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(54) A HEAVY DUTY PNEUMATIC RADIAL TIRE

(71) We, BRIDGESTONE TIRE KABUSHIKI KAISHA of No. 10—1, 1-Chome, Kyobashi, Chuo-Ku, Tokyo, Japan, a company organized according to the laws of Japan, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a heavy duty pneumatic radial tire, and aims to diminish railway wear (as hereinafter explained) which is apt to occur in such tires when continuously travelling at a high speed over a long distance.

In general, radial tires of this type provided with metal cords as a belt reinforcement have excellent resistances to wear and puncture as compared with conventional bias tires because they have a highly stiff belt arranged between the tread rubber and the carcass ply. On the other hand, the radial tires give a less comfortable ride owing to the rigid reinforcing effect of such a belt. Accordingly, these radial tires have been developed for use on good roads aside from bad roads. Recently, the demand for such tires has considerably increased in association with the remarkable improvement in road conditions such as the development of networks of highways.

In such applications, zig-zag type ribs extending circumferentially of the tire are provided in the tread of the tire having regard to traction and braking performances, general wear resistance, and resistance to heat buildup. Generally, a tire having such a tread pattern is called a rib-type tire.

In the rib-type tire, the ribs are usually continuous in the circumferential direction of the tire but may be discontinuous due to the presence of transverse grooves arranged along the widthwise direction of the tire. In any case, when a vehicle provided with such tires travels continuously straight at a high speed over a long distance, there is caused irregular wear (hereinafter referred to as eccentric wear) which has never been observed in the conventional tires.

Namely, as shown in Figure 1 of the accompanying drawings, which is a partial schematic view illustrating the eccentric wear caused in a conventional heavy duty pneumatic radial tire, the eccentric wear is locally caused in a shadowed region A near the apex of a convex part 3 of a circumferential rib 2 formed in the tread of a tire T, this convex part extending in the widthwise direction of the tire T toward a main groove 1 extending in zigzag fashion along the circumferential direction of the tread, and then gradually increases to form a region A having a stepwise height h and a width w in section as shown in Figure 2 of the accompanying drawings, which is a cross-sectional view taken along the line II—II in Figure 1. The region A of the eccentric wear gradually grows with the increase of the travelling distance and finally communicates with adjoining regions A. As a result, these regions are continuously joined with each other in the circumferential direction of the tire. Moreover, the stepwise height h and the width w are gradually enlarged with the increase of the travelling distance.

The above eccentric wear is generally called railway wear, which produces not only the recess on the main groove 1 to render the appearance of the tire T undesirable, but also adversely affects the tire performance, particularly traction and braking performances depending upon the function of an edge line of the rib 2 adjacent the main groove 1, and further considerably reduces the life of the tire.

The eccentric wear begins to occur only in the vicinity of the apex of the convex part 3 of the zigzag circumferential rib 2 and does not start from a concave part 4 of the circumferential rib in opposition to the convex part 3 along the widthwise direction of the tire T. However, the concave part 4 is also subjected to railway wear

in due time with the evolution of the eccentric wear.

The present inventors have considered the cause of the railway wear in rib-type heavy duty pneumatic radial tires of various sizes, and as a result have discovered the following.

That is, the railway wear is an inherent phenomenon in the case of continuous travel of a rib-type tire provided with highly stiff metal cords as a belt reinforcement at a high speed and hardly occurs when such a tire is used on general roads with discontinuous travelling at a low speed or on bad roads. causing a considerable degree of wear. Therefore, the inventors, having further considered that the vicinity of the apex of the convex part 3 of the circumferential rib 2 extending toward the main groove 1 in the widthwise direction of the tire T undergoes a transverse stress concentration owing to the occurrence of railway wear when continuously travelling straight at a high speed, have found that the stress applied to the vicinity of the apex of the convex part 3 of the circumferential rib 2 can be diminished by providing a stress-mitigating rib near such apex, whereby the formation of a railway wear nucleus and its propagation in the circumferential and radial directions can be prevented or at least diminished.

According to the invention, there is provided a heavy duty pneumatic tire having a tread pattern formed in a tread divided into a plurality of continuous or discontinuous zigzag circumferential ribs along the widthwise direction of the tire by at least two zigzag main grooves extending circumferentially of the tread, the width of each said circumferential rib being at least 10% of the tread width measured in the direction perpendicular to the circumferential direction of the tire, wherein a stress-mitigating rib is arranged adjacent the apex of each convex part of the circumferential ribs extending toward the main grooves in the widthwise direction of the tire, the said stress-mitigating rib being substantially parallel to the edge of the said convex part and spaced from the said circumferential rib through an isolation groove, the width of the stress-mitigating rib being less than the width of the main groove, and the depth of the said isolation groove being at least 30% of the depth of the main groove.

