shape of the preformed steel wire of the first embodiment in X-Y plane

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[0034] Figure 4 shows the elliptical shape of the preformed steel wire of the prior art in X-Y plane.

[0035] Figure 5 shows the measurement of Feret diameter.

[0036] Figure 6 shows the second embodiment with a construction of 4x1.

Mode(s) for Carrying Out the Invention

[0037] The steel wires for steel cord are made from a wire rod.

[0038] The wire rod is firstly cleaned by mechanical descaling and / or by chemical pickling in a H_2SO_4 or HCl solution in order to remove the oxides present on the surface. The wire rod is then rinsed in water and is dried. The dried wire rod is then subjected to a first series of dry drawing operations in order to reduce the diameter until a first intermediate diameter.

[0039] At this first intermediate diameter D1, e.g. at about 3.0 to 3.5 mm, the dry drawn steel wire is subjected to a first intermediate heat treatment, called patenting. Patenting means first austenitizing until a temperature of about

1000 °C followed by a transformation phase from austenite to pearlite at a temperature of about 600 - 650 °C. The steel wire is then ready for further mechanical deformation.

5 [0040] Thereafter the steel wire is further dry drawn from the first intermediate diameter D1 until a second intermediate diameter D2 in a second number of diameter reduction steps. The second diameter D2 typically ranges from 1.0 mm to 2.5 mm.

10 [0041] At this second intermediate diameter D2, the steel wire is subjected to a second patenting treatment, i.e. austenitizing again at a temperature of about 1000 °C and thereafter quenching at a temperature of 600 to 650 °C to allow for transformation to pearlite.

[0042] If the total reduction in the first and second dry drawing step is not too big a direct drawing operation can be done from wire rod till diameter D2.

15 [0043] After this second patenting treatment the steel wire is usually provided with a brass coating: copper is plated on the steel wire and zinc is plated on the copper. A thermo-diffusion treatment is applied to form the brass coating. Alternatively, the steel wire can be provided with a ternary alloy coating, including copper, zinc and a third alloy of cobalt, titanium, nickel, iron or other known metal.

20 [0044] The brass-coated steel wire is then subjected to a final series of cross-section reductions by means of wet drawing machines. The final product is a steel wire with a carbon content above 0.60 per cent by weight, e.g. higher than 0.70 per cent by weight, or higher than 0.80 per cent by weight, or even higher than 0.90 per cent by weight, with a tensile strength typically above 2000 MPa, e.g. above 3800-2000xD (HT) Mpa, or above
25 4100-2000xD MPa (ST) or above 4400-2000xD (UT) MPa (D is the diameter of the final steel wire) and adapted for the reinforcement of elastomer products.

30 [0045] Steel wires adapted for the reinforcement of tyres typically have a final diameter ranging from 0.05 mm to 0.60 mm, e.g. from 0.10 mm to 0.40 mm. Examples of wire diameters are 0.10 mm, 0.12 mm, 0.15 mm, 0.175 mm, 0.18 mm, 0.20 mm, 0.22 mm, 0.245 mm, 0.28 mm, 0.30 mm, 0.32 mm, 0.35 mm, 0.38 mm, 0.40 mm.

[0046] Then the steel wires are subjected to a sleeve preforming which provides the steel wires with a preforming, and then the preformed steel wires are twisted together or together with some non-preformed (straight) steel wires to form a nx1 steel cord or other construction steel cord. Finally the steel cord is wound on a spool.

[0047] "Sleeve" is a roller shaped preforming device. One single sleeve is used for each wire preforming, the sleeve is rotating when the steel wire is contacting with the sleeve, the steel wire follows the rotation of the sleeve and thereby gets a preforming, so that there is limited or even no scraping from the sleeve to the steel wire. The sleeve according to the invention has a roller shape with a very smooth surface which is for contacting with the steel wire, this also minimizes the scraping from the sleeve to the steel wire and thereby makes the preforming being consistent. "Sleeve" is different from the "pins" which is the preforming device described in US4258543 or KR100635328B. Pin is a pillar shaped preforming device which is fixed and is longer and thinner than sleeve. At least three individual pins which are arranged in line shall be used for each wire preforming, the pins are fixed without rotating during the preforming process, and the steel wire goes through the gaps between the pins and then get preforming by the scraping from the pin to the steel wire. The scraping causes the serious damage to the surface of the steel wire and thereby make the preformation of the steel wire being unstable and un-consistent. While passing by each individual pin, the steel wire is subjected to one time deformation, and this means the steel wire is subjected to at least three times deformation when passing through the pin preformation device which comprises at least three pins, and the deformations on the adjacent pins are in different even opposite direction, all these also make the deformation of the steel wire being unstable and un-consistent. This type of preforming device - pin is not suitable for the steel wire with super tensile strength since this will lead to high fracture of the steel wire.

