

(19) World Intellectual Property Organization
International Bureau(43) International Publication Date
15 March 2007 (15.03.2007)

PCT

(10) International Publication Number
WO 2007/030285 A1(51) International Patent Classification:
B60C 9/12 (2006.01) *B60C 13/04* (2006.01)

(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LV, LY, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(21) International Application Number:
PCT/US2006/031720

(22) International Filing Date: 15 August 2006 (15.08.2006)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
11/219,160 1 September 2005 (01.09.2005) US

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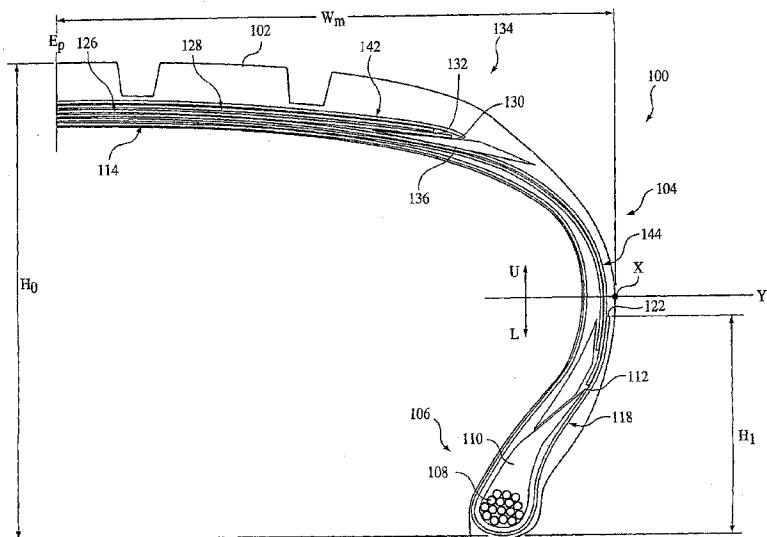
(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— with international search report

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: TIRE HAVING A SIDEWALL REINFORCEMENT

(57) Abstract: A tire (100), which has a maximum section width (W_m), an upper section (U) above the maximum section width (W_m), and a lower section (L) below the maximum section width (W_m), includes a tread (102) extending circumferentially about the tire (100), a pair of sidewalls (104), a pair of bead portions (106), and at least one carcass ply (114, 116) extending circumferentially about the tire (100) from one bead portion to the other. The tire (100) further includes first and second reinforcement plies (202, 204) extending circumferentially about the tire (100) and being disposed between the at least one carcass ply (114, 116) and the tread (102) and at least one of the sidewalls (104) of the tire (100). The first and second reinforcement plies (202, 204) have lower ends (208, 212) that terminate in the lower section (L) of the tire (100).

TIRE HAVING A SIDEWALL REINFORCEMENT

FIELD OF THE INVENTION

[0001] The present application relates to tires and, more particularly, to a tire with a sidewall reinforcement to improve sidewall performance of the tire.

BACKGROUND

[0002] In an inflated and loaded condition, a radial tire is subject to bending moments at the sidewall areas at the center of the tire footprint. The strains and stresses created by the moments are directly related to the sidewall performance of the tire.

[0003] Previous research and studies have demonstrated that the maximum sidewall surface strain occurs in the least stiff area of the sidewall of a tire. Because of cord compression created during the loading of the tire, the combined cord tension in the upper sidewall area is reduced and that area is most vulnerable to sidewall bending. Therefore, the maximum sidewall surface strain is located in the upper sidewall area.

SUMMARY

[0004] A tire, which has a maximum section width, an upper section above the maximum section width, and a lower section below the maximum section width, includes a tread extending circumferentially about the tire, a pair of sidewalls, a pair of bead portions, and at least one carcass ply extending circumferentially about the tire from one bead portion to the other. The tire further includes first and second reinforcement plies extending circumferentially about the tire and being disposed between the at least one carcass ply and the tread and at least one of the sidewalls of the tire. The first and second reinforcement plies have lower ends that terminate in the lower section of the tire.

BRIEF DESCRIPTION OF DRAWINGS

[0005] The accompanying drawings, together with the detailed description provided below, describe exemplary embodiments of the claimed invention. In the drawings and description that

follow, like elements are identified with the same reference numerals. The drawings are not to scale and the proportion of certain elements may be exaggerated for the purpose of illustration.

- [0006] **Figure 1** is a cross-sectional view of one embodiment of half of a tire **100**.
- [0007] **Figure 2** is an enlarged perspective view of a portion of the tire **100** of **Figure 1**.
- [0008] **Figure 3** is a perspective view of one embodiment of a portion of a dual reinforcement layer provided in the tire **100** of **Figure 1**.
- [0009] **Figure 4** is a sidewall surface strain plot comparing a P255/45R18 tire with and without a sidewall dual layer reinforcement.

DETAILED DESCRIPTION

[0010] The following includes definitions of selected terms employed herein. The definitions include various examples and/or forms of components that fall within the scope of a term and that may be used for implementation. The examples are not intended to be limiting. Both singular and plural forms of terms may be within the definitions.

