(12) PATENT (11) Application No. AU 200013833 B2
(19) AUSTRALIAN PATENT OFFICE (10) Patent No. 756168

(54) Title
Supporting envelope for running tread

(51)6 International Patent Classification(s)
B60C 017/02

(21) Application No: 200013833 (22) Application Date: 1999.11.16

(87) WIPO No: WO00/30877

(30) Priority Data

(31) Number	(32) Date	(33) Country
98/14695	1998.11.20	FR

(43) Publication Date : 2000.06.13
(43) Publication Journal Date : 2000.08.10
(44) Accepted Journal Date : 2003.01.09

(71) Applicant(s)
Societe De Technologie Michelin; Michelin Recherche Et Technique S.A.

(72) Inventor(s)
Alain Clouet

(74) Agent/Attorney
WATERMARK PATENT and TRADEMARK ATTORNEYS,Locked Bag 5,HAWTHORN VIC 3122

(56) Related Art
US 6283185
US 4164250
DE 2520321

PCT ORGANISATION MONDIALE DE LA PROPRIETE INTELLECTUELLE
Bureau international

DEMANDE INTERNATIONALE PUBLIEE EN VERTU DU TRAITE DE COOPERATION EN MATIERE DE BREVETS (PCT)

(51) Classification internationale des brevets 7 : B60C 17/02	A1	(11) Numéro de publication internationale: **WO 00/30877** (43) Date de publication internationale: 2 juin 2000 (02.06.00)

(21) Numéro de la demande internationale: PCT/EP99/08792

(22) Date de dépôt international: 16 novembre 1999 (16.11.99)

(30) Données relatives à la priorité:
98/14695 20 novembre 1998 (20.11.98) FR

(71) Déposant *(pour tous les Etats désignés sauf CA US)*: SOCIETE DE TECHNOLOGIE MICHELIN [FR/FR]; 23, rue Breschet, F-63000 Clermont-Ferrand (FR).

(71) Déposant *(pour tous les Etats désignés sauf US)*: MICHELIN RECHERCHE ET TECHNIQUE S.A. [CH/CH]; 10 et 12, route Louis-Braille, CH-1763 Granges-Paccot (CH).

(72) Inventeur; et
(75) Inventeur/Déposant *(US seulement)*: CLOUET, Alain [FR/FR]; Rue de la Chapelle, Sainte-Marguerite, F-63270 Saint-Maurice (FR).

(74) Mandataire: DEVAUX, Edmond-Yves; Michelin & Cie, Service SGD/LG/PI-LAD, F-63040 Clermont-Ferrand Cedex 09 (FR).

(81) Etats désignés: AU, BR, CA, JP, US, brevet européen (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

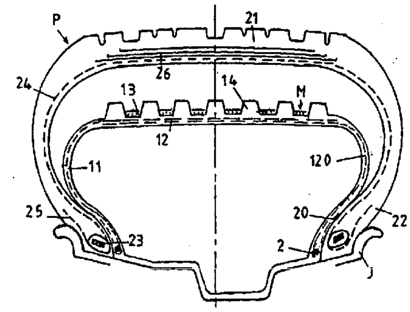
Publiée
Avec rapport de recherche internationale.

(54) Title: SUPPORTING ENVELOPE FOR RUNNING TREAD

(54) Titre: MEMBRANE DE SOUTIEN DE BANDE DE ROULEMENT

(57) Abstract

The invention concerns a reinforced toric rubber envelope (M), inflated at a pressure p_0 higher than pressure p_1 of the tyre cavity P wherein it is used, having, when inflated, a crown radius R_M less than the deflection radius R_E of the inflated tyre, and reinforced in its crown (1) by at least two plies of yarns or cords crisscrossed from one ply to the next, at least one of said plies being a ply (13) of yarns or cords, circumferentially oriented, and in each of its sidewalls by a least a reinforcing ply (120), wound around a reinforcing ring-shaped element (15), each consisting of a core (150) with a breaking force higher than the tension, per ply element, due to the pressure differential $p_0 - p_1$ and to the maximum centrifugal force to which said element (15) is subjected and such that it enables the rupture of said elements (15) for a pressure differential $p_0 - p'_1$, greater than $p_0 - {}_1$ and after the bracing ply (13) is ruptured, the core around which is wound at least one yarn or cord (151), the ultimate elongation ϵ_R of the reinforcing element (15) being at least equal to the ratio of the difference between the tyre internal meridian length and the envelope external meridian length over the envelope external meridian length.



TREAD SUPPORTING MEMBRANE

The invention relates to a support means for the tread of a tyre. Said support means constitutes with said tyre and its mounting rim a rolling assembly for a vehicle, intended to be able to travel after a consequent and unexpected loss of pressure of the tyre, said tyre being more particularly a tubeless tyre of the heavy-vehicle or civil-engineering type.

