



- (51) International Patent Classification:
B60C 15/04 (2006.01)
- (21) International Application Number:
PCT/EP2013/070325
- (22) International Filing Date:
30 September 2013 (30.09.2013)
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data:
PCT/CN2012/083273
22 October 2012 (22.10.2012) CN
- (71) Applicant: NV BEKAERT SA [BE/BE]; Bekaertstraat 2,
B-8550 Zwevegem (BE).
- (72) Inventors: GILLARD, Jean-Michel; Anneessensplein 8,
B6, 1000 Brussel (BE). TANG, Wenjun; Jincheng East
Road 158#, 6-1201, New District, Wuxi, Jiangsu 214111
(CN).
- (74) Agent: MESSELY, Marc; NV BEKAERT SA,
Bekaertstraat 2, B-8550 Zwevegem (BE).
- (81) Designated States (*unless otherwise indicated, for every
kind of national protection available*): AE, AG, AL, AM,

AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY,
BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM,
DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT,
HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KN, KP, KR,
KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME,
MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ,
OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA,
SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM,
TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM,
ZW.

- (84) Designated States (*unless otherwise indicated, for every
kind of regional protection available*): ARIPO (BW, GH,
GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ,
UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ,
TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK,
EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV,
MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM,
TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW,
KM, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

— *of inventorship (Rule 4.17(iv))*

Published:

— *with international search report (Art. 21(3))*

(54) Title: STEEL BEAD CORE

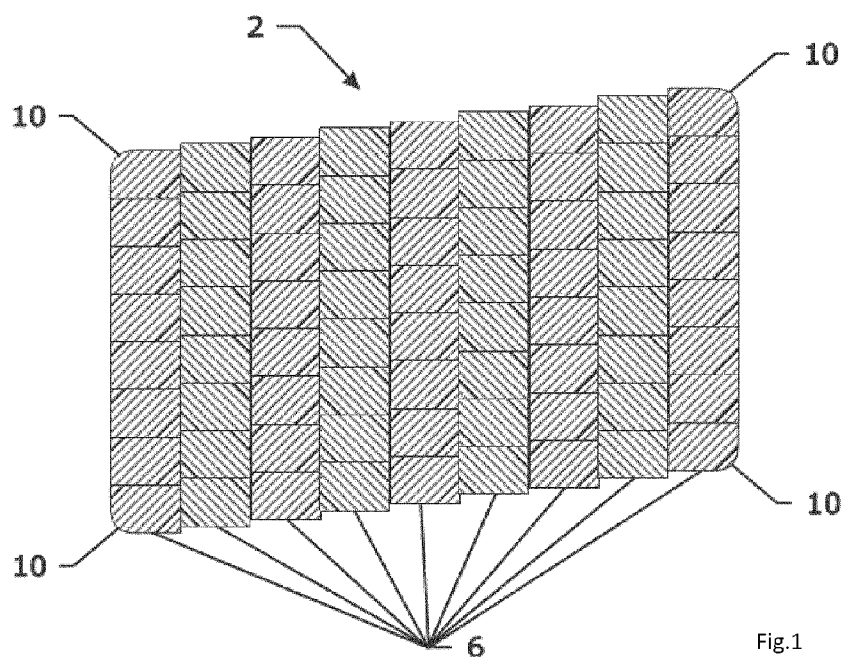


Fig.1

(57) Abstract: A steel bead core for pneumatic tires, comprises at least one metal wire having a cross section of a quadrilateral with two parallel opposite faces, the at least one wire forming adjoining multiple windings through the bead core, the adjoining windings making metal-to-metal contact with each other along their facing surfaces, wherein the edges at the four corners of the bead core are round. The steel bead core has stable profile, and limits the fretting between carcass ply and bead.



Steel bead core**Description****Technical Field**

[1] The invention relates to a steel bead core for pneumatic tyres, more particularly, a steel bead core with stable profile, and limit the fretting between carcass ply and bead.