- [0011] “Axial” or “axially” refer to a direction that is parallel to the axis of rotation of a tire.
- [0012] “Circumferential” and “circumferentially” refer to lines or directions extending along the perimeter of the surface of the tread parallel to the equatorial plane and perpendicular to the axial direction of the tire.
- [0013] “Equatorial plane” refers to the plane that is perpendicular to the tire’s axis of rotation and passes through the center of the tire’s tread.
- [0014] “Groove” refers to an elongated void area in the tread of the tire that extends circumferentially in a straight, curved or zig-zag manner.
- [0015] “Lateral” or “laterally” refer to a direction along the tread of the tire going from one sidewall of the tire to the other sidewall.

[0016] “Radial” or “radially” refer to a direction perpendicular to the axis of rotation of the tire.

[0017] “Sidewall” refers to that portion of the tire between the tread and the bead.

[0018] “Tread” refers to that portion of the tire that comes into contact with the road under normal load.

[0019] Directions are also stated in this application with reference to the axis of rotation of the tire. The terms “upward” and “upwardly” refer to a general direction towards the tread of the tire, whereas “downward” and “downwardly” refer to the general direction towards the axis of rotation of the tire. Thus, when relative directional terms such as “upper” and “lower” are used in connection with an element, the “upper” element is spaced closer to the tread than the “lower” element. Additionally, when relative directional terms such as “above” or “below” are used in connection with an element, an element that is “above” another element is closer to the tread than the other element. The terms “inward” and “inwardly” refer to a general direction towards the equatorial plane of the tire, whereas “outward” and “outwardly” refer to a general direction away from the equatorial plane of the tire and towards the sidewall of the tire. Thus, when relative directional terms such as “inner” and “outer” are used in connection with an element, the “inner” element is spaced closer to the equatorial plane of the tire than the “outer” element.

[0020] Illustrated in **Figure 1** is a cross-sectional view of half of one embodiment of a tire **100**. Although only half of the tire **100** is depicted in the drawings, it will be appreciated that the other half of the tire **100** is a substantial mirror image of the half depicted. The tire **100** has an equatorial plane **E_p** and a maximum section width **W_m** measured from the equatorial plane **E_p** to the outer most point of the tire **100** (i.e., point **X**). The tire **100** can be divided into two sections – an upper section **U** and a lower section **L**. Separating the upper section **U** from the lower section **L** is a hypothetical line **Y** drawn through point **X** that is substantially parallel to the axis of rotation of the tire **100**. The upper section **U** is the portion of the tire **100** that is disposed above the maximum section width **W_m** of the tire **100** (represented by line **Y**), while the lower section **L** is disposed below the maximum section width **W_m** of the tire **100** (represented by line **Y**).

[0021] With continued reference to **Figure 1**, the tire **100** includes a tread **102** provided in the upper section **U** of the tire **100**, a sidewall **104** provided in both the upper and lower sections **U, L** of the tire **100**, and a bead assembly **106** provided in the lower section **L** of the tire **100**. The bead assembly **106** includes a bead core **108** and a bead filler **110** having an upper end **112**.

[0022] The tire **100** includes a carcass ply **114** that extends circumferentially about the tire **100** from one bead assembly (e.g., bead assembly **106**) to the other bead assembly (not shown). The carcass ply **114** is wound outwardly about the bead core **108** and extends upwardly towards the tread **102** to form a turn-up portion **118**. The turn-up portion **118** terminates at a turn-up end **122**. Although the tire **100** illustrated in **Figure 1** includes one carcass ply, the tire **100** can include two or more carcass plies in alternative embodiments (not shown).

[0023] With continued reference to the embodiment illustrated in **Figure 1**, the turn-up portion **118** of the carcass ply **114** has a height **H₁** measured radially from the turn-up end **122** to the base of the bead core **108**. Preferably, the height **H₁** of the first turn-up portion **118** is between about 30% and about 70% of the section height **H₀** (which is measured from the outer tread surface at the equatorial plane **E_p** to the base of the bead core **108**). In alternative embodiments (not shown), the height **H₁** of the first turn-up portion **118** may be less than 30% or greater than 70% of the section height **H₀** depending on the design.

[0024] In one embodiment, the carcass ply **114** includes parallel-aligned cords that are radially disposed. In other words, the parallel-aligned cords are oriented substantially perpendicular to the equatorial plane **E_p** of the tire **100**. In alternative embodiments, the carcass ply can include parallel-aligned cords that are biased with respect to the equatorial plane **E_p** of the tire **100**. In all cases, the cords can be constructed of, for example, nylon or polyester.

[0025] With continued reference to **Figure 1**, the tire **100** further includes first and second belts **126, 128** that extend circumferentially about the tire **100**. The first and second belts **126, 128** are provided between the tread **102** and the first and second carcass plies **114, 116** as shown in **Figure 1**. The first and second belts **126, 128** terminate at edges **130, 132**, respectively, at a location near a shoulder region **134** of the tire **100**. Although the tire **100** illustrated in **Figure 1** features two belts, the tire **100** can include a single belt or more than two belts in alternative embodiments (not shown).

[0026] In one embodiment, the first and second belts 126, 128 include parallel-aligned cords or wires that are radially disposed. In alternative embodiments, one or more of the belts can include parallel-aligned cords or wires that are biased with respect to the equatorial plane E_p of the tire 100. In all cases, the cords or wires can be constructed of, for example, steel or other steel alloys.