French Application FR 2 756 221 describes and claims as support means for a tread a toric membrane of reinforced rubber, inflated to a pressure p_0 greater than the pressure p_1 of the cavity of the tyre, and having, in the inflated state, a crown radius R_M less than the loaded radius R_E of the tyre used at its recommended pressure, said membrane, at least in its crown, being reinforced by at least one ply of cords or cables, said crown of said membrane furthermore comprising at least one hooping reinforcement of circumferentially oriented cords or cables having a breaking load per cm of ply at least equal to the product of the crown radius R_M and the pressure, per cm^2 of surface of said ply, resulting in a tension per cm of ply equivalent to the tension due to the maximum centrifugal force to which the tyre can be subjected and permitting the breaking of the hooping cords or cables for a pressure differential $p_0 - p'_1$, existing in the event of a loss of pressure experienced by the tyre, greater than the initial pressure differential $p_0 - p_1$, that is to say, during normal travel. Said hooping reinforcement may be composed of at least one ply, generally located among the crown reinforcement plies, or of several bands located in the recesses formed on the protective layer or support band radially covering the subjacent plies.

The internal pressure p_0 of said membrane, measured in the cold state, that is to say at 20°C, is greater than the pressure p_1 of the inner cavity of the tyre by an amount between 0.5×10^5 Pa and 5.0×10^5 Pa, depending on the tyre dimensions concerned. Given that the crown radius R_M of the toric membrane is preferably between 0.80 and 0.97 times the loaded radius R_E of the tyre, mainly for reasons of heating of said tyre, too high a pressure difference risks adversely affecting a certain number of properties of the tyre itself, for example the life of the carcass reinforcement of said tyre, while requiring an excessively large hooping reinforcement.

The crown of said membrane is preferably reinforced by two plies of cords or cables which are parallel to each other in each ply and crossed from one ply to the next, forming an angle of between 50° and 85° with the circumferential direction. The cables or cords are advantageously textile ones for reasons of lightness, flexibility and good corrosion resistance, and preferably are made of aromatic polyamide. The axial ends of the two plies are preferably located on the sidewalls of the membrane, such that, if S is the maximum axial width of the carcass reinforcement of the tyre, the width of the plies is preferably between S and 1.30 S.

The pressure difference $p_0 - p_1$ increases in the event of the tyre puncturing and the cables of the hooping ply or plies break, and the toric supporting membrane expands into the cavity of the tyre and enables the whole to continue travelling despite the drop in pressure in the cavity of the tyre.

The toric membrane according to the invention described in the above French application may possibly comprise sidewalls each reinforced by at least one ply of radial cords or cables, said sidewalls possibly being provided advantageously with radial grooves opening on to the metal mounting rim of the tyre.

Under normal conditions of travel of the assembly formed by the tyre, its mounting rim and the membrane, loading conditions, pressure conditions and speed conditions recommended for the tyre in question, the membrane retains an equatorial radius which is practically constant and less than the loaded radius of the tyre, and the outer walls of its sidewalls are for a very major part in permanent contact with the inner walls of the tyre. The friction existing between said walls results in premature degradation and wear of the impermeable layer of rubber which covers the inner wall of the tyre.

French Application 97/16450, in order to overcome the disadvantages referred to above, proposes imparting to the membrane a particular sidewall architecture in that the sidewall reinforcement ply is wound on either side around an annular reinforcement element, the makeup of which permits breaking after the breaking of the hooping plies, said sidewall reinforcement ply having a meridian profile in the inflated state which is adapted such that there is no contact between the membrane and the inner wall of the closest sidewall from a certain height onwards. In other words, the presence of an annular reinforcement element makes it possible, in the inflated state and during normal travel, to maintain the desired meridian profile of the sidewall reinforcement ply or plies, while not preventing normal, complete expansion of the supporting membrane upon loss of pressure in the tyre cavity.

The presence of an annular element or bead wire for winding the sidewall reinforcement plies of the membrane results in two major disadvantages:

- it is difficult, not to say impossible, to control the position of the pieces of bead wire after breaking: in particular, accentuated asymmetry, relative to the equatorial plane, of the positioning of the crown of the membrane after expansion, has thus been very frequently observed, which causes certain driving problems for the vehicle thus equipped;

- the breaking of the winding bead wires, in the case of a so-called closed supporting membrane (the cross-section through said membrane has a continuous contour), causes great extension of the membrane portions located radially beneath said bead wires, which results in breaking of said portions and escape of inflation gas from said membrane.