Background Art

[2] A pneumatic tire generally comprises a crown that comes into contact with the ground and, on either side of the crown, a sidewall the inner edge of which, intended to be supported by the rim of a wheel, is formed by the bead. The bead has among its components at least one bead core. The latter fulfils various functions. It serves in particular as anchorage for the ply or plies forming the carcass of the tire and withstands the forces exerted on it by the carcass under the effect of the inflation pressure and the deformations resulting from the travel of the tire. The bead core also serves to ensure the transmission of longitudinal forces and, in the case of tubeless tire, to ensure a seal between the tire and the wheel rim.

[3] Prior art US3949800 discloses a tire having beads provided with package cores around which the carcass reinforcement ply or plies are wound. The bead comprises at least one package bead core of one or more wires having a quadrilateral section with at least two parallel opposite sides to improve the stability of shape. The category of quadrilaterals having at least two parallel opposite sides comprises rectangles, squares, diamonds, parallelograms, trapezoids and isosceles trapezoids.

[4] Prior art US4166492 further discloses a bead core having a substantially parallelogram-shaped cross section, in which the individual wires in the wound wire ply are juxtaposed in the same plane extending substantially axially of the bead core, and the planes of the individual wire piles which are closely superposed are mutually radially displaced with respect to one another. The stability of the cross-sectional shape of a bead core formed of individual wires of rectangular cross-section is improved.

[5] Although the beads possibly comprise an insert of stuffing rubber, and the bead cores possibly have a sheathing or covering of rubber, fretting

happens between the carcass ply and bead under the complex transverse and longitudinal forces during utilization of the tire. The sharp edges of the bead core may cut through the sheathing rubber, and metal to metal fretting occurs between carcass ply reinforcement and bead core.

- 5 [6] Prior art DE8033602U discloses a bead core wherein the two edges at the two corners connecting the inner surface of the bead core are round. Although the two round edges reduce the fretting between carcass ply reinforcement and bead core, the fretting at the corners connecting the outer surface of the bead core still occurs under the complex transverse
10 and longitudinal forces during utilization of the tire.

Disclosure of Invention

- [7] The primary object of the invention is to provide a steel bead core with stable profile and limit the fretting between carcass ply and bead.
- [8] The second object of the invention is to provide a steel bead core with
15 simple structure and easy to make.
- [9] According to present invention, a bead core comprises at least one metal wire having a cross section of a quadrilateral with two parallel opposite faces, the at least one wire forming adjoining multiple windings through the bead core, the adjoining windings making metal-to metal contact with each
20 other along their facing surfaces, wherein the edges at the four corners of the bead core are round to decrease fretting. The round edge means on the cross-sectional view of the bead core the profile of the corner is a curve without sharp angle. The radius of the round edges of the bead core is between 0.3mm and 1.6mm. Here a winding means a loop of metal wire, and multiple windings are radially superposed loops of metal wire.
- 25 [10] According to present invention, a bead core has a substantially parallelogram-shaped cross section, the individual wires in the wound wire ply are juxtaposed on the same line extending substantially axially of the bead core on the cross sectional view, the individual wire plies which are
30 closely radially superposed are mutually axially displaced with respect to one another. The edges at the four corners of the bead core are round to decrease fretting, and the radius of the round edges of the bead core is between 0.3mm and 1.6mm. Here a ply means a layer of individual wires which are juxtaposed on the same line extending substantially axially of

the core on the cross sectional view. Mutually axially displaced means in the cross sectional view of the bead core, the plies of the individual wires are shifted over a step in the axial direction of the bead core to form a substantially parallelogram-shaped cross section.

- 5 [11] According to one embodiment, the wire forming the bead core has a rectangular cross section with four round edges along the entire length of the wire, in order to form the four round edges of the bead core. Alternatively, the wire has only round edges at the level of the four corners of the bead core. In the cross sectional view, the width of the wire is between 1.5mm and 2.5mm. The thickness of the wire is between 1.0mm and 1.6mm. The radius of the round edges of the wire is between 0.3mm and 0.8mm.

- [12] According to another embodiment, the edges at the two ends of the wound wire plies are round, wherein the juxtaposed multiple wires form a ply extending substantially axially of the bead core. The wire may be a flat wire with naturally rounded surfaces as a result of rolling by means of two rollers. Further more, the surfaces at the two ends of the wound wire plies are round, while the wires in between have rectangular cross section.