[0048] Furthermore the sleeves are well positioned (relative to the steel wire to be preformed) to make the deformation of the steel wire being stable and

consistent thereby the steel wire shows well controlled average ellipticity when it is unravelled from the steel cord.

[0049] Figure 2 shows part of the production process of the steel cord. 6 steel wires 105 are paid off, and then all the steel wires 105 are subjected to a preforming by sleeves 210 which have a smooth surface. The sleeve 210 makes quite less the damage and abrasion to the preformed steel wire. Then the 6 preformed steel wires are twisted together to form a steel cord. The steel cord is passing through a straighter 215 which is specially set on the impression and the number of the rollers to minimize the damage to the preforming (this also contributes to the better preforming retaining), and it finally is wound on a spool.

[0050] Then the first embodiment is 6x1 steel cord is obtained as shown in figure 1. The steel cord 100 comprises 6 steel wires 105, and all the steel wires 105 are preformed before they are twisted to form a steel cord.

[0051] Figures 3a-3c are the view tested by the linear scanning apparatus mentioned above. Figure 3a is the scanned view in X-Z plane, Figure 3b is the scanned view in Y-Z plane and Figure 3c is the scanned view in X-Y plane. The Z-axis is the central axis of the helical line of the preformed steel wire. In figure 3a-3c, for ensuring the data accuracy, the data is the data of 10mm-90mm (in Z-axis) of the tested wire sample which is the effective data, while the rest data (<10mm, more than 90mm to 100mm) are left out. Figure 4 is the scanned view in X-Y plane of the prior art (10mm-90mm in Z-axis). For figure 3c and figure 4, the abscissa is the X-axis and the ordinates is the Y-axis 9 (not shown in the figures).

Compared with figure 4, the shape in figure 3c is much more round.

[0052] Table 1 is the test result of the first embodiment and the prior art. Figure 5 is an example to illustrate the method of measuring the Feret diameter, the Feret diameter is the distance between the two parallel tangential lines A and A' restricting one ellipse. The test is first to get the Feret diameters of three ellipses of three continues twists of one preformed steel wire which is unravelled from the steel cord (for example the section from wave trough "a" to wave trough "d" as shown in figure 3a), and the major axis and minor axis of each ellipse within one twist can be obtained, and three ellipticity value can be obtained for one preformed steel wire. And then it is

to test the rest preformed steel wire and then to calculate the average value of the ellipticity of all the six preformed steel wire. Therefore for the first embodiment, the average ellipticity is an average value of 18 tested value from 6 preformed steel wire samples.

	Prior art	First embodiment
Construction	6x0.32	6x0.32
Tensile strength of the steel wires before being twisted into steel cord(MPa)	UT	UT
Number of preformed steel wires	6	6
Preforming device	Pins	Sleeve
Elongation at 50N with a preload of 2.5N (%) of the steel wire when being unravelled from the steel cord	0.85	1.20
Average ellipticity	1.74	1.11
Air Drop result	40%	0%
Cord Elongation at 50N with a preload of 2.5N (%)	0.6	0.9

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[0053] Air Drop method according to the invention has the similar working principle with the Air permeability method described in US2012227885, the difference is: the specimen with steel cord in rubber for testing has a length being 90% of the lay length of the steel cord and with a minimum of 8.0mm, for the invention air drop method the air pressure ΔP showing in the display is the result when the testing time is 60 seconds. The ΔP result of "100" in the display is recorded as "0%" which means full rubber penetration of the sample steel cord, the ΔP result of "0" in the display is recorded as "100%" which means no rubber penetration, the ΔP result of "60" in the display is recorded as "40%" which means 60% rubber penetration.