In order to overcome the disadvantages referred to above, while retaining, firstly, the principle of an expandable toric supporting membrane capable of filling the cavity of the tyre when the inflation pressure of said cavity decreases and/or is cancelled out, and secondly the principle of the lowest possible length of contact between the membrane and the inner wall of the tyre in the case of normal travel, the invention provides:

- a reinforced rubber membrane M for use as a tread support means for a tyre P, and forming with said tyre P and its mounting rim J a rolling assembly which is capable of travel when the tyre is subject to a loss of pressure, said mounting rim J having two flanges of external diameter D_R and two rim seats, each rim seat having a width L_S and a nominal diameter of D_S, said membrane
  - being inflated to a pressure p_0 greater than the pressure p_1 of the cavity of the tyre,
  - having, in the inflated state, a crown radius R_M less than the loaded radius R_E of the tyre used at its recommended pressure,
  - being in its crown (1), reinforced by at least two plies of cords or cables parallel to each other in each ply and crossed from one ply to the next, at least one of said plies being a so-called hooping ply (13) composed of at least one layer of cords or cables, oriented circumferentially and having a breaking load per cm of ply making it possible firstly to resist the tension due to the pressure differential $p_0 - p_1$ existing during normal travel, and secondly to permit the

breaking of the cords or cables for a pressure differential $p_0 - p'_1$ greater than $p_0 - p_1$, and

- reinforced in each of its sidewalls by at least one ply (120),

said membrane being characterized in that, viewed in meridian section,

- the sidewall reinforcement ply (120) is anchored in each lower part of the sidewall by winding around an inextensible annular reinforcement element (2), which does not break under the action of the sidewall ply (120) and the internal diameter D of which is between the value D_R and a value equal to D_S minus the product of the width L_S of the rim seat and the tangent of the angle of inclination of said rim seat,
- said sidewall reinforcement ply (120) being formed of reinforcement elements (15), each element (15) including a core (150) surrounded by a helically wound cord or cable (151) said core having a breaking load which is firstly greater than the tension, per element of ply, due to the pressure differential $p_0 - p_1$ and to the maximum centrifugal force to which said element (15) is subjected, and secondly such that it permits the breaking of said cores of said elements (15) of the sidewall ply (120) for a pressure differential $p_0 - p'_1$ greater than $p_0 - p_1$ and after the breaking of the elements of the hooping ply (13),
- and said reinforcement element (15) of the sidewall ply (120) having a curve, representing the tension as a function of the relative elongation ε, having for an elongation greater than the elongation at break e_A of the core, a segment in which the variation in the tension as a function of the elongation is substantially zero,
- the elongation at break ε_R of the reinforcement element (15) being at least equal to the ratio of the difference between the internal meridian length of the tyre and the external meridian length of the membrane to the external meridian length of the membrane.

Preferably, the internal diameter D of the inextensible annular reinforcement element lies between the value D_s and the value equal to D_s minus the product of the width L_s of the rim seat and the tangent of the angle of inclination of said rim seat.

The membrane crown is said to be reinforced by a ply when the presence of said ply at the crown is effective, whatever the real width of the ply. A membrane sidewall is said to be reinforced by a ply if there is actually a ply in the sidewall; thus a ply anchored to the two membrane bead wires is a sidewall reinforcement ply but also a crown reinforcement ply.

The characteristics and advantages of the invention will be better understood with reference to the following description, which refers to the drawings illustrating an example of embodiment in non-limitative manner, in which drawings:

- Figure 1 is a diagram of a toric supporting membrane according to the invention,
- Figure 2 is a diagram of the membrane of Figure 1 in position in the tyre mounted on its operating rim and inflated,
- Figure 3 is a diagram of a reinforcement element used for the sidewall reinforcement ply of the membrane,
- Figure 4 is the curve showing the tensile force as a function of the relative elongation of a reinforcement element of a sidewall reinforcement ply,
- Figures 5 to 7 are diagrams of variants of the supporting membrane according to the invention.

The toric membrane M according to the invention, in the first example described (Figure 1), is closed and

(the next page is 8)

reinforced at its crown (1). Of low thickness which is constant over its radially inner part (10), it is thicker on its sidewalls (11) and at its crown (1). It is reinforced overall by two plies (120), each ply being formed of reinforcement elements which are parallel to each other in the ply, and forming an angle of between 50° and 85°, more precisely equal to 60°, with the equatorial line XX' of the assembly, which angle will be of one direction for one of the plies and of the opposite direction for the other ply. The width of each of the two plies (120) is such that one of its ends A is located in the region of one of the shoulders of the membrane M, whereas the other end B of said ply (120) is the end of the upturn (20) which it forms after winding around an annular reinforcement element (2) in the lower part of the membrane sidewall located on the opposite side to said shoulder. The two plies (120), in the region AA of the crown of the membrane M, therefore perform the function of two crown reinforcement plies of elements which are parallel to each other in each portion of ply and are crossed from one ply to the next, forming an angle of 60° with the equatorial direction, and in the region AB of the sidewalls perform the function of a sidewall reinforcement ply, each sidewall being reinforced by a ply of elements forming with the equatorial direction a variable angle of less than 90° and greater than the angle measured in the equatorial plane.