Brief Description of Figures in the Drawings

- 20 [13] Figure 1 illustrates a cross sectional view of a bead core according to present invention.
- [14] Figure 2 illustrates a cross sectional view of a bead core according to present invention.
- [15] Figure 3 illustrates the cross-sectional changes at different positions on the same wire.
- 25 [16] Figure 4 illustrates a cross sectional view of a wire having rectangular cross section with four round edges.
- [17] Figure 5 illustrates a cross sectional view of a wound wire ply, wherein the edges at the two ends of the ply are round.
- 30 [18] Figure 6 illustrates a cross sectional view of a flat wire with naturally rounded surfaces.
- [19] Figure 7 illustrates a cross sectional view of a wound wire ply, wherein the surfaces at the two ends of the ply are round.

Mode(s) for Carrying Out the Invention

[20] Figure 1 illustrates a cross sectional view of a bead core according to present invention. The bead core 2 comprises nine metal wires 6 having a cross section of a quadrilateral with two parallel opposite faces. Each wire 6 forms adjoining eight windings through the bead core 2, the adjoining eight windings make metal-to-metal contact with each other along their facing surfaces. The edges 10 at the four corners of the bead core 2 are round.

[21] Figure 2 illustrates a cross sectional view of a bead core according to present invention. The bead core 2 has a cross-section which is in the general form of a parallelogram. The bead core 2 consists of eight radially superposed, and mutually axially displaced wire plies 4. Each ply 4, in turn, is formed of nine laterally adjacent individual wires 6 of substantially rectangular cross-section on the same line extending substantially axially of the bead core on the cross sectional view. The radially inner surface 8 of the bead core 2 is smooth and inclined at an angle α relative to the horizontal, wherein the angle corresponds to the angle of inclination of the inclined shoulder of the wheel rim. The individual wire plies 4 which are closely radially superposed are mutually axially displaced with respect to one another. The edges 10 at the four corners of the bead core 2 are round.

[22] The round edges 10 at the corners of the bead core 2 avoid the tension concentration at the corner and reduce the pressure on the sheathing rubber to maintain the cushion between carcass ply and bead to limit the fretting between carcass ply and bead. The four round edges 10 can be made by Turks head as disclosed in DE8033602U.

[23] Figure 3 illustrates the cross-sectional changes at different positions on the same wire 6 which is located at one end of the bead core. 3a shows the cross sectional view of the wire 6 at the first winding wherein the left-low edge is round. 3b shows the cross sectional view of the wire 6 at the intermediate windings, 2nd to 7th turns in Figure 1 and Figure 2, wherein the wire 6 has rectangular cross section. 3c shows the cross sectional view of wire 6 at the last winding wherein the left-up edge is round. If wire

6 is located at the other end of the bead core, the right-low edge of the first winding and the right-up edge of the last winding are round, while the other portion of wire 6 at the intermediate windings remains the rectangular cross section. Under the control of PLC (program logic control), a series of Turks heads for different cross section profiles, can work systematically to produce a wire as illustrated in Figure 3.

[24] Figure 4 illustrates a cross sectional view of a wire 6 having a rectangular cross section with four round edges 12. W is the width of wire 6, T the thickness, and R the radius of the round edge 12. If wire 6 is used to make a bead core 2, the Turks head disclosed above to make the round edges 10 at the four corners of the bead core can be eliminated, because the wires 6 at the four corners of the bead core 2 already have round edges 12. Therefore, using pre-made wire 6 having a rectangular cross section with four round edges 12 may simplify the bead making process.

[25] Figure 5 illustrates a cross sectional view of a wound wire ply 4 comprising multiple wires 6, wherein the edges 10 at the two ends of the ply 4 are round. Compared with the bead core disclosed in prior art DE8033602U, bead core according to present invention not only has two round edges 10 at the two corners connecting the inner surface of the bead core, but also has two round edges 10 at the two corners connecting the outer surface of the bead core, which reduces the fretting between carcass ply and bead. The edges 10 can either be made by Turks head, or the wires 6 at the two ends of the ply 4 can be replaced with profiled wire 6 with round edges 12. Since the profiled wire 6 can be pre-made, the bead core making process can be simplified.

