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(54) Pneumatic tyre with wide central groove
Reifen mit einer breiten zentralen Nut
Bandage pneumatique avec large rainure centrale

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Description

[0001] The present invention relates to a pneumatic tyre with a wide central groove, more particularly to a tread pattern having a specific land ratio arrangement being capable of improving wet performance and steering stability.

[0002] In laid-open Japanese patent application Nos. JP-A-6-143932, JP-A-6-143937 and JP-A-5-191227, pneumatic tyres with a wide central groove are disclosed, wherein the wide central groove has a width in the range of from 35 to 45 mm and extends on the tyre equator continuously in the tyre circumferential direction.

[0003] In such a tyre, when additional grooves are provided, the steering stability is liable to deteriorate because the tread rigidity, is already considerably decreased by the wide central groove. From this point of view, it is preferable to decrease the additional grooves. However, if such grooves are decreased, wet performance, especially anti-aquaplaning performance greatly decreases.

[0004] Therefore, the present inventors studied the tread pattern to obtain maximum effect from minimum additional grooves, and found that the steering stability and wet performance became compatible with each other by specifically limiting the distribution of land ratio.

[0005] It is therefore, an object of the present invention to provide a pneumatic tyre with a wide central groove, in which both the steering stability and wet performance are improved.

[0006] According to the present invention, a pneumatic tyre comprises a circumferentially continuously extending wide groove having a width of from 35 to 45 mm disposed in a tread centre, a tread part on each side of the wide groove, which is defined as extending at least 10 mm axially outwards from the groove edge, formed as a substantially continuous rib part, a tread part between the rib part and a tread edge, provided with circumferentially discontinuous grooves so that: an axially inner part has a land ratio La of not less than 90%; a middle part has a land ratio Lb in a range of from 80 to 90%; and an axially outer part has a land ratio Lc in a range of from 85 to 95%, wherein the axially inner part, middle part and axially outer part are three equiwidth parts between the wide groove and the tread edge.

[0007] An embodiment of the present invention will now be described in detail in conjunction with the accompanying drawings in which:

Fig.1 is a cross sectional view of a pneumatic tyre according to the present invention;
Fig.2 is a developed plan view thereof showing an example of the tread pattern;
Fig.3 is a foot print thereof; and
Fig.4 is a diagram for explaining the oblique groove.

[0008] In the drawings, a pneumatic tyre 1 according to the invention comprises a tread portion 2, a pair of sidewall portions 3, a pair of bead portions 4 each with a bead core 5 therein, a carcass 6 extending between the bead portions 4 and a belt 7 disposed radially outside the carcass 6 in the tread portion 2. In this embodiment, the tyre 1 is a radial tyre for passenger cars.

[0009] The carcass 6 comprises at least one ply of cords arranged radially at an angle of from 75 to 90 degrees with respect to the tyre equator C. For the carcass cords, organic fibre cords, e.g. nylon, rayon, polyester and the like are used in case of passenger car tyres. But, it is also possible to use steel cords according to the requirements and/or type and use of the tyre.

[0010] In each of the bead portions 4, a bead apex 8 is disposed between the main portion 6a and turned up portion 6b of the carcass 6. The bead apex 8 is made of hard rubber extend radially outwardly from the bead core 5.

[0011] The belt 7 comprises a breaker and optionally a band (not shown in this example).

[0012] The breaker 7 comprises at least two crossed plies 7A and 7B of steel cords laid at an acute angle of from 40 to 45 degrees with respect to the tyre equator.

[0013] The band is disposed radially outside the belt layer 7 and made of parallel cords or spiral windings of at least one cord, wherein the cords or windings are laid at a small angle or substantially parallel to the tyre circumferential direction. For the band cords, organic fibre cords, e.g. nylon, aramid and the like can be used.

[0014] According to the present invention, a wide groove 9 having a width GW in the range of from 35 to 45 mm is disposed in the centre of the tread portion 2. The wide groove 9 extends continuously in the tyre circumferential direction. Preferably, the depth thereof is set in the range of from 0.1 to 0.3 times the width GW. The wide groove 9 is centred on the tyre equator C in this example, but it is also possible to be somewhat off-set from the tyre equator C. The wide groove 9 is the only groove which extends continuously in the tyre circumferential direction.