The assembly (12) of the two crown plies (120) which is thus formed, which is readily expandable, may be surmounted by a rubber support band (14) provided with frustoconical elements in relief (140) separated from each other by recesses (141). These frustoconical "blocks" form circumferential rows on the surface of the band (14), such that, between two axially adjacent rows of blocks (140), there is arranged a hooping strip

(131) of circumferential cables, formed of three cords of aromatic polyamide. The assembly consisting of the strips (131) of 3 circumferential cables which are thus defined and forming the hooping assembly (13), their number being equal to the number of axial gaps between rows of blocks (140), performs the function of hooping the membrane M, firstly against the forces due to centrifugal force and secondly against the forces due to the pressure differential $p_0 - p_1$, p_0 being the inflation pressure of the toric membrane M, which is equal to 10 x 10^5 Pa, and p_1 being the pressure of the tyre P which is equal to 9.0 x 10^5 Pa. Said hooping function makes it possible for the membrane M and its crown plies, under normal travelling conditions of the assembly, that is to say, under the loading, pressure and speed conditions recommended for the tyre in question, to retain respective radii R_M and R_{M1} which are practically constant (Figure 2) and less than the loaded radius R_E of the tyre P under normal travelling conditions.

Each annular reinforcement element (2) is formed by winding 167x2 cables of aromatic polyamide. Such a composition imparts to said annular element virtually perfect extensibility and a tensile strength of at least 1.05 times the necessary strength induced by the tension exerted on the annular element of the reinforcement elements of the sidewall ply: thus the annular element (2), under the conditions mentioned, may be said to be inextensible and unbreakable. Said annular element is arranged radially as close as possible to the mounting rim of the tyre and, in the case illustrated, its internal diameter is between the nominal diameter of the rim D_S and the value D_S minus the product L_S x tan δ, L_S being the axial width of the tyre bead seat and tan δ the tangent of the angle of inclination of the seat of the mounting rim.

Each reinforcement element (15) of the sidewall and crown reinforcement ply (120) (Figure 3) is formed of a core (150), which in turn is formed of a 122x1 rayon reinforcement element. Said core has (Figure 4) a breaking load F_{RA} of 6.2 daN for a relative elongation ε_A of 7.5% (point M of the curve representing the force as a function of the relative elongation). Around said core are wound cords (151) of 167 tex, each cord (151) being twisted on itself and the two cords (151) being twisted around the core (150). The reinforcement element (15) thus obtained, referred to as a breaking-core element, has a elongation at break ε_R of 90% (point R on the curve), which is far greater than the elongation ε_A at break of the core (150): after breaking of said core, the reinforcement element (15) therefore has a high potential of elongation before it itself breaks (portion NR of the curve), said potential being estimated at more than 80%. Said potential is very largely sufficient to permit complete expansion of the membrane until the tyre cavity is filled, since the necessary, sufficient elongation is equal to the ratio of the difference between the internal meridian length of the tyre and the external meridian length of the membrane to the external meridian length of the membrane, said lengths being measured from bead wire to bead wire.

In the case looked at previously, the circumferential reinforcement elements of the hooping bands (131) break at a certain pressure difference $p_0 - p'_1$. It is obvious that using reinforcement elements having a structure similar to that of the elements (15) used for the plies (120) as reinforcement elements for the hooping bands does not involve departing from the scope of the invention. For example, each hooping element will be formed of a 110x1 core of aromatic polyamide, and, wound around said core, of two 167x2 cables of aromatic polyamide. The core of the hooping element then breaks at the supported tension which results from lowering the pressure p_1, whereas the overall element is not broken, although it has become very extensible. The solution makes it possible to avoid as far as possible the dispersion of the pieces of strip after the latter have broken, but at the expense of substantially higher material costs.

In Figure 2, the assembly E is composed of the tyre P, of dimension 495/45-R-22.5 in the example described, the mounting rim J, and the toric membrane M according to the invention. The tyre P is a universally known tyre, with sidewalls joined radially on the outside to a tread (21) and extended radially on the inside to two beads (22), each bead (22) being reinforced by at least one bead wire (23) around which a radial carcass reinforcement (24) is anchored to form upturns (25). Said carcass reinforcement (24) is surmounted radially in the crown by a crown reinforcement (26), composed of at least two plies of metal cords or cables which are parallel to one another in each ply and crossed from one ply to the next, forming an angle which may be between 5° and 45° with the circumferential direction. The tyre P is referred to as tubeless, and comprises on the inside a layer of rubber mix which is impermeable to the inflation gas.