[0027] With continued reference to **Figure 1**, the tire 100 also includes a belt edge insert 136 provided in the shoulder region 134 of the tire 100 between the edges 130, 132 of the first and second belts 126, 128, respectively, and the carcass ply 114. The belt edge insert 136 has an inner end 138 and an outer end 140. The belt edge insert 136 is configured to protect the carcass ply 114 from the edges of the belts 126, 128. The belt edge insert 136 is constructed of extruded rubber, but may be constructed of another elastomeric material. Although shown in the **Figure 1** embodiment, the belt edge insert 136 is optional and may be omitted in alternative embodiments (not shown).

[0028] The tire 100 further includes a tread cap 142 provided between the tread 102 and the first and second belts 126, 128. The tread cap 142 can be used to assist in holding the components of the tire together (e.g., the belts, plies, and tread). The tread cap 142 can include, for example, one or more polyester or nylon fabric plies. Although shown in the **Figure 1** embodiment, the tread cap 142 is optional and may be omitted in alternative embodiments (not shown).

[0029] As shown in **Figure 1**, the tire 100 also includes a dual layer reinforcement 144 provided between the carcass ply 114 and the tread 102 and sidewall 104 (or portion thereof) of the tire 100. Although the tire 100 features a dual layer reinforcement 144, the reinforcement can include one layer or three or more layers in alternative embodiments (not shown).

[0030] Illustrated in **Figure 2** is an enlarged perspective view of a portion of the tire 100 of **Figure 1** depicting the positioning of the dual layer reinforcement 144 in the tire 100 in greater detail. The dual layer reinforcement 144 includes first and second reinforcement plies 202, 204 that extend circumferentially about the tire 100. The first and second reinforcement plies 202, 204 are provided between the carcass ply 114 and the tread 102 and sidewall 104 of the tire 100. The first reinforcement ply (or inner reinforcement ply) 202 has a lower end 208, while the second reinforcement ply (or outer reinforcement ply) 204 a lower end 212.

[0031] As shown in the embodiment illustrated in **Figure 2**, the lower end **212** of the second reinforcement ply **204** extends below the lower end **208** of the first reinforcement ply **202**. More specifically, the lower end **212** of the second reinforcement ply **204** extends below the lower end **208** of the first reinforcement ply **202** a radial distance **B₁** between about 3 mm and about 6 mm. In alternative embodiments (not shown), the lower end **212** of the second reinforcement ply **204** may not extend below the lower end **208** of the first reinforcement ply **202**.

[0032] With continued reference to **Figure 2**, the tire **100** also includes a bead filler insert **214** having an upper end **216** and a lower end **218**. The bead filler insert **214** is positioned above the bead filler **112** and between the reinforcement plies **202**, **204** and the carcass ply **114**. The bead filler insert **214** is configured to serve as a cushion between the reinforcement plies **202**, **214** and the carcass ply **114**. The bead filler insert **214** is constructed of rubber, but may be constructed of another elastomeric material. Although the bead filler insert **214** is illustrated as a separate component, it can be an extension of the bead filler **112**.

[0033] The lower ends **208**, **212** of the first and second reinforcement plies **202**, **204** terminate in the lower section **L** of the tire **100**. More specifically, the lower ends **208**, **212** of the first and second reinforcement plies **202**, **204** may extend below the upper end **216** of the bead filler insert **214**. In other words, the bead filler insert **214** may overlap the first and second reinforcement plies **202**, **204**. Preferably, the lower end **208** of the first reinforcement ply **202** extends below the upper end **216** of the bead filler insert **214** a radial distance **R₁** between about 4 mm and about 6 mm. Similarly, the lower end **212** of the second reinforcement ply **204** extends below the upper end **216** of the bead filler insert **214** a radial distance **R₂** between about 10 mm and about 15 mm.

[0034] The termination of the lower ends **208**, **212** of the first and second reinforcement plies **202**, **204** can also be discussed in relation to the turn-up end **124** of the carcass ply **114**. For example, the lower ends **208**, **212** of the first and second reinforcement plies **202**, **204** extend below the turn-up end **124** of the carcass ply **114**. In other words, the turn-up portion **118** of the carcass ply **114** overlaps the first and second reinforcement plies **202**, **204**. Preferably, the lower end **212** of the second reinforcement ply **204** extends below the turn-up end **124** of the carcass ply **114** a radial distance **R₃** (which is approximately the same distance as **R₂** as shown in **Figure 2**) between about 10 mm and about 15 mm. Similarly, the lower end **208** of the first

reinforcement ply 202 extends below the turn-up end 124 of the carcass ply 114 a radial distance R_4 (which is approximately the same distance as R_1 as shown in **Figure 2**) between about 4 mm and about 6 mm.

[0035] Although **Figures 1** and **2** illustrate only half of a cross-section of the tire **100**, the dual layer reinforcement extends to the other sidewall (not shown) of the tire **100** where lower ends of the dual layer reinforcement terminate in the lower section **L** of the other sidewall (not shown) of the tire **100**. In other words, the dual layer reinforcement can be referred to as a “half-ply” reinforcement since it covers the upper half of the tire **100** and extends from the lower section **L** of one sidewall (e.g., sidewall **104**) of the tire to the lower section **L** of the other sidewall (e.g., the sidewall not shown) of the tire **100**.