[0015] If the width GW is less than 35 mm, air tube resonance is liable to occur in the wide groove in the ground contacting patch and running noise (air tube resonance noise) increases, if the width GW exceeds 45 mm, it is difficult to maintain even a minimal steering stability.

[0016] In this embodiment, both edges 9b of the wide groove 9 are straight. But, it is also possible to make the edges 9b zigzag or wavy as long as the amplitude thereof is not so large, for example, the amplitude does not exceed the under-mentioned width W.
Here, the groove width is measured between the groove edges under a normally inflated unloaded condition in which the tyre is mounted on its standard rim, and inflated to a standard pressure but loaded with no tyre load. Usually, the groove edge is an intersection of the groove wall and tread surface. But, if the corner therebetween is rounded, it may be defined as an intersection of extensions of the groove wall and tread surface. The standard rim is the “standard rim” specified in JATMA, the “Measuring Rim” in ETRTO, the “Design Rim” in TRA or the like. The standard pressure is the “maximum air pressure” in JATMA, the “Inflation Pressure” in ETRTO, the maximum pressure given in the “Tyre Load Limits at Various Cold Inflation Pressures” table in TRA or the like. The standard load is the “maximum load capacity” in JATMA, the “Load Capacity” in ETRTO, the maximum value given in the above-mentioned table in TRA or the like. Further, the under-mentioned tread edges E are defined as the axial outermost edges E of the ground contacting region under such a condition that the tyre is mounted on the standard rim and inflated to the standard pressure, and then loaded with the standard load. In the case of passenger car tyres, however, 200 kPa is used as the standard pressure, and the standard load determined as above is reduced to 88%.

A part 10 on each side of the wide groove 9 is not provided with a groove having a positive width. This part 10 is defined as extending axially outwards from the edge 9b of the wide groove 9 and having an axial width W in the range of at least 10 mm, preferably 10 to 25 mm, more preferably 15 to 25 mm. The “positive width” is such a width that the groove walls do not contact with each other in the ground contacting patch. In case of a sipe or cut having a width less than 1 mm, the groove walls contact each other in the ground contacting patch. Therefore, sipes can be disposed in this part.

This part accordingly forms a rib part 10 which is substantially continuous in the tyre circumferential direction.

In general, a very wide groove is not preferable for steering stability. In the present invention, however, steering stability such as handling response during cornering, stability during straight running and the like can be improved by the rib part 10 on each side of the wide groove 9. If the width W of the rib part 10 is less than 10 mm, the steering stability cannot be improved. If the width W exceeds 25 mm, the heat radiation tends to decrease, which is not preferable for high-speed durability.

According to the present invention, as shown in Fig. 2, a part between the wide groove 9 and each of the tread edges E is provided with grooves having positive width so that an axially inner part A1, middle part A2 and axially outer part A3 have specific land ratios La, Lb and Lc, respectively.

Here, the inner part A1, middle part A2 and outer part A3 are defined as three equiwidth parts between the edge 9b of the wide groove 9 and the tread edge E. In the case of zigzag or wavy edge, a straight line drawn along the centre of the amplitude is used instead of the actual groove edge in defining these parts A1-A3. The land ratio La, Lb, Lc of each part A1, A2, A3 is defined as the percentage of the land area to the total area of the part. The land area is the total ground contacting area of the part around the tyre.

The land ratio La of the inner part A1 is set in the range of not less than 90%, preferably not less than 92%, more preferably not less than 95%.

The land ratio Lb of the middle part A2 is set in the range of from 80 to 90%.

The land ratio Lc of the outer part A3 is set in the range from 85 to 95%.

The land ratios La and Lc are set to be more than the land ratio Lb. Thus, (La = Lc > Lb) or (La > Lc > Lb) or (Lc > La > Lb).

By these limitations, the axially inner and outer parts A1 and A3 have relatively higher rigidity than the middle part A2 to thereby generate a relatively large side force. Thus, this limitation is important to the steering stability during cornering. Further, these are effective in heat radiation. The middle part A2 has a tendency to generate a relatively large amount of heat during running. But, as the middle part A2 has a relatively large grooved area, heat radiation is promoted, and high-speed durability can be improved.

