LU 1666

Brevet N° 817725
du 26 septembre 1979
Titre délivré : 24 JAN 1980

GRAND-DUCHÉ DE LUXEMBOURG

Monsieur le Ministre
de l'Économie Nationale et des Classes Moyennes
Service de la Propriété Industrielle
LUXEMBOURG

Demande de Brevet d'Invention

I. Requête

La société dite: THE GOODYEAR TIRE & RUBBER COMPANY, 1144 East Market Street, Akron, Ohio, U.S.A. (1)

représentée par Monsieur A. Zewan, ing.-conseil en Propriété Industrielle, 4, place Winston-Churchill, Luxembourg, agissant en qualité de mandataire (2)

dépose ce vingt-six septembre 1900 soixante dix-neuf (3)

à 15⁰⁰ heures, au Ministère de l'Économie Nationale et des Classes Moyennes, à Luxembourg :

1. la présente requête pour l'obtention d'un brevet d'invention concernant :

"Pneumatique Isostable" (4)

déclare, en assumant la responsabilité de cette déclaration, que l'(es) inventeur(s) est (sont) :

GAZUIT Georges (5)
10, rue de la Gaîté
03100 MONTLUCON
France

2. la délégation de pouvoir, datée de Akron le 14 septembre 1979
3. la description en langue française de l'invention en deux exemplaires ;
4. 3 planches de dessin, en deux exemplaires ;
5. la quittance des taxes versées au Bureau de l'Enregistrement à Luxembourg,

le 24 septembre 1979

revendique pour la susdite demande de brevet la priorité d'une (des) demande(s) de

(6) brevet déposée(s) en (7) France

le 28-9-78 + 3-11-78 sous les numéros 7827751 + 7831167 (8)

au nom de Monsieur GAZUIT Georges dont la demanderesse est l'ayant droit (9)

élit domicile pour lui (elle) et, si désigné, pour son mandataire, à Luxembourg

4, place Winston-Churchill, Luxembourg (10)

sollicite la délivrance d'un brevet d'invention pour l'objet décrit et représenté dans les annexes susmentionnées, — avec ajournement de cette délivrance à / mois.

Le mandataire

II. Procès-verbal de Dépôt

La susdite demande de brevet d'invention a été déposée au Ministère de l'Économie Nationale et des Classes Moyennes, Service de la Propriété Industrielle à Luxembourg, en date du :

26 septembre 1979

à 15⁰⁰ heures

Pr. le Ministre
de l'Économie Nationale et des Classes Moyennes,
p. d.

A 68007

(1) Nom, prénom, firme, adresse — (2) s'il y a lieu «représenté par ...» agissant en qualité de mandataire — (3) date du dépôt en toutes lettres — (4) titre de l'invention — (5) noms et adresses — (6) brevet, certificat d'addition, modèle d'utilité — (7) pays — (8) date — (9) déposant originaire — (10) adresse — (11) 6, 12 ou 18 mois.

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M E M O I R E   D E S C R I P T I F
déposé à l'appui d'une demande de
B R E V E T   D ' I N V E N T I O N
au nom de
la société dite:
THE GOODYEAR TIRE & RUBBER COMPANY
pour:
"Pneumatique Isostable"
C.I. Priorité des demandes de brevets
français No 78 27 751 du 28-09-78
et 78 31 167 du 03-11-78 au nom de
Monsieur Georges GAZUIT dont la
demanderesse est l'ayant droit.

ISOSTABLE TIRE

The present invention concerns a tire for automobiles of the type containing radial reinforcement, a belt, a tread, sidewalls ending in beads, and two bead wires.

Theoretically, the most rational use of the traction characteristics of the materials composing the body of the tire makes it necessary for the wires in the body to be positioned in the tire's radial planes for the most current types of tires. However, if such a tire is subjected to transversal strain (rolling effect) deformation of the radial wires occurs in the part of the tire which is in contact with the ground. This rolling effect is accompanied by a secondary twisting effect on the wires in contact with the ground, and the angle of distortion which results causes loss of lateral stability in normal operation conditions.

In order to eliminate this serious defect, the tire manufacturers have inclined the radial wires by a certain angle on both sides of the circumferential direction of the tire in order to establish a geodesic force field (tires with slanted folds, currently called conventional tires). When a conventional tire undergoes a rolling effect under a transversal strain, the twisting effect of the forces created by the oblique strain in the slanted folds (horizontal component). The geodesic system of construction thus had a self-stabilizing action on the rolling effect of the tire caused by transversal strain. Nevertheless, geodesic construction also has a drawback. In effect, the distortion of the rhombus formed by the slanted folds in the ground contact zone creates creeping between the folds, resulting in heating up and skidding on the road, which substantially increases the wear on the tire.

These disadvantages were partially eliminated with the introduction of the belted tire, currently called the "radial body tire," or briefly, the "radial tire." The radial tire resumed the rational use of radial wires for the body, and the deformation of the radial wires in the ground contact zone under the effect of transversal strain is prevented by a non-deformable belt. With a rolling effect, only the sides of the tire undergo a twisting effect. Theoretically, the non-deformable belt incorporated in the tread undergoes no angular deformation. The tire's road-holding qualities, with respect to transversal stability, are thus uniquely a function of the precision of development of the non-deformable belt incorporated in the tread on the road up to a limit value of the twisting effect on the sidewalls, which is a function of the tread's adherence to the road. Beyond this threshold value, the tread suddenly loses its adherence. This explains the well-known poor transversal stability of radial tires.