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[0054] A second embodiment is a steel cord 600 with a construction of 4x1 shown in figure 6. 3 of the steel wires 610 are helically preformed prior to being twisted to form a steel cord, while one steel wire 605 is not preformed but straight prior to being twisted to form a steel cord 600. All the steel wires 605, 610 have a tensile strength being more than (4130-2000xD) when being unravelled from the steel cord 600. The average

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ellipticity of the three preformed steel wire 610 is 1.18. The steel cord 600 has an elongation at 2.5N-50N being 0.85%, and it has an elongation at break being 4.5%. The manufacturing method of the second embodiment is almost the same as the manufacturing method of the first embodiment.

Claims

1. A steel cord, said steel cord comprising two or more steel wires, said two or more steel wires being twisted to form said steel cord, at least one of said steel wires having obtained a preforming wherein the preformed steel wire having an elongation at 50N with a preload of 2.5N being larger or equal to 0.7% when being unravelled from said steel cord, the centreline of said preformed steel wire forming a helical line when being unravelled from said steel cord, characterized in that the projection of said helical line over one twist in a plane perpendicular to the axis of the helical line shows an ellipse, said ellipse has a major axis and a minor axis, said ellipse has a ellipticity within one twist which is expressed by the ratio of said major axis and said minor axis, the average ellipticity of said at least one preformed steel wire over three consecutive twists is ranging from 1.02 to 1.50.
2. A steel cord as claimed in claim 1, characterized in that said average ellipticity of said at least one preformed steel wire is ranging from 1.08 to 1.38.
3. A steel cord as claimed in claim 2, characterized in that said average ellipticity of said at least one preformed steel wire is ranging from 1.10 to 1.27.
4. A steel cord as claimed in claim 3, characterized in that said average ellipticity of said at least one preformed steel wire is ranging from 1.10 to 1.22.
5. A steel cord as claimed in any one of claims 1 to 4, characterized in that all steel wire of said steel cord are preformed.
6. A steel cord as claimed in any one of claims 1 to 5, characterized in that said steel cord has a construction of nx1.
7. A steel cord as claimed in claim 6, characterized in that said n is 5, 6, 7 or 8.
8. A steel cord as claimed in any one of claims 1 to 7, characterized in that said preformed steel wire has a tensile strength being more than $(3890-2000xD)$ MPa when being unravelled from said steel cord, D is the diameter of said preformed steel wire.
9. A steel cord as claimed in claim 8, characterized in that said preformed steel wire has a tensile strength being more than $(4130-2000xD)$ MPa when being unravelled from said steel cord.
10. A steel cord as claimed in any one of claims 1 to 9, characterized in that said steel cord has an elongation at 50N with a preload of 2.5N that is larger or equal to 0.65% and lower or equal to 1.1%.

11. A steel cord as claimed in any one of claims 1 to 10, characterized in that said steel cord has an elongation at break ranging from 3.0% to 6.0%.

12. A steel cord as claimed in any one of claims 1 to 11, characterized in that said at least one preformed steel wire has an elongation at 50N with a preload of
5 2.5N being larger or equal to 0.9% when being unravelled from said steel cord.

13. A steel cord as claimed in any one of claims 1 to 12, characterized in that said steel cord has full rubber penetration performance.

14. A tire, comprising the belt layer, the carcass layer, the tread layer and a pair of bead portions, characterized in that said belt layer is embedded with at least
10 one steel cord as claimed in any one of claims 1 to 13.