Figure 5 shows the simplest architecture of the supporting membrane, the crown and the sidewalls of said membrane being viewed in a plane. The sidewalls (11) are reinforced by a single radial ply (120) of breaking-core reinforcement elements (15) of the same composition as those described previously, but radial. Said radial ply is also the crown ply since it is axially continuous from bead wire (2) to bead wire (2) of the membrane M. The crown (1) of said membrane is complementarily reinforced by a hooping ply (13) arranged radially beneath the support band (14), said hooping ply being formed of reinforcement elements such that the breaking load per cm of ply is a linear function of the inflation pressure p_1 of the cavity of the tyre, the angular coefficient of the representative straight line being equal to 0.05 and the ordinate at the origin of said straight line being equal to 0.3 x 10^5 Pa, the tyre in question being a "heavy-vehicle" tyre. The crown will advantageously be completed, radially to the outside of the hooping ply, by at least one ply of metallic reinforcement elements undulating in the plane of the ply, which are parallel to each other within the ply and oriented relative to the circumferential direction at an angle which may lie between 0° and 90°, the amplitude and the wavelength of the undulations obviously being selected so as not to hinder the radial expansion of the membrane.

Figure 6 shows a membrane architecture with two plies (120) which are continuous from bead wire (2) to bead wire (2), formed of breaking-core reinforcement elements (15) of the same composition as those described previously, but crossed from one ply to the next, forming with the circumferential direction an angle, measured in the equatorial plane of the membrane, of between 50° and 85°, and more precisely equal to 60°. The two plies (120) are sidewall reinforcement plies and crown reinforcement plies, the crown being complementarily reinforced by a hooping ply (13) such as that shown in Figure 5 and described previously.

The architecture shown in Figure 7 comprises a sidewall and crown reinforcement ply (120), since it is continuous from bead wire (2) to bead wire (2), said ply (120) being formed of the same breaking-core elements as previously, said elements being parallel to each other in the ply and forming an angle of 60° (but possibly being between 50° and 85°) with the circumferential direction, measured at the crown of the membrane. The ply (120) in the crown is surmounted radially by a crown ply (121) of defined axial width composed of the same reinforcement elements as those of the ply (120), but crossed with the latter, forming the same angle, but of opposite direction, with the circumferential direction. The ply (121) may be radially surmounted by the support strip (14) provided with frustoconical elements in relief (140) which are spaced apart by the recesses (141). These frustoconical "blocks" form circumferential rows on the surface of the tread (14), such that, between two axially adjacent rows of blocks (140), there is arranged a hooping strip (131) of circumferential cables, the assembly of which forms the hooping ply (13). The ply (121) may also be surmounted more simply by a hooping ply such as that shown in Figure 5 and described in the passage corresponding to said figure.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. A reinforced rubber membrane M for use as a tread support means for a tyre P, and forming with said tyre P and its mounting rim J a rolling assembly which is capable of travel when the tyre is subject to a loss of pressure, said mounting rim J having two flanges of external diameter D_R and two rim seats, each rim seat having a width L_S and a nominal diameter of D_S, said membrane

- being inflated to a pressure p_0 greater than the pressure p_1 of the cavity of the tyre,
- having, in the inflated state, a crown radius R_M less than the loaded radius R_E of the tyre used at its recommended pressure,
- being in its crown (1), reinforced by at least two plies of cords or cables parallel to each other in each ply and crossed from one ply to the next, at least one of said plies being a so-called hooping ply (13) composed of at least one layer of cords or cables, oriented circumferentially and having a breaking load per cm of ply making it possible firstly to resist the tension due to the pressure differential $p_0 - p_1$ existing during normal travel, and secondly to permit the breaking of the cords or cables for a pressure differential $p_0 - p'_1$ greater than $p_0 - p_1$, and
- reinforced in each of its sidewalls by at least one ply (120),

said membrane being characterized in that, viewed in meridian section,

- the sidewall reinforcement ply (120) is anchored in each lower part of the sidewall by winding around an inextensible annular reinforcement element (2), which does not break under the action of the sidewall ply (120) and the internal diameter D of which is between the value D_R and a value equal to D_S minus the product of the width L_S of the rim seat and the tangent of the angle of inclination of said rim seat,
- said sidewall reinforcement ply (120) being formed of reinforcement elements (15), each element (15) including a core (150) surrounded by a helically wound cord or cable (151) said core having a breaking load which is firstly greater than the tension, per element of ply, due to the pressure differential $p_0 - p_1$ and to the maximum centrifugal force to which said element (15) is subjected, and secondly such that it permits the breaking of said cores of said elements (15) of

the sidewall ply (120) for a pressure differential $p_0 - p'_1$ greater than $p_0 - p_1$ and after the breaking of the elements of the hooping ply (13),

- and said reinforcement element (15) of the sidewall ply (120) having a curve, representing the tension as a function of the relative elongation ε, having for an elongation greater than the elongation at break e_A of the core, a segment in which the variation in the tension as a function of the elongation is substantially zero,
- the elongation at break ε_R of the reinforcement element (15) being at least equal to the ratio of the difference between the internal meridian length of the tyre and the external meridian length of the membrane to the external meridian length of the membrane.