[26] Figure 6 illustrates a cross sectional view of a flat wire 6 with naturally rounded surfaces. The flat wire 6 is also disclosed in WO90/12696A1. If a flat wire 6 with naturally rounded surfaces is used to make a bead core 2, the Turks head mentioned above can also be eliminated, because each flat wire 6 at the four corners of the bead core 2 already has round surfaces 14 to avoid the tension concentration at the corner and reduce the pressure on the sheathing rubber to maintain the cushion between carcass ply and bead to limit the fretting between carcass ply and bead.

Since the flat wire 6 can be pre-made by rolling process, the bead core making process can be simplified.

- [27] Figure 7 illustrates a cross sectional view of a wound wire ply 4, wherein the surfaces 14 at the two ends of the ply are round while the wires 6 in between have rectangular cross section. The bead core according to figure 7 is more stable than that of figure 6, because the wires 6 in between have rectangular cross section to have more metal-to-metal surface contact to maintain the geometry of the bead core, while the two round surfaces 14 at the two ends of the ply can avoid the tension concentration and reduce the pressure on the sheathing rubber to maintain the cushion between carcass ply and bead to limit the fretting between carcass ply and bead. The round surface 14 can either be made by Turks head, or the wires 6 at the two ends of the ply 4 can be replaced with profiled wire 6 with round surface 14. Since the profiled wire 6 can be pre-made, the bead core making process can be simplified.
- [28] The carbon content of the metal wire 6 is at least 0.70% by weight, e.g. at least 0.80% or at least 0.85%. The tensile strength of these metal wire 6 is at least 1800N/mm², e.g. at least 2200N/mm². Other contents of metal wire 6 for bead core 2 may be a manganese content between 0.40% and 0.70%, a silicon content between 0.10% and 0.35% and maximum sulphur and maximum phosphorus content of 0.04%, all percentages being percentages by weight. However, the presence of other element is not excluded.
- [29] Usually the metal wire 6 is copper alloy, brass or bronze, coated to make a bead core 2. On one hand, the copper alloy coating on metal wire 6 can act as a lubricant to facilitate the wire drawing process or the profile deformation at Turks head. On the other hand, the copper alloy coating on metal wire 6 can promote the adhesion between bead core and adjacent rubber. Besides, the metal wire 6 can be coated with zinc. The zinc coating can be applied onto the wire by means of an electrolytic process or by means of a hot dip process, followed or not followed by a wiping operation in order to reduce the total weight of the zinc. Because of the presence of an iron zinc alloy layer that forms during the hot dip operation, the adhesion between the zinc coating and the wire is improved. Since

zinc coating provides good corrosion resistance, zinc coating is preferred for bead wire rather than copper alloy coating.

[30]

Claims

1. A bead core comprising at least one metal wire having a cross section of a quadrilateral with two parallel opposite faces, said at least one wire forming adjoining multiple windings through the bead core, said adjoining winding making metal-to-metal contact with each other along their facing surfaces, wherein the edges at the four corners of the bead core are round.
2. A bead core according to claim 1, wherein the bead core having a substantially parallelogram-shaped cross section, the individual wires in the wound wire ply are juxtaposed on the same line extending substantially axially of the bead core on the cross sectional view, the individual wire plies which are closely radially superposed are mutually axially displaced with respect to one another.
3. A bead core according to claim 1 or 2, wherein the radius of the round edges of the bead core is between 0.3mm and 1.6mm.
4. A bead core according to claim 1 or 2, wherein the wire having a rectangular cross section with four round edges.
5. A bead core according to claim 4, wherein the width of the wire is between 1.5mm and 2.5mm.
6. A bead core according to claim 4, wherein the thickness of the wire is between 1.0mm and 1.6mm.
7. A bead core according to claim 4, wherein the radius of the round edges of the wire is between 0.3mm and 0.8mm.
8. A bead core according to claim 1 or 2, wherein the edges at the two ends of the wound wire plies are round.
9. A bead core according to claim 1 or 2, wherein the surfaces at the two ends of the wound wire plies are round.
10. A bead core according to claim 1 or 2, wherein the wire is a flat wire with naturally rounded surfaces.