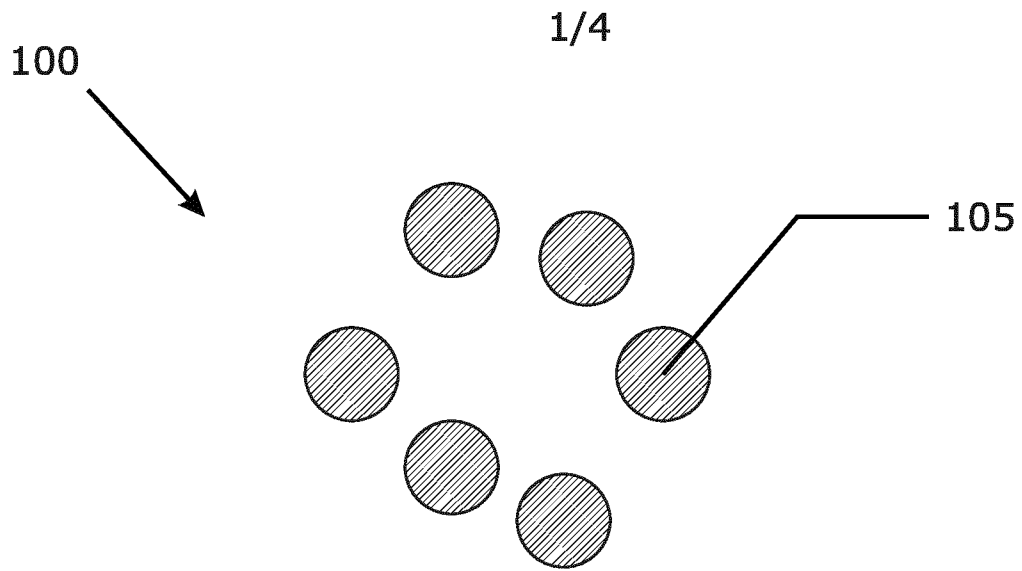


Fig. 1

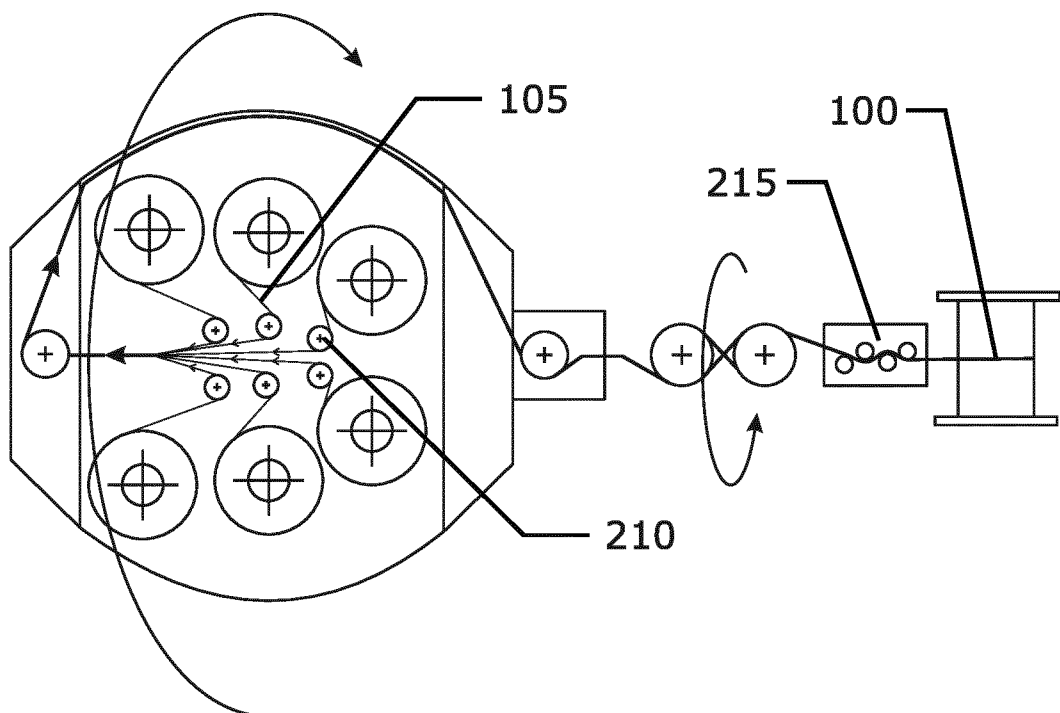