[0036] Illustrated in **Figure 3** is a perspective view of a portion of one embodiment of the dual layer reinforcement **144**, which includes first and second reinforcement plies **202**, **204**. The first reinforcement ply **202** includes a first set of parallel-aligned cords **302** encapsulated in rubber or another elastomeric material. Similarly, the second reinforcement ply **204** includes a second set of parallel-aligned cords **304** encapsulated in rubber or another elastomeric material.

[0037] As shown in **Figure 3**, the dual layer reinforcement **144** is illustrated as an integral component having a first layer (i.e., first reinforcement ply **202**) and a second layer (i.e., second reinforcement ply **204**). In this case, the dual layer reinforcement **144** can be installed as a single component during the green tire assembly process. In an alternative embodiment (not shown), the first and second reinforcement plies **202**, **204** can be discrete layers that are installed separately during the green tire assembly process, yet cooperate with each to form the dual layer reinforcement **144** at the conclusion of the tire manufacturing process.

[0038] With reference to **Figure 3**, the first and second set of parallel-aligned cords **302**, **304** are oriented at an angle α with respect to circumferential direction **C** of the tire **100**. Preferably, the first and second sets of parallel-aligned cords **302**, **304** are oriented at an angle α between about 45° and 85° with respect to the circumferential direction **C** of the tire **100** and are transversely oriented with respect to each other. In alternative embodiments (not shown), the angular orientation of one or both sets of parallel-aligned cords **302**, **304** can be less than 45° with respect to the circumferential direction **C** of the tire **100** depending on the design. In addition, one or both sets of parallel-aligned cords **302**, **304** can be radially or circumferentially

disposed. Furthermore, the parallel-aligned cords 302, 304 need not be oriented transverse to each other.

[0039] The first reinforcement ply 202 preferably has a thickness T_1 between about 0.6 mm and about 1.2 mm and the second reinforcement ply 204 preferably has a thickness T_2 between about 0.6 mm and about 1.2 mm. Most preferably, the first reinforcement ply 202 has a thickness of about 1.0 mm and the second reinforcement ply 204 has a thickness of about 1.0 mm. Hence, the preferred total thickness T_3 of the dual layer reinforcement is about 2.0 mm.

[0040] In one embodiment, the first and second sets of parallel-aligned cords 302, 304 are constructed of nylon. In alternative embodiments, one or both sets of parallel-aligned cords 302, 304 may be constructed of polyester, rayon, or steel.

[0041] By providing the dual layer reinforcement in one or both sidewalls of a tire, sidewall performance of the tire is improved. For example, when the tire deflects, the dual layer reinforcement is shifted outward towards the sidewall of the tire, thereby increasing the stiffness of the sidewall of the tire. As stiffness of the sidewall of the tire increases, surface strain in the sidewall of the tire decreases. Reduction of surface strain at the sidewall of the tire can lead to a reduction of surface cracks at the sidewall of the tire, a reduction of deflection of the sidewall, and/or an improvement in vehicle handling.

[0042] The following example demonstrates the potential effects of providing the dual layer reinforcement in both sidewalls of a tire and should not be construed as limiting the scope or spirit of the present application.

Example 1

[0043] A P255/45R/18 tire, having a maximum allowable inflation of 35 psi and maximum load capacity of 1709 lb (hereinafter referred to as the “Control Tire”), was inflated to 19 psi (its minimum allowable inflation) and mounted on a fixture. A computer system was used to simulate the Control Tire to obtain dimensional data of the Control Tire in its unloaded state.

[0044] A maximum load of 1709 psi was then applied to the Control Tire causing it to deflect. The computer system then obtained dimensional data of the Control Tire in its loaded state. The dimensional data of the Control Tire in its unloaded state was then compared to the

dimensional data of the Control Tire in its loaded state to determine actual strain values along various points on the sidewall of the Control Tire.

[0045] This dimensional data was also used to create a computer simulated model of the Control Tire. Modifications could be made to the computer simulated model of the Control Tire to create virtual tires. From these virtual tires, surface strain values along any point on the sidewall of a tire could be predicted. In this case, the computer simulated model of the Control Tire was modified to create a virtual tire that included a half-ply, dual layer reinforcement (nylon cords; 45° equal, but opposite bias) similar to the one described above and shown in **Figure 3** (hereinafter be referred to as the “Reinforced Tire”).

[0046] **Figure 4** illustrates the sidewall surface strain graph comparing the predicted surface strain values of the Control Tire with the predicted surface strain values of the Reinforced Tire. The x-axis represents the radial distance in inches from the axis of rotation of the tires, while the y-axis represents the surface strain at the center of the footprint of the tires. In this case, since both tires have a diameter of 18 inches, surface strain measurements were taken at a radial distance beginning at 9 inches and ending at about 13.5 inches (which is the end of the sidewall of the tires). As shown in the graph in **Figure 4**, the predicted maximum sidewall surface strain of the Control Tire was 21.8%, while the predicted maximum sidewall surface strain of the Reinforced Tire was 4.7%. This represents a reduction in sidewall surface strain of about 17.1%.