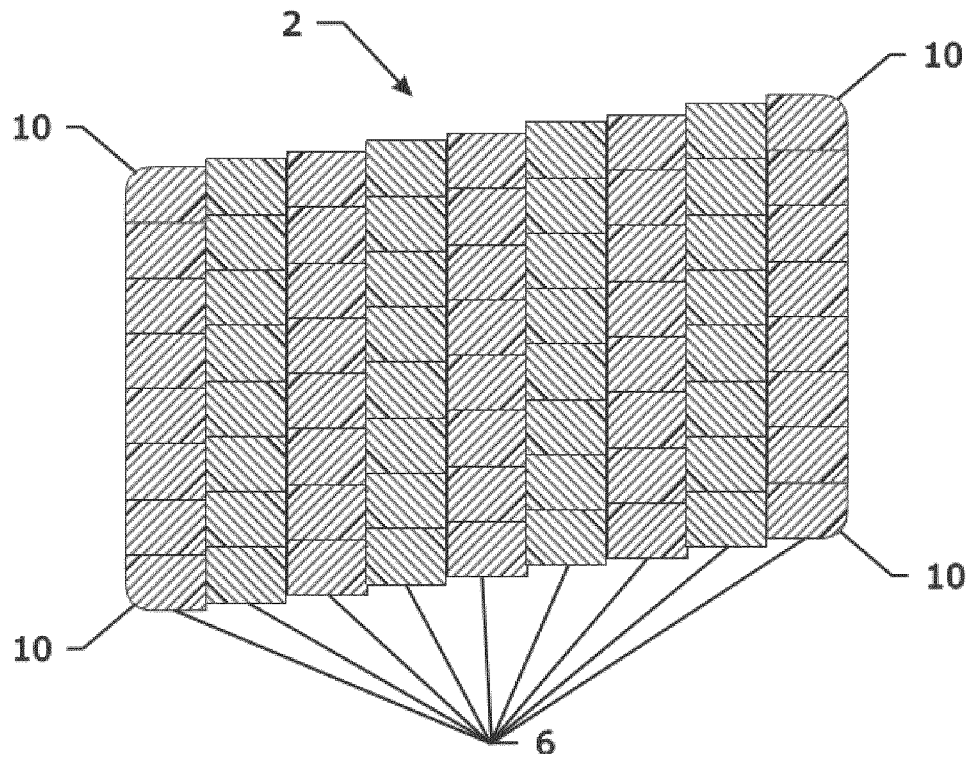


Fig.1

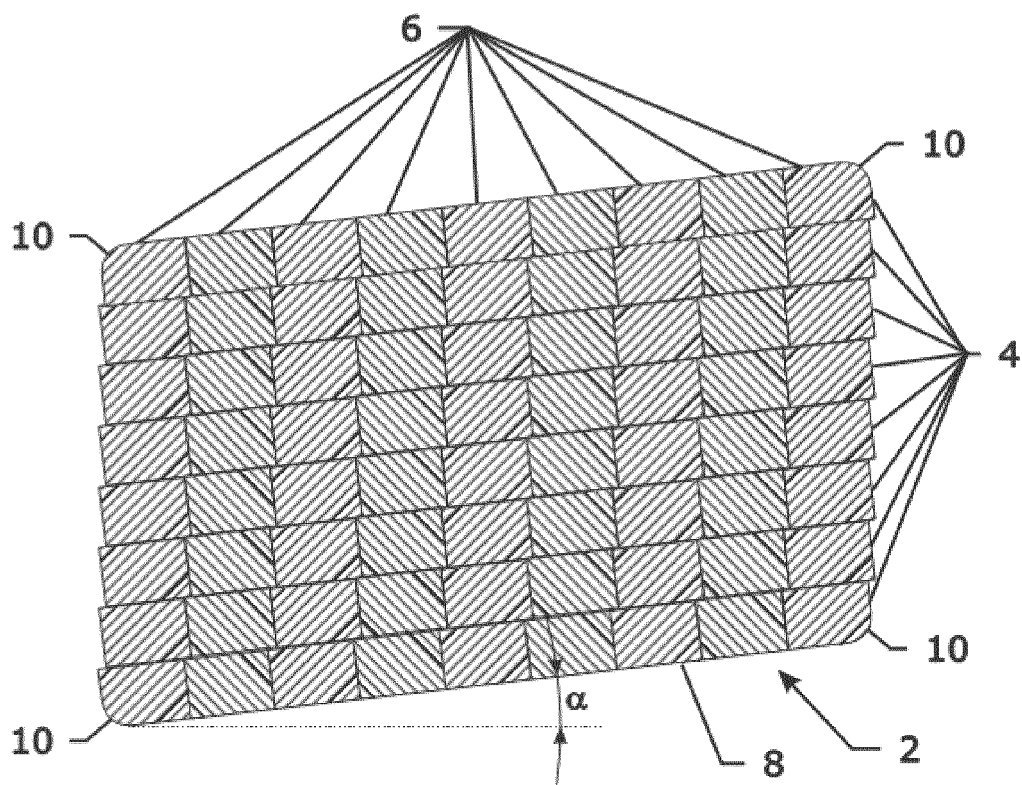


Fig.2

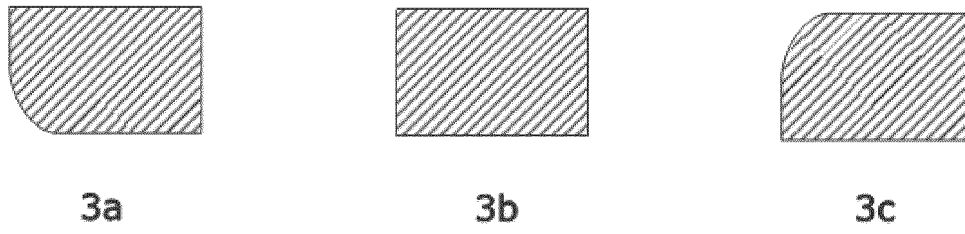


Fig.3

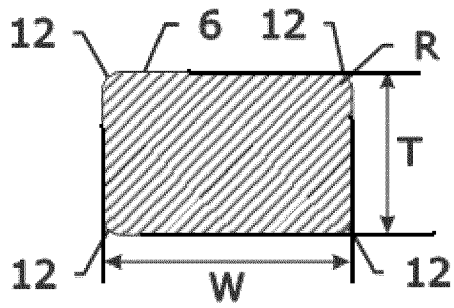


Fig.4

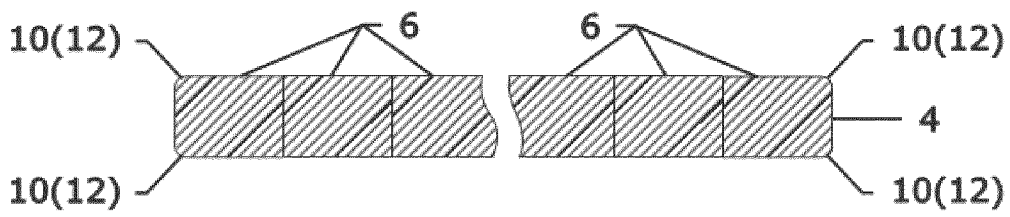


Fig.5

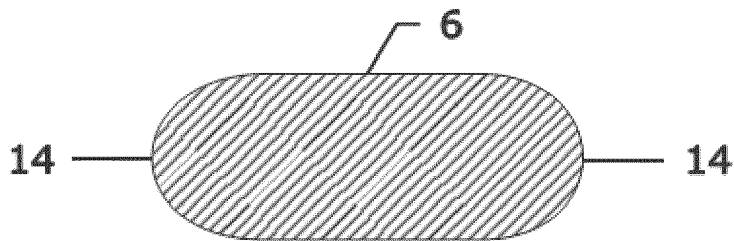


Fig.6

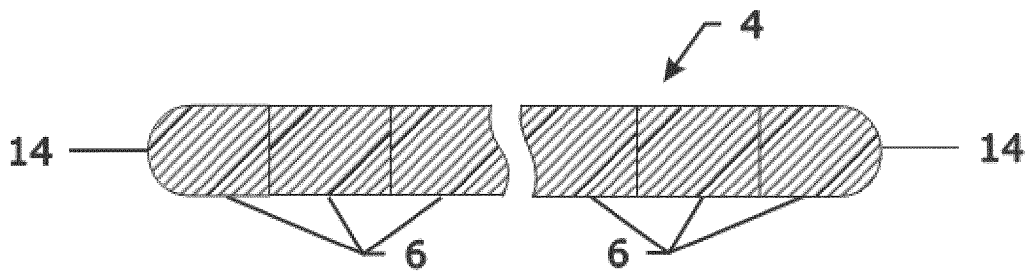


Fig.7

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2013/070325

A. CLASSIFICATION OF SUBJECT MATTER
INV. B60C15/04
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)
B60C

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 2 147 807 A1 (BRIDGESTONE CORP [JP]) 27 January 2010 (2010-01-27)	1,2
A	abstract; claims 1, 4; figures 1,2c, 4,8,9 paragraphs [0011], [0021], [0024], [0027], [0035]	3,4,6
X	US 3 949 800 A (LEJEUNE DANIEL) 13 April 1976 (1976-04-13)	1,4-7,10
A	abstract; claim 1; figures 1, 2, 5 column 2, line 23 - column 3, line 10 column 3, line 42 - column 4, line 44	2,3,8
	----- -/--	



Further documents are listed in the continuation of Box C.



See patent family 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 application or patent but published on or after the international filing date

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