2. A membrane M according to claim 1, characterized in that the internal diameter D of the inextensible annular reinforcement element (2) lies between the value D_S and the value equal to D_S minus the product of the width L_S of the rim seat and the tangent of the angle of inclination of said rim seat.

3. A membrane M according to claim 2, characterized in that the reinforcement elements of the crown and/or hooping reinforcement ply (plies) are also formed of breaking-core reinforcement elements.

4. A membrane M according to one of claims 1 to 3, characterized in that it is reinforced overall by two plies (120), each ply being formed of breaking-core reinforcement elements (15) which are parallel to each other in the ply, and crossed from one ply to the next, each ply having a width such that one of its ends A is located in the region of one of the shoulders of the membrane M, whereas the other end B of said ply (120) is the end of the upturn (20) which it forms after winding around an annular reinforcement element (2) in the lower part of the membrane sidewall located on the opposite side to said shoulder, the two plies (120), in the region AA of the crown of the membrane M, performing the function of crown reinforcement plies of elements which are parallel to each other in each portion of ply and crossed from one ply to the next,

(The next page is 17)

forming an angle of between 50° and 85°, measured in the equatorial plane, with the circumferential direction, and in the region AB of the sidewalls performing the function of a sidewall reinforcement ply, each sidewall being reinforced by a ply of elements forming with the equatorial direction an angle of at most 90° but greater than the angle measured in the equatorial plane, and the reinforcement of the crown being completed by hooping bands (13) of reinforcement elements oriented circumferentially.

5. A membrane M according to one of Claims 1 to 3, characterised in that it is reinforced overall by a ply (120) of radial breaking-core elements (15) which are axially continuous from bead wire (2) to bead wire (2), surmounted radially to the crown of said membrane by a hooping ply (13), formed of reinforcement elements such that the breaking load per cm of ply (13) is a linear function of the inflation pressure p_1 of the cavity of the tyre, the angular coefficient of the representative straight line being equal to 0.05 and the ordinate at the origin of said straight line being equal to 0.3×10^5 Pa.

6. A membrane M according to one of Claims 1 to 3, characterised in that it is reinforced overall by two plies (120) which are continuous from bead wire (2) to bead wire (2), formed of breaking-core reinforcement elements (15) crossed from one ply to the next, forming with the circumferential direction an angle, measured in the equatorial plane of the membrane, of between 50° and 85°, said two plies (120) being sidewall reinforcement plies and crown reinforcement plies, the crown being complementarily reinforced by a hooping ply (13) formed of reinforcement elements such that the breaking load per cm of ply (13) is a linear function of the inflation pressure p_1 of the cavity of the tyre,

the angular coefficient of the representative straight line being equal to 0.05 and the ordinate at the origin of said straight line being equal to 0.3×10^5 Pa.

7. A membrane M according to one of Claims 1 to 3, characterised in that it is reinforced overall by a reinforcement ply (120), which is continuous from bead wire (2) to bead wire (2), said ply (120) being formed of breaking-core reinforcement elements, said elements being parallel to each other in the ply and forming an angle of between 50° and 85° with the circumferential direction, measured in the equatorial plane of the membrane, said ply (120), in the crown, being surmounted radially by a crown ply (121) of defined axial width composed of the same reinforcement elements as those of the ply (120), but crossed with the latter, forming the same angle in absolute value with the circumferential direction, said ply (121) itself being radially surmounted by a support band (14) provided with frustoconical elements in relief (140) which are spaced apart by circumferential rows (141) in which there are arranged hooping strips (131) of circumferential cables, the assembly of which forms the hooping ply (13).

8. A membrane M according to Claim 7, characterised in that the ply (121) is itself radially surmounted by a support band (14) provided with frustoconical elements in relief (140) which are spaced apart by circumferential rows (141) in which there are arranged hooping strips (131) of circumferential cables, the assembly of which forms the hooping ply (13).

9. A membrane according to Claim 7, characterised in that the ply (121) is surmounted by a hooping ply (13) arranged radially beneath the support band (14), said hooping ply being formed of reinforcement elements such

that the breaking load per cm of ply is a linear function of the inflation pressure p_1 of the cavity of the tyre, the angular coefficient of the representative straight line being equal to 0.05 and the ordinate at the origin of said straight line being equal to 0.3 x 10^5 Pa.