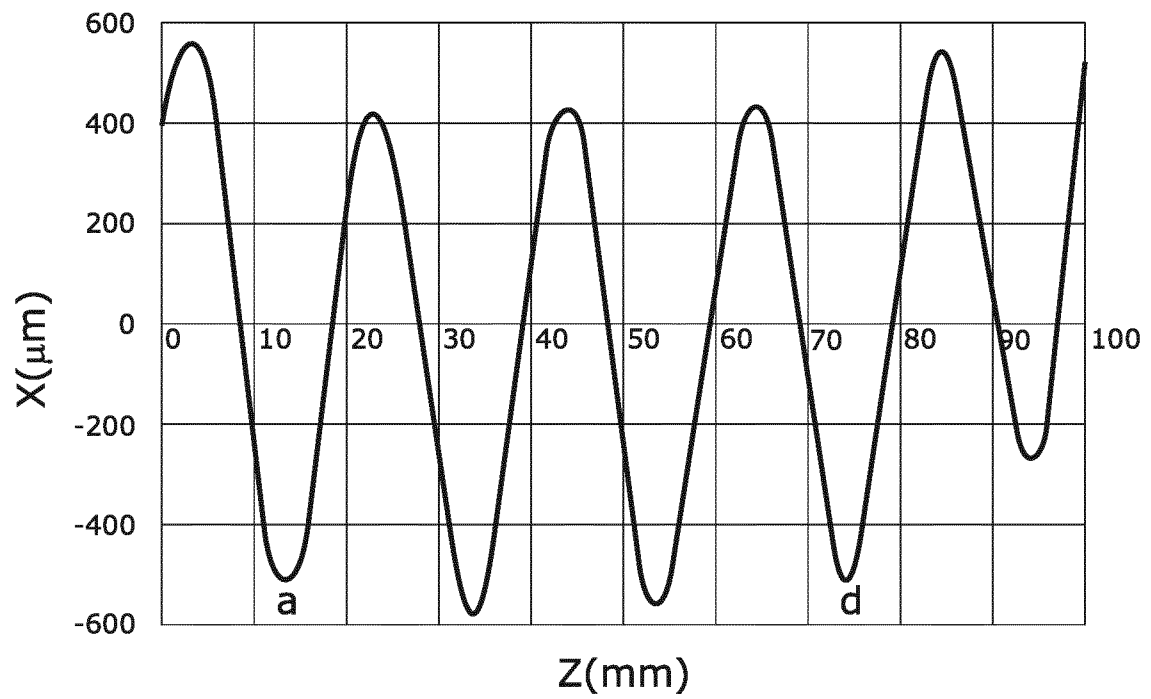
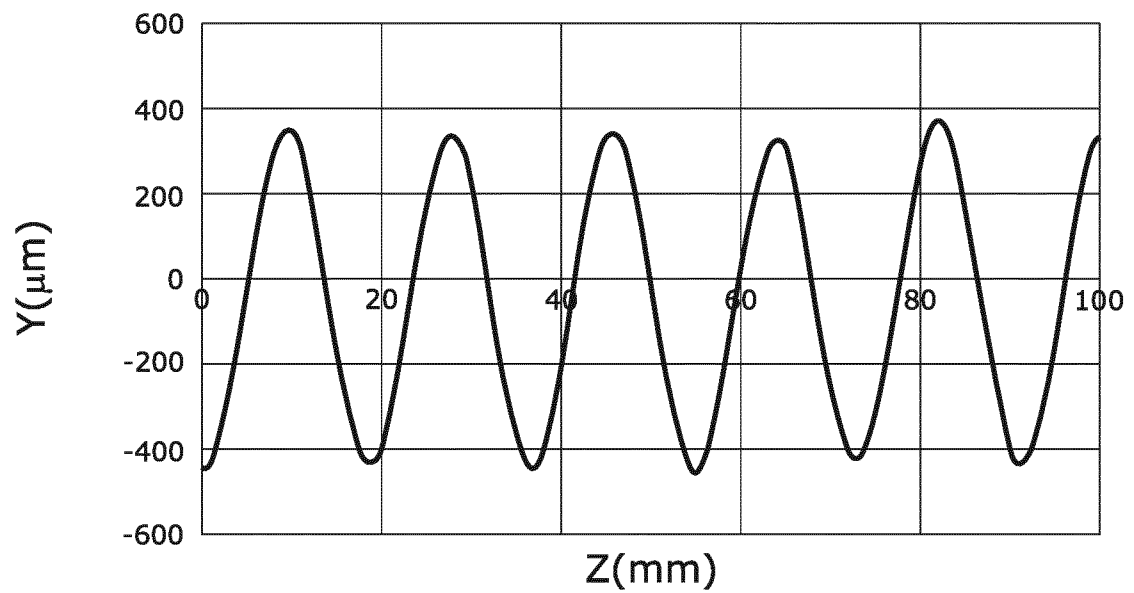