In addition, radial tires have another well-known defect; heating of the sidewalls. In effect, under vertical strain (effect of crushing the tire), each wall undergoes a buckling effect characterized by a sudden variation in the wall curvature radius between the wall and the tread. These sudden variations in the curvature radius are manifested by important heating of these two critical zones following a repeated crushing action. Under transversal strain, similar heating is produced in the critical connection zone between each wall and the tread. The heating can cause detachment of the beading in the critical beading zone and detachment of the tread in the critical connection zone between the walls and the tread. The effect of damping of a radial tire thus systematically causes heating, particularly in the two critical zones on each wall indicated above; one of these can have serious effects on the strength of the tire.

Despite the defects mentioned above (faulty transversal stability and heating in the two critical zones) and despite the construction difficulties which are greater than the difficulties involved with a conventional tire, radial tires have been on the market for several years.

In addition to the classic tires mentioned above (conventional tires and radial tires), there are also so-called "tubeless" tires. These tubeless tires were derived from the first tires invented at the first of the century. The air chamber or chambers, round or oval, is or are reinforced with slanted or radial wires, either by one-wire winding or by a casing of stitched fabric. These tubeless tires have a certain number of advantages:

1. Incorporated air chamber, thus the so-called "tubeless" system.

2. In some tubeless tires, elimination of the wires as resistance elements.

3. Balanced force fields in the body of the tire.

This type of tubeless tire has been described in French patent Nos. 2,052,885 and 2,348,066. The tires described in these two documents have the same faults as radial tires with respect to heating of the walls (each wall also has two critical zones). In the case of the radial tubeless tire described in French patent No. 2,052,885, the transversal stability fault is even increased with respect to the classic radial tire. In effect, this increase in the transversal stability defect is due to the fact that the section of the tire (seen in radial section) can roll over itself under the effect of transversal strain. On the other hand, the tire described in French patent No. 2,348,066 has improved transversal stability with respect to the tubeless tire in French patent No. 2,052,885 and the classic radial tire, but the improvement in transversal stability is obtained at the detriment of damping and at the price of important heating of the elastic binding material between the air chambers.

In fact, the ideal tire should thus have the following characteristics:

1. Great vertical flexibility (damping of the vertical strains the tire undergoes).

2. Great rigidity or stability transversally for resistance to transversal strains.

3. Minimum internal heating (body with preferably radial cords; no critical heating zone in the walls).

The present invention is thus essentially intended to produce a tire which meets the three requirements mentioned above.

In this respect, the tire is characterized by the fact that each wall, seen in transversal section, has a profile corresponding to the profile of the upper part of the curve representing the equilibrium equation (Fig.2) for a classic radial tire:

$$x = \int_{y}^{a} \frac{y^2 - b^2}{\sqrt{(a^2 - b^2)^2 - (y^2 - b^2)^2}} \, dy$$

the upper part is included between the points on the curve where the tangents are almost vertical and horizontal respectively, and the metacenter of the upper part of the curve is in substantially the same almost vertical plane with a varying load, wherein x is the lateral distance from the radial (circumferential) centerline of the tire cross-section to a point on the carcass neutral contour line, y is the radial distance from the axis of rotation of the tire to a point on the carcass neutral contour line, a is the radial distance from the axis of rotation to the carcass neutral contour line at the radial (circumferential) centerline of the tire cross-section such that when the value of y equals a, x is 0, and b is the radial distance from the axis of rotation to the point of maximum cross-section, i.e. maximum x, of the carcass neutral contour line.

Hanging width l can be between 0.25 L and 0.45 L, where L represents the width of the tread, and the transversal section of the tire can have a H/B ratio between 0.4 and 0.6, where H represents the height of the section measured between the hanging diameter of the tire and the belt, and B represents the total width of the tire; the entire system is such that the tire, seen in transversal section, forms an isostable triangular system.

"Hanging width of the tire" means the distance between the bead hanging points on the rim intended to receive the tire, that is, the nominal width of the rim. "Hanging diameter" means the diameter measured at the bead hanging point on the wheel rim, that is, the nominal diameter of the rim.

Due to this type of structure and the particular shape of the walls, the tire in the present invention is very flexible in the vertical direction, is very rigid transversally, and there is no critical heating zone.

We will now describe the present invention, referring to the attached drawings where:

Fig. 1 is a partial transversal view of a tire according to the invention.

Fig. 2 is a graph showing the curve representing the equilibrium equation for a classic radial tire, and more particularly the portions of the curve which are used to determine the shape of the walls of a classic radial tire and the shape of the walls of the tire in Fig. 1.

Fig. 3 is a schematic view illustrating the reasons why the tire in the invention has good transversal stability and good vertical flexibility.

Tire 1 shown in Fig. 1 essentially includes belt 2, radial reinforcement 3, tread 4, sidewalls 5 ending in beads 6; each equipped with semi-rigid circular wire 7.