[0047] To the extent that the term “includes” or “including” is used in the specification or the claims, it is intended to be inclusive in a manner similar to the term “comprising” as that term is interpreted when employed as a transitional word in a claim. Furthermore, to the extent that the term “or” is employed (e.g., A or B) it is intended to mean “A or B or both.” When the applicants intend to indicate “only A or B but not both” then the term “only A or B but not both” will be employed. Thus, use of the term “or” herein is the inclusive, and not the exclusive use. See, Bryan A. Garner, A Dictionary of Modern Legal Usage 624 (2d. Ed. 1995). Also, to the extent that the terms “in” or “into” are used in the specification or the claims, it is intended to additionally mean “on” or “onto.” Furthermore, to the extent the term “connect” is used in the specification or claims, it is intended to mean not only “directly connected to,” but also “indirectly connected to” such as connected through another component or multiple components.

[0048] While the present application illustrates various embodiments, and while these embodiments have been described in some detail, it is not the intention of the applicant to restrict or in any way limit the scope of the claimed invention to such detail. Additional advantages and modifications will readily appear to those skilled in the art. Therefore, the invention, in its broader aspects, is not limited to the specific details, the representative apparatus, and illustrative examples shown and described. Accordingly, departures may be made from such details without departing from the spirit or scope of the applicant's claimed invention.

CLAIMS

1. A tire (100) having a section height (H_o), a maximum section width (W_m), an upper section (U) above the maximum section width (W_m), and a lower section (L) below the maximum section width (W_m), the tire (100) comprising:
 - a tread (102) extending circumferentially about the tire (100);
 - a pair of sidewalls (104);
 - a pair of bead portions (106);
 - at least one carcass ply (114) extending circumferentially about the tire (100) from one bead portion (106) to the other; and
 - at least two reinforcement plies, the at least two reinforcement plies including first and second reinforcement plies (202, 204) extending circumferentially about the tire (100) and being disposed between the at least one carcass ply (114) and the tread (102) of the tire (100), the first and second reinforcement plies (202, 204) have lower ends (208, 212) that terminate in the lower section (L) of the tire (100).
2. The tire of claim 1, wherein the first reinforcement ply (202) includes a first set of parallel-aligned cords (302) and the second reinforcement ply (204) includes a second set of parallel-aligned cords (304).
3. The tire of claim 2, wherein the angular orientation of the first and second sets of parallel-aligned cords (302, 304) are between about 45 degrees and 85 degrees with respect to a circumferential direction (C) of the tire (100).
4. The tire of claim 2, wherein the first and second sets of parallel-aligned cords (302, 304) are transversely oriented with respect to each other.
5. The tire of claim 1, wherein each bead portion (106) includes a bead core (108) and a bead filler (110).
6. The tire of claim 5, wherein the at least one carcass ply (114) is wound outwardly about one of the bead cores (108) and extends toward the tread (102) to form a turn-up portion

(120) that terminates at a turn-up end (124), wherein the lower ends (208, 212) of the first and second reinforcement plies (202, 204) extend below the turn-up end (124) of the at least one carcass ply (114).

7. The tire of claim 6, wherein the turn-up end (124) of the turn-up portion (120) is located in the lower section (L) of the tire (100).
8. The tire of claim 6, wherein the turn-up portion (120) has a height (H_1) that is between about 30% and about 70% of the section height (H_0) of the tire (100).
9. The tire of claim 6, wherein at least one of the lower ends (208, 212) of the first and second reinforcement plies (202, 204) extends below the turn-up end (124) of the at least one carcass ply (114) a radial distance between about 4 mm and about 15 mm.
10. The tire of claim 6, wherein the lower ends (208, 212) of the first and second reinforcement plies (202, 204) are provided between the at least one carcass ply (114) and the turn-up portion (120) of the at least one carcass ply (114).
11. The tire of claim 5, further comprising a bead filler insert (214) provided above the bead filler (110) and between the first and second reinforcement plies (202, 204) and the at least one carcass ply (114).
12. The tire of claim 11, wherein the lower ends (208, 212) of the first and second reinforcement plies (202, 204) extend below an upper end (216) of the bead filler insert (214).
13. The tire of claim 12, wherein the upper end (216) of the bead filler insert (214) extends above the lower ends (208, 212) of the first and second reinforcement plies (202, 204) and a lower end (218) of the bead filler insert (214) extends below an upper end (112) of the bead filler (110).