10. A membrane M according to one of Claims 4 to 9, characterised in that at least one ply of reinforcement elements which undulate in the plane of the ply completes the crown reinforcement of said membrane.

1 / 4

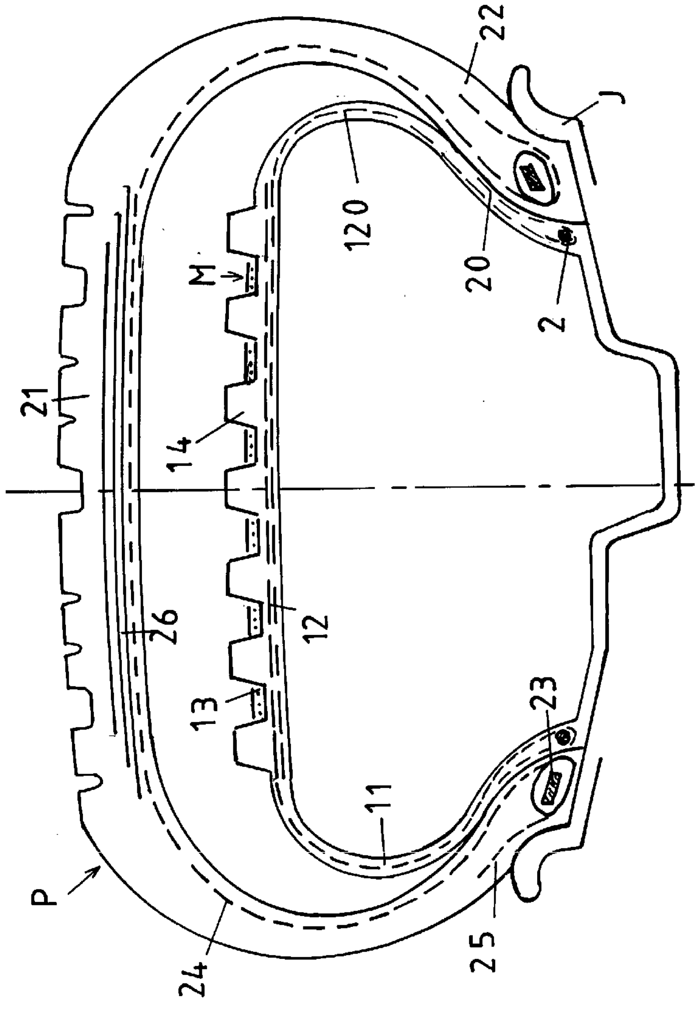


FIG 2

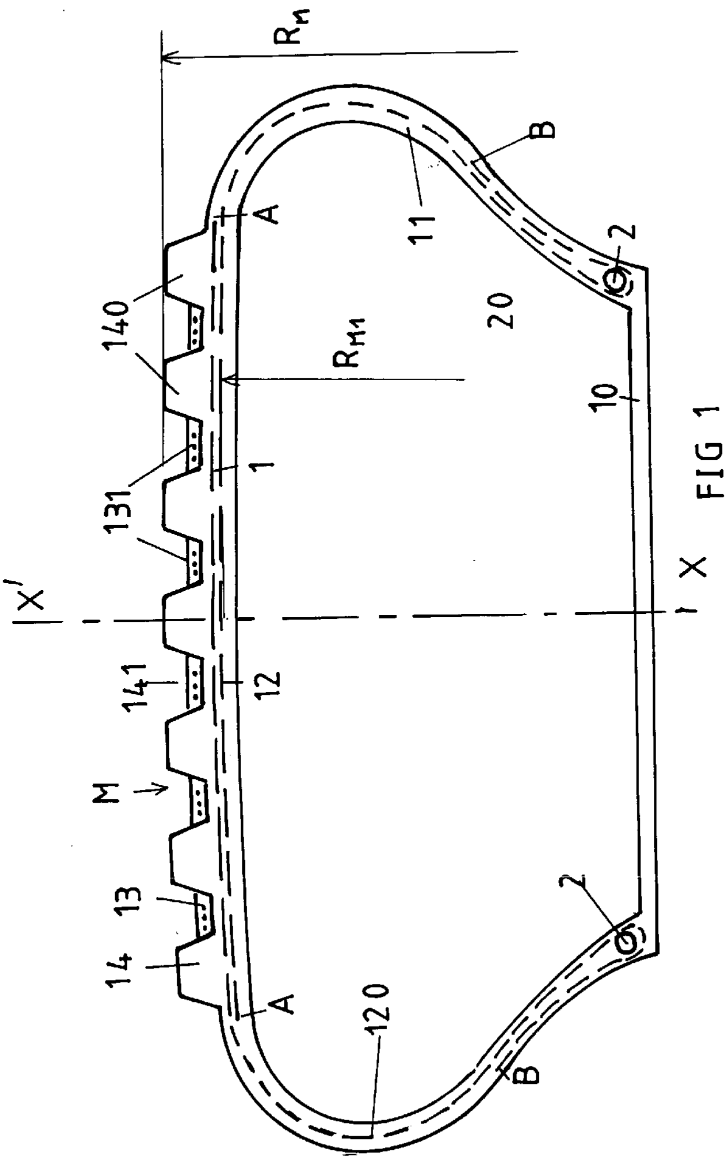