Width $\underline{1}$ of the tire, measured between points 9 where beads 6 are hung on wheel rim 10, is between approximately 0.25 L and approximately 0.45 L, where L represents the width of tread 4. The transversal section of the tire has a H/B ratio between approximately 0.4 and 0.6, where H represents the height between belt 2 and points 9, and B represents the total width of the tire.

Walls 5 have a profile corresponding to the profile of the upper part of the curve defined by the following equation:

$$x = \int_y^a \frac{y^2 - b^2}{\sqrt{(a^2 - b^2)^2 - (y^2 - b^2)^2}}\, dy$$

This equation represents the well-known equilibrium equation for a classic radial tire. The significance of the different parameters in this equation and the calculations relating to this equation are given in "Tyre Science and Technology TSTCA," vol. 1, No. 3, August 1973, pages 290-315. Curve E, representing this equation, is shown in Fig. 2. More precisely, left wall 5 (seen in Fig. 1) has a profile corresponding to the profile of arc CD in curve E in Fig. 2. Point C is a point near or congruent with the point on curve E where the tangent to this curve is almost vertical. Point D is a point near to congruent with the top of curve E, where the tangent to the curve is almost horizontal. Right wall 5 has a symmetric C'D profile with respect to the left wall related to median plane XX (Fig. 1). For comparison, the left wall of a classic radial tire has a profile corresponding to the profile of arc AB in curve E in Fig. 2.

In addition, the location of points C (or C') and D on curve E is selected so that the metacenter of arc CD (or C'D) in curve E remains in the same almost vertical plane with varying loads. More precisely, arc CD, which has a metacenter under a given load corresponds to each location of points C and D on curve E. By varying the position of points C and D, it is possible to plot the geometric site of the metacenter (metacenter curve) of arc CD under a given load. For example, the geometric sites of the metacenter are plotted for a minimum load and for a maximum load, respectively. It is thus possible to find arc CD whose metacenters under a minimum load and under a maximum load are located in the same almost vertical plane, which determines the position of points C and D for the profile of walls 5. Fig. 3 shows (solid line) arc CD_1 on curve E_1 corresponding to a minimum load, with center of gravity G_1 and metacenter M_1 of arc CD_1, and (broken line) arc CD_2 on curve E_2, corresponding to a maximum load, with center of gravity G_2 and metacenter M_2 of arc CD_2; the two points M_1 and M_2 are in the same almost vertical plane. In selecting the position of points C and D on curve E, it is also possible to obtain congruent metacenters M_1 and M_2.

Radial reinforcement 3 can be done conventionally with gummed cords, synthetic or metallic textiles. Belt 2 can be conventionally made from adhesive-treated fabric, synthetic or metallic textiles.

An isostable triangulated system is obtained with the same structure of the tire and the shape of walls 5 described above. A tire with good transversal stability and good vertical flexibility is obtained. In addition, when the load varies, sides 5, due to their particular shape, do not operate with buckling as in the case of a classic radial tire, but with flexion and little or no angular distortion near bead 6 and the connection zone between wall 5 and tread 4. There is thus very little or no heating in these zones and consequently, there is no danger of detachment of beads 6 and tread 4.

One embodiment of the present invention is characterized by the fact that, as illustrated in Fig. 4, extreme point P on the tread, center T in the transversal section of the bead area which is located on the same side of the tire's median plane as extreme point P, and center O on the wheel are substantially aligned when the tire is installed on the wheel rim under nominal internal inflation pressure with no external load, so that the profile of the left side corresponds to upper part CD of curve E, representing the equilibrium equation for the tire under nominal internal inflation pressure with no external load; this is included between point C, where the tangent to curve E is almost vertical, and point D, where the tangent to curve E forms angle ϕ measured in a counterclockwise direction with respect to the horizontal, so that $\phi = \phi_1+\alpha$, where ϕ_1 is an angle between approximately 5° and approximately 15°, and α is the angle formed by straight line OTP with the vertical; the profile of the left side is obtained by clockwise rotation of part CD of curve E around point D by angle α, so that the tangent to point D forms angle ϕ_1 with the horizontal, and the tangent to point C forms angle α with the vertical, which is almost equal to angle ϕ_2 under nominal internal inflation pressure with no external load, and so that the tangents to points D and C are respectively almost horizontal and almost vertical under a maximum external load; the right side has a profile obtained in a similar manner so that it is symmetric to the left side with respect to the median plane of the tire.

We will now describe a method for producing the tire in the present invention, referring to the figure in the attached drawing which shows the left half of the tire's transversal section.

The following is done to determine the shape of the tire 1 and particularly the shape of its sides 5. Tire rim 10, preferably of standard dimensions, and the nominal diameter of the tire under nominal internal inflation pressure but with no external load are first selected. These two choices determine the position of beads 6 and thus the position of wires 7 on one hand, and on the other, height H of the transversal section of the tire, measured between hanging point 9 and belt 2 or between point 9 and the external diameter of tread 4 according to the tire manufacturers.

Center O on the wheel is jointed with center T in the transversal section of one of two wires 7, for example, the left wire is shown in the drawing. Straight line OT intersects the ground line at P. P will be the extreme left point of contact of tread 4 with the ground. This thus determines width L of tread 4. α is the angle between the vertical and line OTP. Angle α has a fixed value for the wheel rim selected.