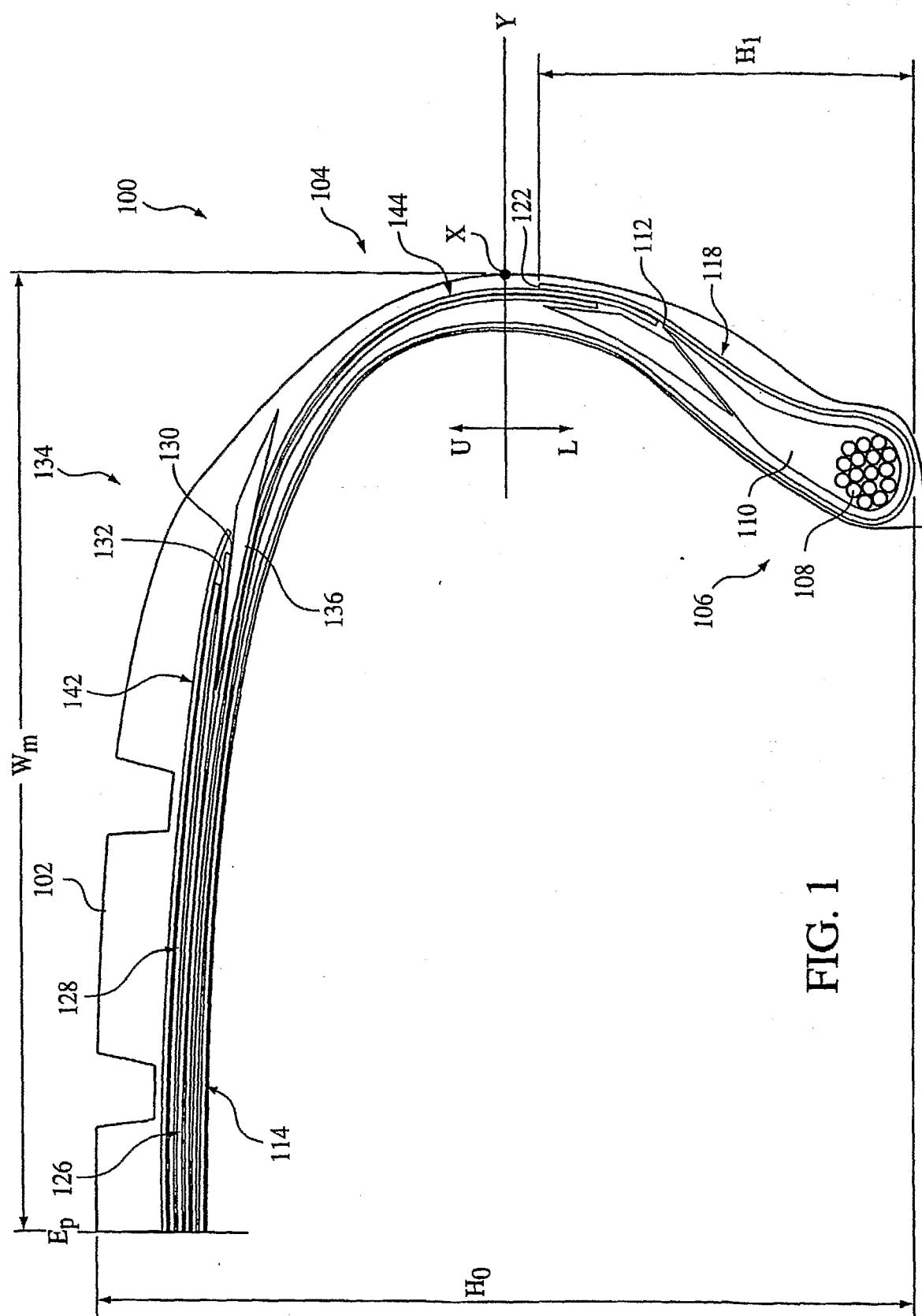


FIG. 1

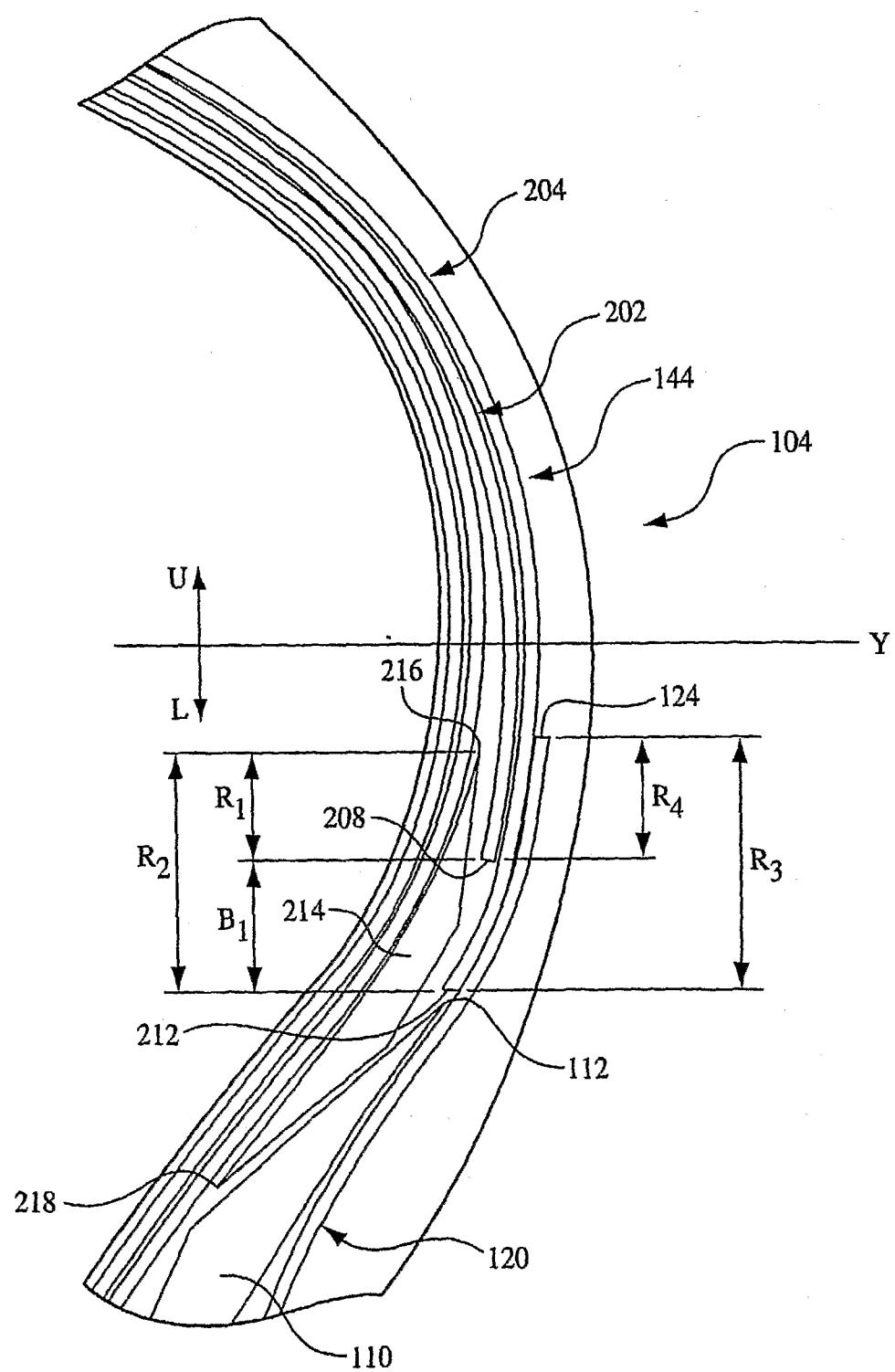


FIG. 2