Fig. 2

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Fig. 3aFig. 3b

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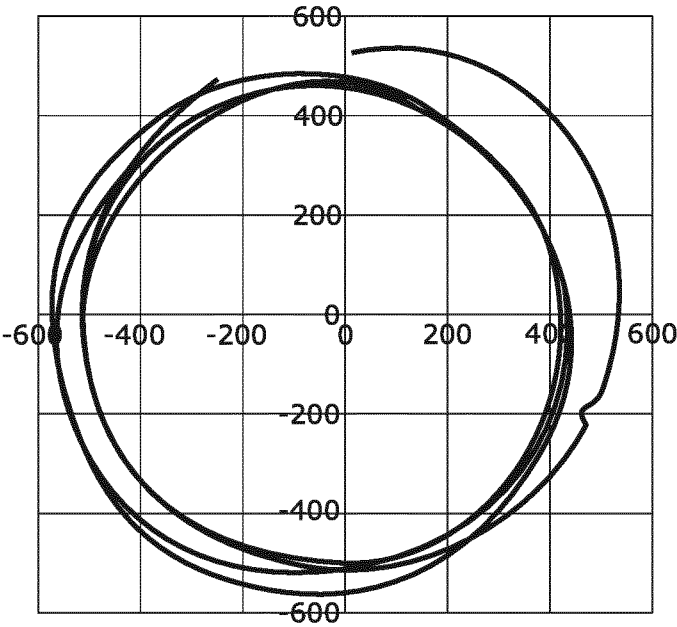