Curve E, representing the equilibrium equation for the tire for the nominal internal inflation pressure selected with no external load, is then plotted using the aforementioned equation. Point D is then selected on equilibrium curve E so that the tangent to curve E at co-point D forms angle ϕ measured in a counter-clockwise direction with respect to the horizontal, so that $\phi = \phi_1 + \alpha$, where ϕ_1 is an angle contained between approximately 5° and approximately 15°, and has the value indicated above. We will indicate how to select the value of angle ϕ_1 in the range indicated below. The location of point D on curve E can be easily determined with the equilibrium equation given in the principal patent. In effect, the following equation can be derived from the equation mentioned above:

$$\frac{dy}{dx} = \frac{\sqrt{(a^2 - b^2)^2 - (y^2 - b^2)^2}}{y^2 - b^2} = \text{tg } \phi$$

This equation can also be written in the form:

$$\frac{y^2 - b^2}{a^2 - b^2} = \cos \phi$$

As a consequence, if ϕ is equal to $\phi_1 + \alpha$, it is possible to calculate the ordinate of point D on curve E with the last equation.

Since point D has been determined, curve E is plotted on the drawing by placing point D on line OTP just below wire 7. Curve E then occupies the position represented by the broken lines in the drawing. Curve E is then rotated clockwise around point D by an angle α. In this way, the profile of left wall 5 of tire 1 is obtained.

In these conditions, the profile of left wall 5 is such that the tangent to point D now forms angle ϕ_1 with the horizontal, and the tangent to point C, which was almost vertical before rotation of curve E by angle α around point D, now forms angle ϕ_2 with the vertical, which is almost equal to angle α under nominal internal inflation pressure and no external load. The initial values thus imposed on the angles formed by the tangents to points D and C are important for obtaining good stability of the tire when it is subjected to a varying load during use. When the tire is subject to an external load, profile CD in wall 5 is deformed. For the tire to be stable, the metacenter of profile in CD in wall 5 must shift in a vertical or almost vertical plane during deformation of wall 5. Graphic tracings done in the laboratory for various values and orientations of the external load showed that this result can be obtained by giving an initial slope ϕ_1 to the tangent at D, and an initial slope ϕ_2 to the tangent at C. Under an increasing external vertical load, the tangent to point D tends to approach the horizontal during deformation of profile CD on wall 5. The tangent to point D should not go from the other side of the horizontal under a maximum vertical external load. This, therefore, conditions the choice of the value for the initial slope ϕ_1 of the tangent to point D for a given nominal internal inflation pressure. The greater maximum vertical external load the tire must be able to bear, the greater the initial slope ϕ_1, unless the nominal internal inflation pressure is increased. The selection of the value for initial slope ϕ_1 of the tangent to point D will also be a function of flexibility, that is, the damping capacity under a crushing strain which must be obtained for the tire. The greater flexibility or damping capacity the tire must have, the smaller the initial slope ϕ_1. The nominal internal inflation value and the value of initial slope ϕ_1 of the tangent to point D should thus be selected in consideration of the value of the maximum vertical external load which the tire must bear, and the flexibility or damping capacity desired for the tire. It will generally be sufficient to give initial slope ϕ_1 a value between approximately 5° and approximately 15° to satisfy the requirements indicated above for obtaining good stability.

Under increasing lateral or horizontal external strain, the tangent to point C tends to approach the vertical during deformation of profile CD in wall 5, and it should not pass from the other side of the vertical under maximum lateral strain so that the metacenter of profile CD remains in a vertical or almost vertical plane during deformation of profile CD. This is obtained by giving initial slope ϕ_2 of the tangent to point C a value almost equal to the value of angle α.

In these conditions, the tangents to points D and C on wall 5 during use will remain almost horizontal and almost vertical under a maximum vertical, horizontal or oblique external load, and as a consequence, the metacenter of profile CD on wall 5 will remain in a vertical or almost vertical plane during deformation of wall 5 under a varying vertical, horizontal or oblique external load, and hence, the great stability of the tire.

Another advantage of the tire in the present invention is based on the fact that the gum in the connection zone between tread 4 and wall 5 only undergo weak compression when the tire undergoes a varying external load due to the alignment of points P, T and O and the particular shape of wall 5. As a consequence, the gum in this connection zone heats very little during use and there is thus no risk of the gum detaching between tread 4 and wall 5.

Although the preceding description was given with respect to the left wall of the tire, it is obvious that the profile of the right wall is obtained in a similar manner so that the right wall is symmetric to the left wall with respect to median plane XX of the tire.

Since the dimensions of the tire and the shape of right and left walls were determined in this way, the tire can be concretely manufactured in any conventional way.

The preceding clearly indicates that the tire obtained in this way forms a perfectly triangulated and isostable system under varying vertical, horizontal or oblique external loads.

WE CLAIM:

1. Automobile tires of the type which contain radial reinforcement, a belt, a tread, sidewalls ending in beads, and two bead wires, characterized by the fact that each wall 5 of tire 1 has a transversal profile corresponding to the profile of the upper part CD of curve E, representing the equilibrium equation for a classic radial tire:

$$x = \int_{y}^{a} \frac{y^2 - b^2}{\sqrt{(a^2 - b^2)^2 - (y^2 - b^2)^2}} \cdot dy$$

upper part CD is contained between points C and D on this curve where the tangents are almost vertical and horizontal, so that the metacenter of the upper part of this curve remains in the same almost vertical plane under a varying load.