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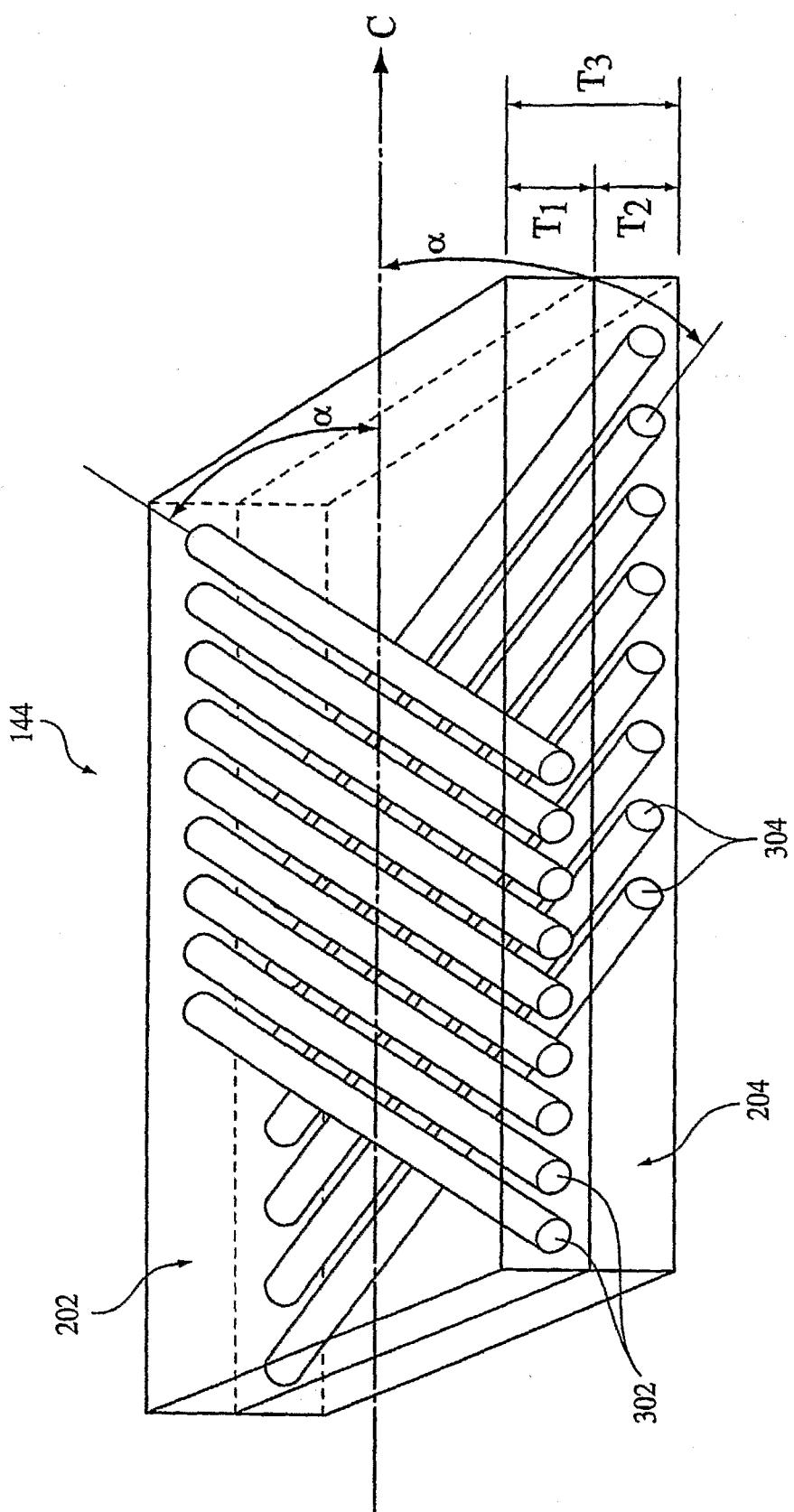