FIG 1

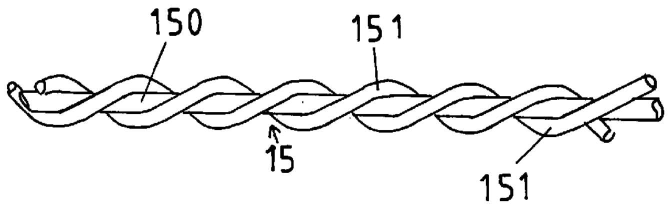

150
151
15
151

FIG 3

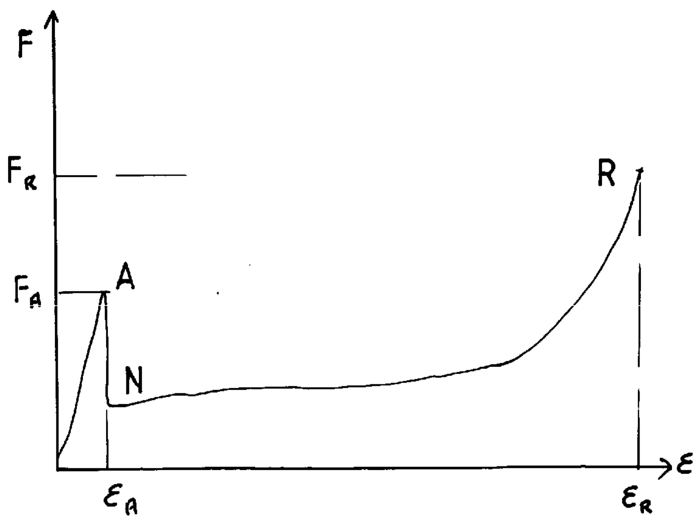

F
F_R
F_A
A
N
R
ε
ε_A
ε_R

FIG 4

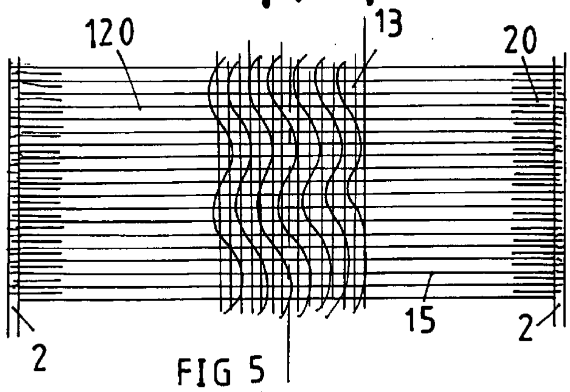


FIG 5

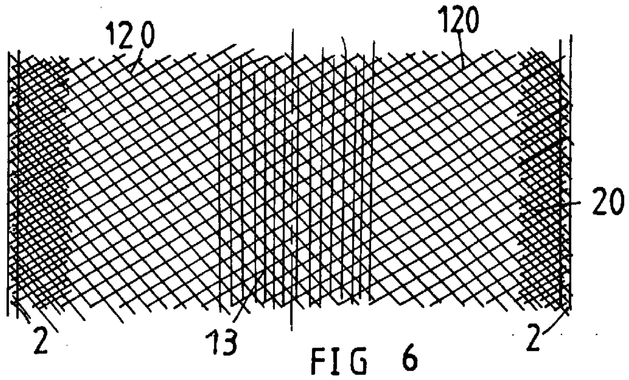


FIG 6

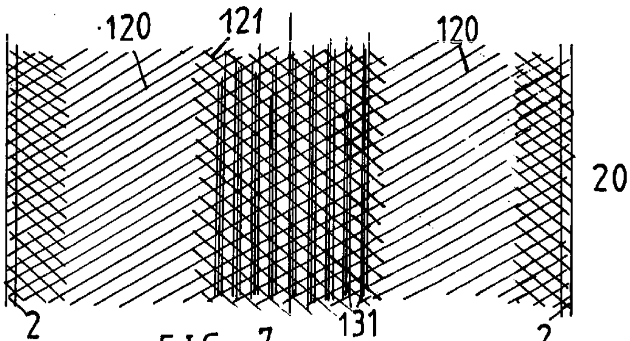


FIG 7