Fig. 3c

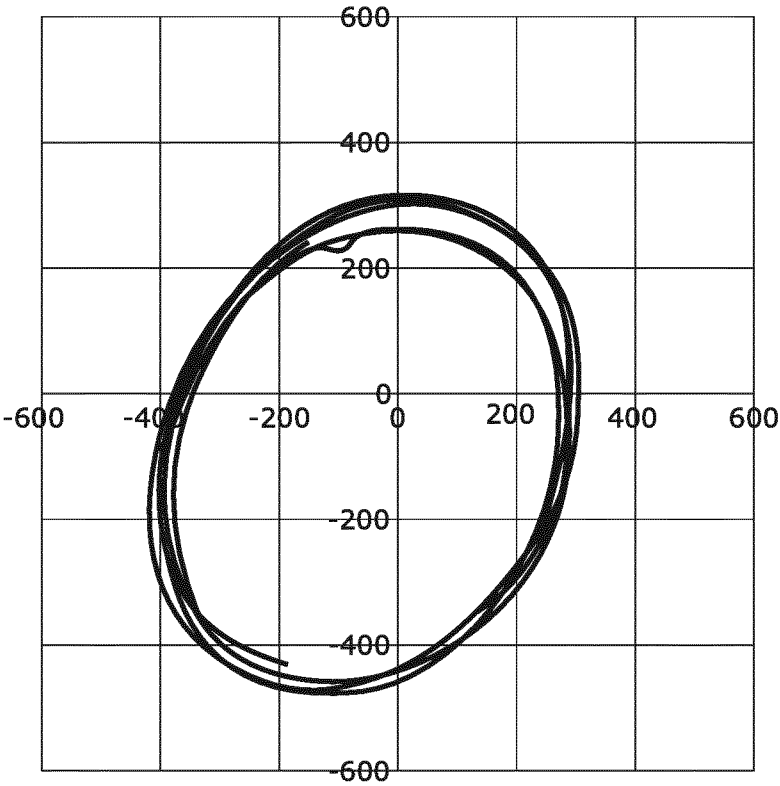


Fig. 4

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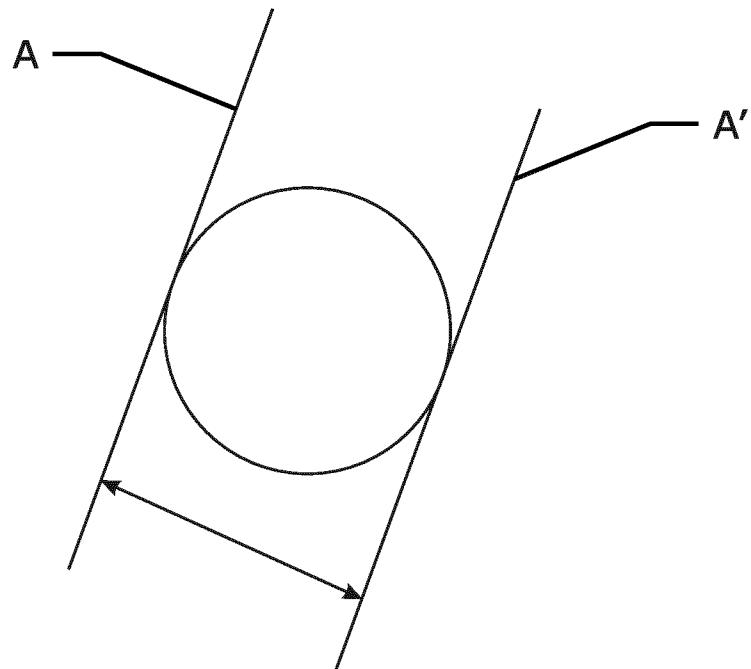


Fig. 5

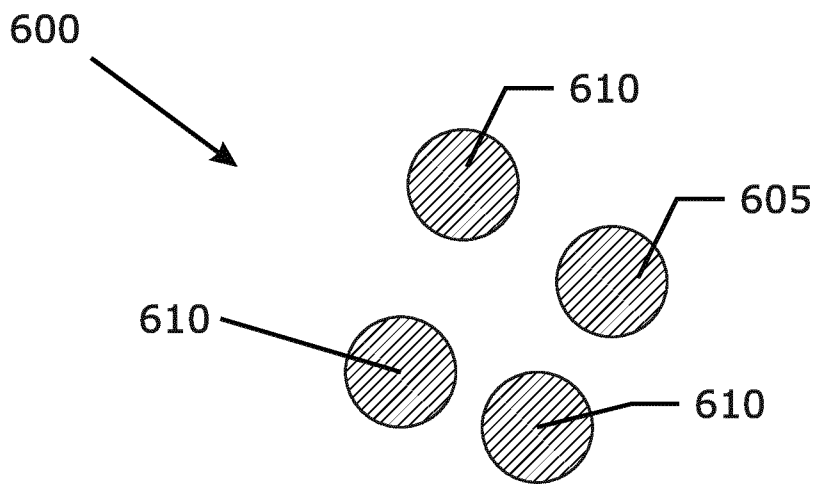


Fig. 6

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2019/076521

A. CLASSIFICATION OF SUBJECT MATTER
INV. D07B1/06
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)
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 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.
X	US 4 938 015 A (KINOSHITA MITSURU [JP]) 3 July 1990 (1990-07-03) cited in the application column 2, line 51 - column 3, line 5 column 3, line 47 column 4, lines 41,42; table 1 -----	1-7, 10-14
A	EP 0 985 555 A2 (HANKOOK TIRE CO LTD [KR]) 15 March 2000 (2000-03-15) paragraphs [0005], [0011], [0017]; figures 1,2 -----	1
A	JP 2006 016704 A (KANAI HIROAKI) 19 January 2006 (2006-01-19) paragraph [0007]; figures; table 1 -----	1



Further documents are listed in the continuation of Box C.



See patent family annex.

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Date of the actual completion of the international search

7 January 2020

Date of mailing of the international search report

17/01/2020

Name and mailing address of the ISA/

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040,
Fax: (+31-70) 340-3016

Authorized officer

Uhlig, Robert

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

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