FIG. 3

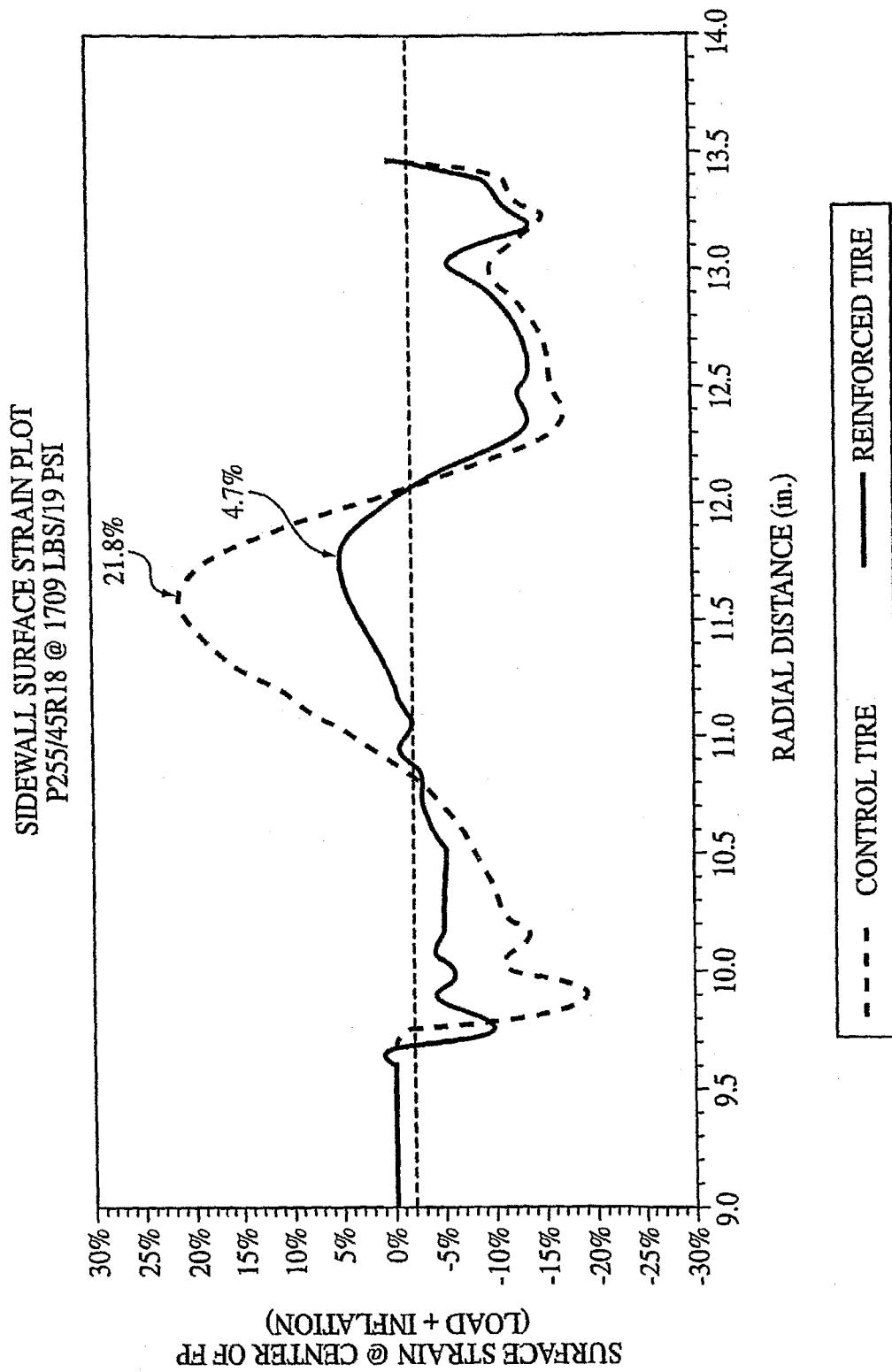


FIG. 4

SUBSTITUTE SHEET (RULE 26)

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2006/031720

A. CLASSIFICATION OF SUBJECT MATTER
INV. B60C9/12 B60C13/04

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 practical, 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	LU 77 020 A (BRIDGESTONE TIRE) 22 July 1977 (1977-07-22) page 34, line 4 – page 35, line 11; figure 5	1
A	EP 0 881 105 A2 (CONTINENTAL AG [DE]) 2 December 1998 (1998-12-02) column 5, line 39 – column 6, line 1; figure 3	1-7
A	EP 1 083 064 A2 (BRIDGESTONE CORP [JP]) 14 March 2001 (2001-03-14) paragraph [0021]; figure 1	1,5,6
A	JP 2001 071714 A (SUMITOMO RUBBER IND) 21 March 2001 (2001-03-21) abstract; figure 1	1,3,5,6, 8,10

Further documents are listed in the continuation of Box C.

See patent family annex.

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6 December 2006

21/12/2006

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INTERNATIONAL SEARCH REPORT

Information on patent family members

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