2. A tire according to claim 1 characterized by the fact that hanging width 1 of tire 1 is included between 0.25 L and 0.45 L, where L represents the width of the tread 4, and the transverse section of the tire has a H/B ratio between 0.4 and 0.6, where H represents the height of the section, measured between the hanging diameter of the tire and belt 2, and B represents the total width of the tire; the total assembly is such that the tire almost forms an isostable triangulated system seen in transversal section.

3. Isostable tire according to claim 1 in the principal patent, characterized by the fact that when it is installed on a wheel rim under nominal internal inflation pressure without any external load, extreme point P on tread 4, center T in the transversal section

of wire 7, which is located on the same side of median plane XX as extreme point P, and center O of the wheel are aligned; the profile of left wall 5 corresponds to the upper part CD of curve E, representing the equilibrium equation for the tire under nominal internal inflation pressure with no external load, which is contained between point C where the tangent to curve E is almost vertical and point D where the tangent to curve E forms angle α measured counter-clockwise with respect to the horizontal so that $\phi = \phi_1 + \alpha$, where ϕ_1 is an angle between approximately 5° and 15°, and α is the angle formed by line OTP with the vertical; the profile of left wall 5 is obtained by rotation of part CD on curve E around point D by angle α in a clockwise direction, so that the tangent to point D forms angle ϕ_1 with the horizontal, and the tangent to point C forms angle ϕ_2 with the vertical; ϕ_2 is almost equal to angle α under nominal internal inflation pressure with no external load, and so that the tangents to points D and C are respectively almost horizontal and almost vertical under maximum external load; the right wall has a profile obtained in a similar manner so that it is symmetric to the left wall with respect to median plane XX of the tire.

4. A radial carcass tire having a tread, a belt, sidewalls and beads characterized by the fact that each of the lower sidewall carcass neutral contour lines of the tire from the point of maximum cross-section of said neutral contour line to the bead area has a profile which corresponds to a portion of the curve represented by the equation

$$x = \int_y^a \frac{y^2 - b^2}{\sqrt{(a^2 - b^2)^2 - (y^2 - b^2)^2}} \cdot dy$$

wherein "x" is the lateral distance from the radial centerline of the tire cross-section to a point on the carcass neutral contour line,"y" is the radial distance from the axis of rotation of the tire to a point on the carcass neutral contour line, "a" is the radial distance from the axis of rotation to the carcass neutral contour line at the radial centerline of the tire cross-section such that when the value of "y" equals "a", "x" is 0, and "b" is the radial distance from the axis of rotation to the point of maximum cross-section, that is, maximum "x", of the tire carcass neutral contour line, the portion of the curve being between the points where the tangents to the curve are substantially horizontal at a value of "y" close to "a" and substantially vertical, wherein said point of tangency with the vertical substantially corresponds to the point of the maximum cross-section of the tire carcass neutral contour line and said point of tangency with the horizontal substantially corresponds with the point at the bead area of the tire, and the curve shape between said tangent points corresponds to the profile between the point of maximum cross-section and the bead area, and the profile of the lower sidewall carcass neutral contour line of the tire being such that the metacenter positions fall along a line substantially radial to the tire section as the profile changes shape during the deflection of the tire.