By setting the land ratios La, Lb and Lc to satisfy the following relationship: La > Lc > Lb, the shortage of rigidity in the tread central region due to the wide groove 9 is corrected.

To realise the above-mentioned land ratios La, Lb and Lc, the tread portion 2 in this embodiment is provided with a plurality of groove sets 12, each set 12 comprising a less-inclined oblique groove 12A inclined at an angle of not more than 30 degrees with respect to the circumferential direction of the tyre, and more-inclined oblique grooves 12B inclined at an angle of more than 30 degrees with respect to the circumferential direction.

Each oblique groove 12A, 12B has a relatively narrow width of from 2 to 5 mm.

The less-inclined oblique grooves 12A are mainly disposed in the middle parts A2. As the less-inclined oblique groove 12A is inclined, it has an axially inner end 12Ai and an axially outer end 12Ao. The inner end 12Ai is spaced apart from the edge 9b of the wide groove 9 by a certain axial distance which is at least the above-mentioned width W. The outer end 12Ao is positioned axially inside the tread edge E, in this example on the border between the middle part A2 and outer part A3.

In this embodiment, both end portions 14 of the less-inclined oblique groove 12A are substantially straight and parallel with the circumferential direction. The inclination angle θ2 of the end portion 14 is set in the range of less than 10 degrees with respect to the circumferential direction. The middle portion 13 between the end portions 14 is inclined at an angle θ1 of from 10 to 30 degrees with respect to the circumferential direction. The circumferential length of the...
middle portion 13 is more than that of the end portion 14. One of the end portions 14 is disposed in the axially inner part A1, and the other end portion 14 is disposed near the axially outer part A3 as shown in Fig.2 or within the axially outer part A3 as shown in Fig.4.

[0032] It is effective in removing water from the tread to concentrate the less-inclined grooves in the middle part A2 as above. Thus, the occurrence of aquaplaning phenomenon can be controlled even at a high speed range, and the wet performance can be improved.

[0033] In each groove set 12, the number of the more-inclined oblique grooves 12B is at least three, and it is preferable that all the more-inclined oblique grooves 12B join the less-inclined oblique grooves 12A.

[0034] Each of the more-inclined oblique grooves 12B has an axially inner end 12Bi spaced apart from the edge 9b of the wide groove 9 by a certain axial distance which is at least the above-mentioned width W. Also the groove 12B extends beyond the tread edge E. Preferably, the more-inclined oblique grooves 12B are inclined at an angle of more than 40 degrees.

[0035] In Fig.2, the number of the more-inclined oblique grooves 12B is four, wherein the first to the third (counted from the axially inner end 12Ai to the axially outer end 12Ao) start from the less-inclined oblique groove 12A and extend beyond the tread edge E. But, the fourth groove starts from a position axially same as the axially inner end 12Ai and extend beyond the tread edge E, intersecting the less-inclined oblique groove 12A.

[0036] As to the junctions of the oblique grooves 12B and the oblique groove 12A: the junction of the first oblique groove 12B is positioned at the axially inner end 12Ai in the axially inner part A1; the junction of the second oblique groove 12B is positioned in the middle part A2 immediately axially outside the border between the middle part A2 and inner part A1; the junction of the third oblique groove 12B is also positioned in the middle part A2; and the intersection between the fourth oblique groove 12B and the oblique groove 12A is positioned near the axially outer end 12Ao.

[0037] The above-mentioned oblique grooves 12A and 12B form a unidirectional tread pattern. The designed rotational direction thereof is indicated in Fig.2 by an arrow R. Rotating in this direction, the oblique grooves 12A and 12B first contact with the ground at the axially inner end. In other words, the oblique grooves 12A and 12B are so inclined towards one circumferential direction.

[0038] Apart from the above-explained oblique grooves, various configurations can be used.

Comparison Tests

[0039] Test tyres of size 225/50R16 having the same internal structure shown in Fig.1 and the tread pattern shown in Fig.2 or a similar pattern were made and tested for pass-by noise, pitch noise, steering stability, wet performance, wear resistance, and high-speed durability. The specifications of the test tyres and test results are given in Table 1.