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

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

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

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" 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

"&" document member of the same patent family

Date of the actual completion of the international search

28 November 2013

Date of mailing of the international search report

05/12/2013

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

Balázs, Matthias

INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2013/070325

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 400 298 A1 (BRIDGESTONE FIRESTONE INC [US]) 5 December 1990 (1990-12-05)	1,3,10
A	abstract; claims 1, 9, 11, 12; figures 1, 3, 4, 5, 7, 8, 9, 11, 13-15 column 4, lines 16-20 column 5, line 53 - column 6, line 26 column 6, line 40 - column 7, line 1 -----	4,6-9
X	FR 2 383 776 A1 (KANAI HIROYUKI [JP]) 13 October 1978 (1978-10-13)	1
A	claims 1-3, 6; figures 1,4a, 4b, 4e, 4f, 4g, , 5a, 5b, 5c; table 1 page 5, paragraphs 2, 3 -----	2-4,6,8

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2013/070325

Patent document cited in search report		Publication date	Patent family member(s)			Publication date
EP 2147807	A1	27-01-2010	CN	101678725	A	24-03-2010
			EP	2147807	A1	27-01-2010
			ES	2393420	T3	21-12-2012
			JP	4850114	B2	11-01-2012
			JP	2008254684	A	23-10-2008
			KR	20090128546	A	15-12-2009
			US	2010163152	A1	01-07-2010
			WO	2008126875	A1	23-10-2008

US 3949800	A	13-04-1976	AR	199243	A1	14-08-1974
			AT	334228	B	10-01-1976
			AU	6635274	A	11-09-1975
			BE	811506	A1	26-08-1974
			CA	986830	A1	06-04-1976
			CH	571962	A5	30-01-1976
			DD	112101	A5	20-03-1975
			DE	2410750	A1	19-09-1974
			DK	151300	B	23-11-1987
			ES	424050	A1	01-05-1976
			FI	58092	B	29-08-1980
			FR	2220396	A1	04-10-1974
			GB	1467490	A	16-03-1977
			IE	39022	B1	19-07-1978
			IT	1011537	B	10-02-1977
			JP	S5324681	B2	22-07-1978
			JP	S49119301	A	14-11-1974
			LU	69562	A1	09-10-1974
			NL	7402914	A	10-09-1974
			NO	137718	B	02-01-1978
			PL	90922	B1	28-02-1977
			SE	405341	B	04-12-1978
			SU	727123	A3	05-04-1980
			US	3949800	A	13-04-1976
			YU	59074	A	30-06-1981
			ZA	7401491	A	26-02-1975

EP 0400298	A1	05-12-1990	CA	2013329	A1	30-11-1990
			EP	0400298	A1	05-12-1990
			JP	2728545	B2	18-03-1998
			JP	H0367709	A	22-03-1991

FR 2383776	A1	13-10-1978	AU	3408978	A	20-09-1979
			DE	2810847	A1	21-09-1978
			FR	2383776	A1	13-10-1978