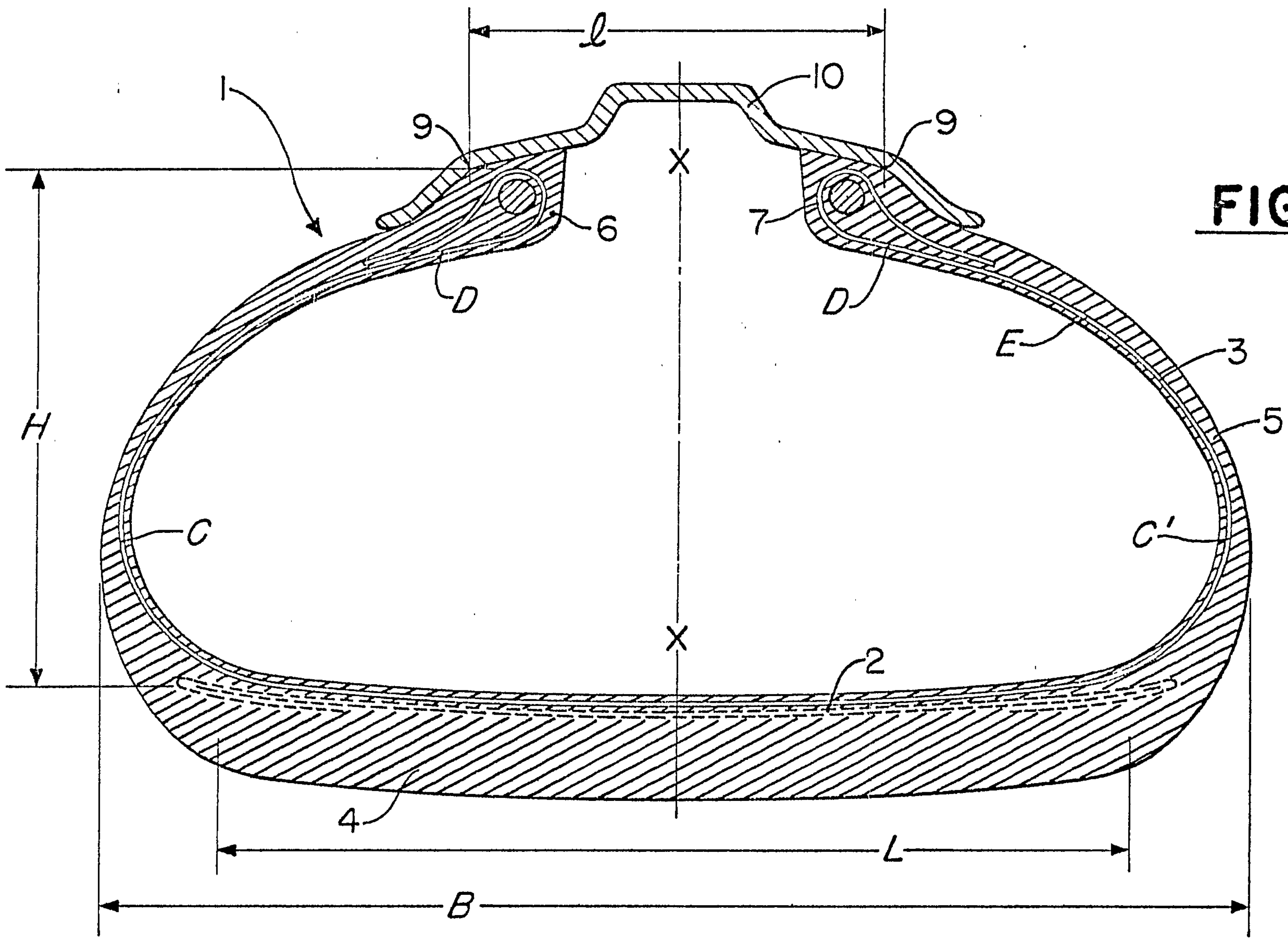
5. A radial carcass tire having a tread, belt, sidewalls and beads characterized by the fact that in the axial plane of the tire the edge of the tread on either side of the tire section, that is the point of maximum tread width, and the point of intersection of the axis of rotation and the radial centerline of the tire are substantially aligned with the center of the bead bundle on that side of the tire section forming

two substantially straight lines each of which forms an angle α with the radial centerline of the tire, each of the lower sidewall carcass neutral contour lines of the tire having a profile corresponding to a portion of the curve represented by the equation

$$x = \int_{y}^{a} \frac{y^2 - b^2}{\sqrt{(a^2 - b^2)^2 - (y^2 - b^2)^2}} . dy$$

wherein "a" is the radial distance from the axis of rotation to the carcass neutral contour line at the radial centerline of the tire cross-section, "b" is a value of radius between the radius "a" and the radius of the bead seat ledge of the wheel and "x" is the lateral distance in a plane from a centerline reference and "y" is a radial distance in a plane from a reference perpendicular to the centerline reference of the points of a curve defined by the above equation said perpendicular reference lines defining the plane, the portion of the curve being used for the tire sidewall carcass neutral contour being that portion of the curve between the point of tangency of a vertical line with the curve and a point between the horizontal lines at radial distance "a" and radial distance "b", said point characterized by the fact that the curve at this point forms an acute angle ϕ with the horizontal line tangent to the curve at the radius "a", said angle ϕ having a value of α plus an angle of 5° to 15° and said point of tangency with the vertical being located toward the point of the maximum cross-section of the tire and said point the tangent of which forms an acute angle ϕ to the horizontal tangent to the curve at radius "a" substantially corresponding with a point at the bead area of the tire, the curve shape between said tangent points corresponding to the profile of the sidewall carcass neutral contour line when the curve shape is oriented by rotation by the angle α about the point in the bead area so as to increase the apparent maximum cross-section of the tire, this shape of the side-wall neutral contour carcass line being characterized such that the metacenter positions fall along a line substantially radial to the tire section as the tire changes shape during deflection.