Pass-by Noise Test:

[0040] According to JASO C-606, a test car (3000 cc FR passenger car) provided on all four wheels with test tyres was coasted on a smooth asphalt road at a speed of 53 km/h for a distance of 50 metres, and in the middle of the course, the maximum level in dB(A) of the pass-by noise was measured with a microphone fixed at a position 7.5 meter sideways from the centre line of the running course and 1.2 meter height from the road surface. The tyres were mounted on a standard rim of size 8JX16 and inflated to an inner pressure of 200 kPa.

Pitch Noise Test:

[0041] The above-mentioned test car was coasted at a speed of 120 km/h and the pitch noise was evaluated into five ranks by the test driver's feelings.

Steering stability Test:

[0042] During running the test car on a dry asphalt road and wet asphalt road on a tyre test course, steering stability was evaluated into five ranks by the test driver's feelings.

Wet performance Test:

[0043] The test car was run on a 100m radius asphalt course provided with a 5 mm depth 20 m length water pool, and changing the entering speed, the lateral acceleration (lateral G) was measured on the front wheels to obtain the average lateral G from 50 to 80 km/h. The results are put into five ranks.
Wear resistance Test:

[0044] The test car was run for 8000 km, and then the tread portion was checked for uneven wear to evaluate into five ranks.

High-speed durability Test:

[0045] The test was conducted according to the load/speed performance test, ECE30, condition W. The results are evaluated into five ranks.

[0046] The results of the above-mentioned tests are shown in Table 1. In the ranking, the larger the number, the better the performance.

Table 1

<table>
<thead>
<tr>
<th>Tyre</th>
<th>Ex.1</th>
<th>Ref.1</th>
<th>Ref.2</th>
<th>Ref.3</th>
<th>Ref.4</th>
<th>Ref.5</th>
<th>Ref.6</th>
<th>Ex.2</th>
<th>Ref.7</th>
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<tbody>
<tr>
<td>Wide groove</td>
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<td>Width GW (mm)</td>
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<td>40</td>
<td>40</td>
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<td>Depth (mm)</td>
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<td>La(%)</td>
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<td>Lb(%)</td>
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<td>82</td>
<td>82</td>
<td>82</td>
<td>92</td>
<td>73</td>
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<td>Lc(%)</td>
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<tr>
<td>Width W (mm)</td>
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<td>16</td>
<td>16</td>
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<td>16</td>
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<td>Test results</td>
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<td>Steering stability</td>
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<td>Wet performance</td>
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<td>3</td>
<td>4</td>
<td>4</td>
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<td>4</td>
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<tr>
<td>Pass-by noise (dB)</td>
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<td>66.7</td>
<td>67.6</td>
<td>68.1</td>
<td>69.4</td>
<td>70.3</td>
<td>68.1</td>
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<td>Pitch noise</td>
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<td>4</td>
<td>4</td>
<td>4</td>
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<tr>
<td>Wear resistance</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4.5</td>
<td>3.5</td>
</tr>
<tr>
<td>High-speed durability</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td>3.5</td>
<td>4</td>
</tr>
</tbody>
</table>

[0047] It was confirmed from the test results that, in the Example tyres according to the present invention, the steering stability and wet performance were improved without sacrificing the tyre noise, wear resistance and high-speed durability.

Claims

1. A pneumatic tyre comprising a circumferentially continuously extending wide groove (9) having a width of from 35 to 45 mm disposed in a tread centre, characterised by a part (10) on each side of the wide groove, which is defined as extending at least 10 mm axially outwards from the groove edge, formed as a substantially continuous rib part, a part between the rib part (10) and a tread edge (E), provided with circumferentially discontinuous grooves so that: an axially inner part (A1) has a land ratio La of not less than 90%; a middle part (A2) has a land ratio Lb in a range of from 80 to 90%; and an axially outer part (A3) has a land ratio Lc in a range of from 85 to 95%, wherein the axially inner part (A1), middle part (A2) and axially outer part (A3) are three equiwidth parts between the wide groove (9) and the tread edge.

2. A pneumatic tyre as set forth in claim 1, characterised in that the land ratios La, Lb and Lc satisfy La > Lb and Lc > Lb.