FIG. I



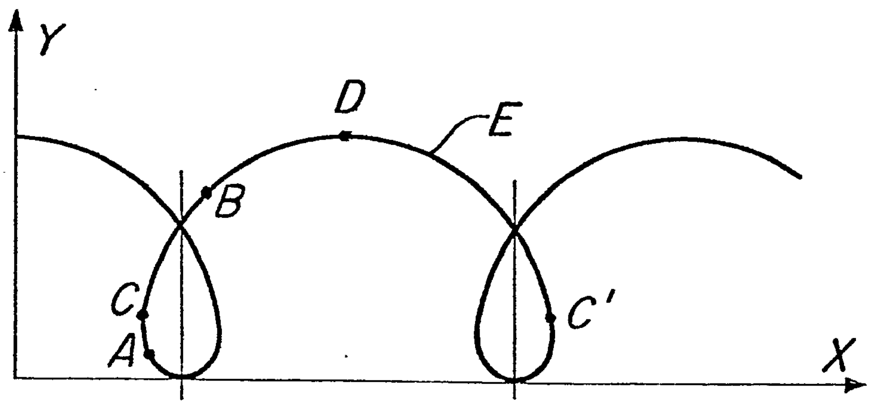


FIG. 2

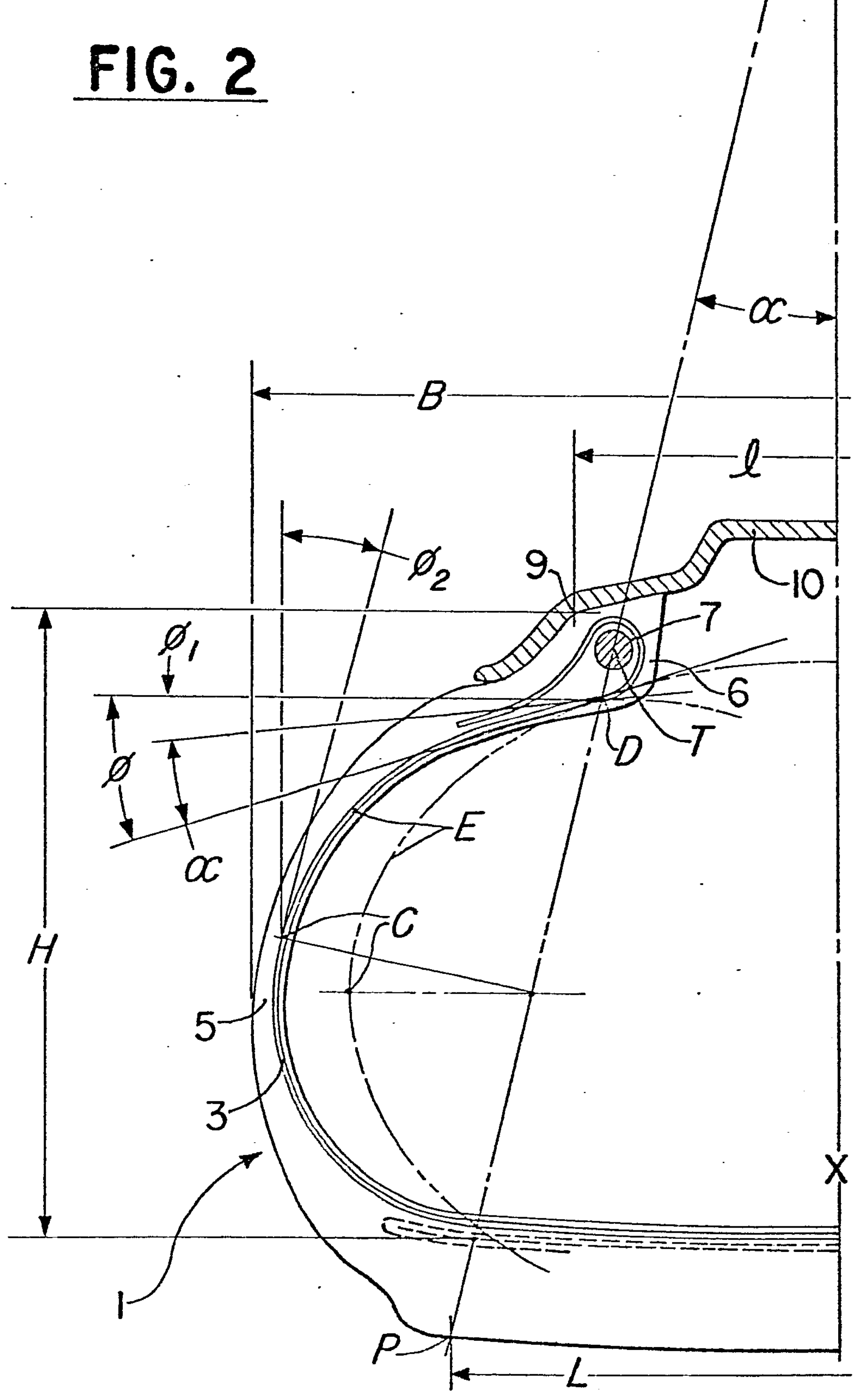
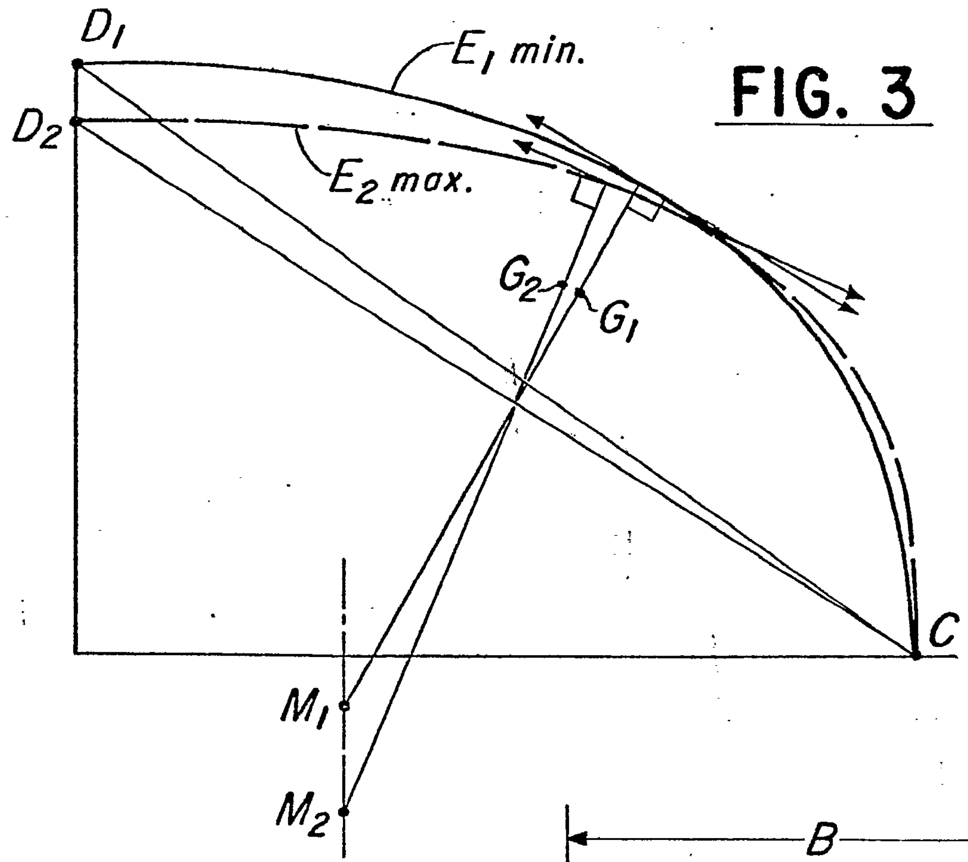


FIG. 4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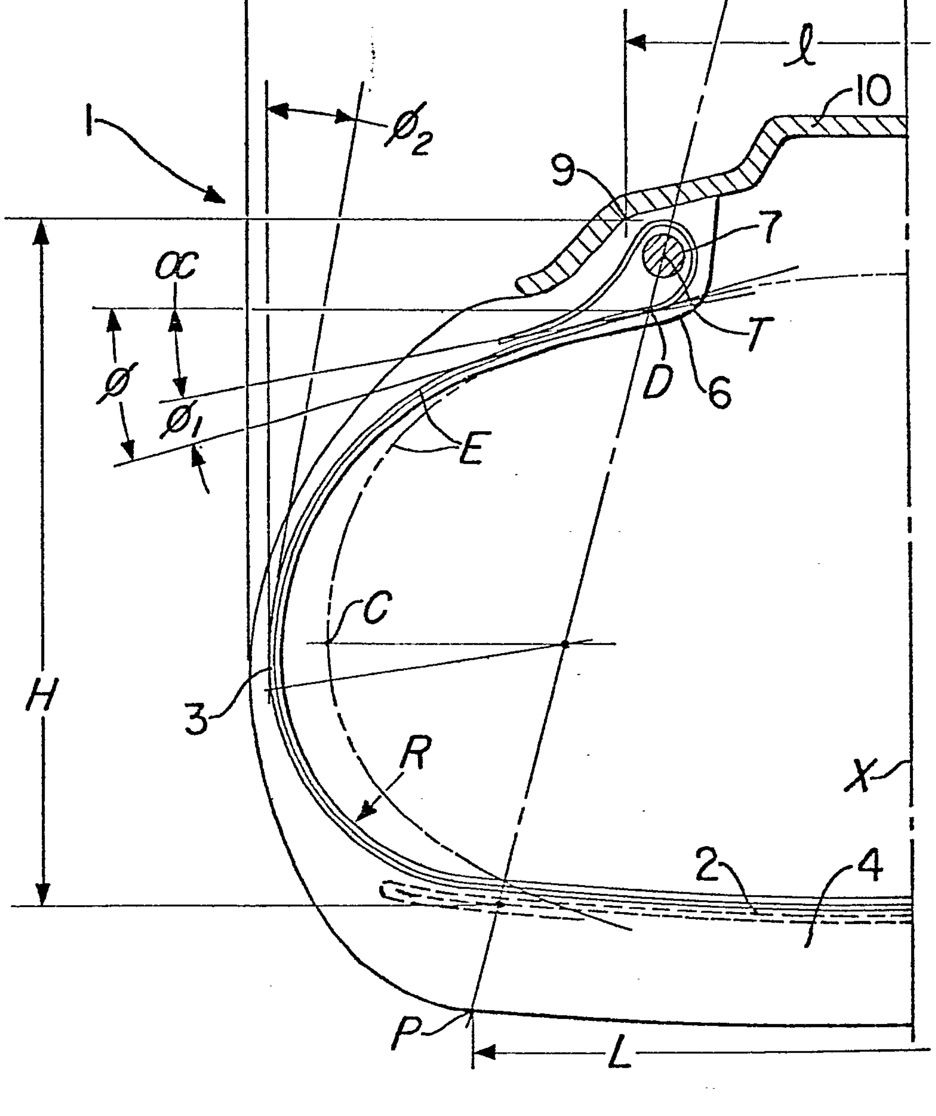
E1 min.
E2 max.
G2
G1
C
M1
M2

FIG. 3


X
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φ2
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φ1
H
C
3
R
2
4
X
P
L

FIG. 5