3. A pneumatic tyre as set forth in claim 1, characterised in that the land ratios La, Lb and Lc satisfy La > Lc > Lb.

4. A pneumatic tyre as set forth in claim 1, 2 or 3, characterised in that said circumferentially discontinuous grooves (12) include less-inclined oblique grooves (12A) inclined at an angle of not more than 30 degrees with respect to the circumferential direction of the tyre, axial inner ends (12Ai) of said less-inclined oblique grooves (12A) are positioned on the same side in the tyre circumferential direction, and each said less-inclined oblique groove (12A)
extends across the substantially entire width of the middle part (A2).

5. A pneumatic tyre as set forth in claim 4, characterised in that both end portions (12Ai, 12Ao) of each said oblique groove (12) are inclined at an angle (θ1, θ2) of less than 10 degrees with respect to the circumferential direction of the tyre.

6. A pneumatic tyre as set forth in claim 4 or 5, characterised in that said circumferentially discontinuous grooves (12) include more-inclined oblique grooves (12B) inclined at an angle of more than 30 degrees with respect to the circumferential direction of the tyre, and each said less-inclined oblique groove (12A) joins a certain number of more-inclined oblique grooves (12B).

7. A pneumatic tyre as set forth in claim 4 or 5, characterised in that said circumferentially discontinuous grooves (12) include more-inclined oblique grooves (12B) starting from the less-inclined oblique grooves (12A) and extending axially outwardly to the tread edge (E) at an inclination angle (θ2) of more than 30 degrees with respect to the circumferential direction of the tyre.

8. A pneumatic tyre as set forth in claim 7, characterised in that the axially inner end (12Ai) of each said less-inclined oblique groove is positioned in the axially inner part (A1).

Patentansprüche

1. Luftreifen, umfassend eine sich in Umfangsrichtung kontinuierlich erstreckende breite Rille (9) mit einer Breite von 35 bis 45 mm, die in einer Lauflächemitte angeordnet ist, gekennzeichnet durch einen Teil (10) auf jeder Seite der breiten Rille, der derart definiert ist, dass er sich zumindest 10 mm axial außen von der Rillenkante erstreckt und als ein im Wesentlichen kontinuierlicher Rippenteil ausgebildet ist, einen Teil zwischen dem Rippenteil 10 und einer Lauflächemitte (E), der mit in Umfangsrichtung diskontinuierlichen Rillen derart versehen ist, dass: ein axial innerer Teil (A1) ein Landverhältnis La von nicht weniger als 90 % aufweist; ein mittlerer Teil (A2) ein Landverhältnis Lb in einem Bereich von 80 bis 90 % aufweist; und ein axial äußerer Teil (A3) ein Landverhältnis Lc in einem Bereich von 85 bis 95 % aufweist, wobei der axial innere Teil (A1), der mittlere Teil (A2) und der axial äußere Teil (A3) drei gleich breite Teile zwischen der breiten Rille (9) und der Lauflächemitte sind.

2. Luftreifen nach Anspruch 1, dadurch gekennzeichnet, dass die Landverhältnisse La, Lb und Lc La > Lb und Lc > Lb erfüllen.

3. Luftreifen nach Anspruch 1, dadurch gekennzeichnet, dass die Landverhältnisse Lb und Lc La > Lc > Lb erfüllen.

4. Luftreifen nach Anspruch 1, 2 oder 3, dadurch gekennzeichnet, dass die in Umfangsrichtung diskontinuierlichen Rillen (12) weniger geneigte schräge Rillen (12A) umfassen, die unter einem Winkel von nicht mehr als 30 Grad in Bezug auf die Umfangsrichtung des Reifens geneigt sind, wobei axial innere Enden (12Ai) der weniger geneigten schrägen Rillen (12A) auf der gleichen Seite in der Umfangsrichtung des Reifens angeordnet sind, und jede der weniger geneigten schrägen Rillen (12A) sich über im Wesentlichen die gesamte Breite des mittleren Teils (A2) erstreckt.

5. Luftreifen nach Anspruch 4, dadurch gekennzeichnet, dass beide Endabschnitte (12Ai, 12Ao) einer jeden schrägen Rille (12) unter einem Winkel (θ1, θ2) von weniger als 10 Grad in Bezug auf die Umfangsrichtung des Reifens geneigt sind.

6. Luftreifen nach Anspruch 4 oder 5, dadurch gekennzeichnet, dass die in Umfangsrichtung diskontinuierlichen Rillen (12) stärker geneigte schräge Rillen (12B) umfassen, die unter einem Winkel von mehr als 30 Grad in Bezug auf die Umfangsrichtung des Reifens geneigt sind, und eine jede der weniger geneigten schrägen Rillen (12A) an einer bestimmten Anzahl von stärker geneigten schrägen Rillen (12B) angrenzt.

7. Luftreifen nach Anspruch 4 oder 5, dadurch gekennzeichnet, dass die in Umfangsrichtung diskontinuierlichen Rillen (12) stärker geneigte schräge Rillen (12B) umfassen, die von den weniger geneigten schrägen Rillen (12A) ausgehen und sich axial nach außen bis zu der Lauflächemitte (E) unter einem Neigungswinkel (θ2) von mehr als 30 Grad in Bezug auf die Umfangsrichtung des Reifens erstrecken.

Revendications

1. Bandage pneumatique comprenant une large rainure (9) s’étendant de manière circonférentielle continue ayant une largeur allant de 35 à 45 mm disposée dans un centre de bande de roulement, caractérisé par une partie (10) de chaque côté de la large rainure, qui est définie comme s’étendant au moins sur 10 mm axialement vers l’extérieur à partir du bord de rainure, formée comme une partie de nervure sensiblement continue, une partie entre la partie de nervure (10) et un bord (E) de bande de roulement, prévu avec des rainures circonférentiellement discontinues de sorte qu’une partie axialement interne (A1) a un rapport de surface d’appui (La) non supérieur à 90% ; une partie centrale (A2) a un rapport de surface d’appui (Lb) de l’ordre de 80 à 90% ; et une partie axialement externe (A3) a un rapport de surface d’appui (Lc) de l’ordre de 85 à 95%, dans lequel la partie axialement interne (A1), la partie centrale (A2) et la partie axialement externe (A3) sont trois parties situées à largeur égale entre la large rainure (9) et le bord de bande de roulement.

2. Bandage pneumatique selon la revendication 1, caractérisé en ce que les rapports de surface d’appui (La, Lb et Lc) satisfont La > Lb et Lc > Lb.

3. Bandage pneumatique selon la revendication 1, caractérisé en ce que les rapports de surface d’appui La, Lb et Lc satisfont La > Lc > Lb.

4. Bandage pneumatique selon la revendication 1, 2 ou 3, caractérisé en ce que lesdites rainures circonférentiellement discontinues (12) comprennent des rainures obliques moins inclinées (12A), inclinées selon un angle non supérieur à 30 degrés par rapport à la direction circonférentielle du bandage, des extrémités internes axiales (12Ai) desdites rainures obliques moins inclinées (12A) sont positionnées du même côté dans la direction circonférentielle du bandage, et chacune desdites rainures obliques moins inclinées (12A) s’étend sensiblement sur toute la largeur de la partie centrale (A2).

5. Bandage pneumatique selon la revendication 4, caractérisé en ce que les deux parties d’extrémité (12Ai, 12Ao) de chacune desdites rainures obliques (12) sont inclinées selon un angle (θ1, θ2) inférieur à 10 degrés par rapport à la direction circonférentielle du bandage.

6. Bandage pneumatique selon la revendication 4 ou 5, caractérisé en ce que lesdites rainures circonférentiellement discontinues (12) comprennent des rainures obliques plus inclinées (12B), inclinées selon un angle supérieur à 30 degrés par rapport à la direction circonférentielle du bandage et chacune desdites rainures obliques moins inclinées (12A) relie un certain nombre de rainures obliques plus inclinées (12B).

7. Bandage pneumatique selon la revendication 4 ou 5, caractérisé en ce que lesdites rainures circonférentiellement discontinues (12) comprennent des rainures obliques plus inclinées (12B) commençant à partir des rainures obliques moins inclinées (12A) et s’étendant axialement vers l’extérieur vers le bord (E) de bande de roulement selon un angle d’inclinaison (θ2) supérieur à 30 degrés par rapport à la direction circonférentielle du bandage.

8. Bandage pneumatique selon la revendication 7, caractérisé en ce que l’extrémité radialement interne (12Ai) de chacune desdites rainures obliques moins inclinées est positionnée dans la partie axialement interne (A1).
Fig. 2