The invention will be further described, by way of example only, with reference to the accompanying drawings, wherein:

Fig. 3 is a partial schematic view of the tread pattern of one embodiment of a tire according to the invention;

Fig. 3a is a partly detailed view of Fig. 3;

Fig. 3b is a cross-sectional view taken along line III—III in Fig. 3a; and

Figs. 4 and 5 are partial schematic views of the tread pattern of other embodiments of tires according to the invention, respectively.

In Fig. 3 is partly shown the tread of a heavy duty pneumatic radial tire according to the invention.

A stress-mitigating rib 5 is located in a relatively wide main groove 1 near the apex of a convex part 3 of a circumferential rib 2 extending toward the main groove 1 in the widthwise direction of the tread and opposite to the convex part 3 as shown in Fig. 3.

The term "circumferential rib" used herein means one having a rib width RW corresponding to at least 10% of the tread width TW measured in the direction perpendicular to the circumferential direction of the tire. When the rib width RW is less than 10%, the rigidity in the circumferential direction of the tread becomes small and eccentric wear hardly occurs. The circumferential rib 2 may be circumferentially discontinuous. In this case, it is necessary that the rib width RW satisfies the above relationship at a zone defined between the two main grooves 1 in the widthwise direction of the tread.

The stress-mitigating rib 5 will be further described in detail. As shown in Figs. 3a and 3b, the stress applied to the vicinity of the convex part 3 is considerably diminished by providing the stress-mitigating rib 5 apart from the circumferential rib 2 near the convex part 3 thereof and parallel to an edge line of the convex part 3. Better results can be obtained when the stress-mitigating rib 5 satisfies the following relations. That is, the length l of the rib 5 in the circumferential direction of the tread is preferably within a range of 0.60 to 0.95 based on the pitch P of the zigzag of the main groove 1 and the width B of the rib 5 is preferably within a range of 0.10 to 0.20 based on the width W_1 of the main groove 1. Furthermore, there is provided an isolation groove 6 for separating the stress-mitigating rib 5 from the circumferential rib 2. The width W_2 of the groove 6 is preferably within a range of 0.02 to 0.05 based on the width W_1 of the main groove 1 and the depth h_1 of the groove 6 must be at least 30% of the depth H of the main groove 1.

According to the invention, by providing the narrow stress-mitigating rib 5 separated from the circumferential rib 2 opposite to the convex part 3 of the rib 2 as mentioned above, the formation of a railway wear nucleus at the apex of the convex part 3 is suppressed, or if partly formed, the propagation of the nucleus can effectively be suppressed.

From various examinations, it has been found that when the length l of the stress-mitigating rib is less than 60% of the zigzag pitch P of the main groove 1, there might be no stress-diminishing effect, while when the length l exceeds 95%, there may be no great difference in the stress-diminishing effect on the one hand and the wear state during the travelling becoming undesirable in appearance on the other hand. Therefore, it is preferable that the length l of the stress-mitigating rib is within the above range based on the zigzag pitch P of the main groove.

Furthermore, when the width B of the stress-mitigating rib 5 is smaller than 10% of the width W_1 of the main groove 1, it is very difficult to produce such a stress-mitigating rib and at the same time that rib is apt to cut during the travelling. When the width B exceeds 20%, there is obtained the effect of diminishing the stress, but various drawbacks such as obstruction of draining function in the main groove 1 are caused. Moreover, if the width B is too large, wear caused in the stress-mitigating rib itself is conspicuous and the appearance thereof becomes undesirable.

When the depth h_1 of the isolation groove 6 is smaller than 30% of the depth H of the main groove 1, the function of the stress-mitigating rib 5 is not developed The depth h_1 of the isolation groove 6 may be substantially equal to the depth H of the main groove 1.

From various examinations, it has also been found that the width W_2 of the isolation groove 6 is preferably within a range of 2% to 5% based on the width W_1 of the main groove 1. When the width W_2 is smaller than 2%, there is caused a problem in the production of the isolation groove 6, while when the width W_2 exceeds 5%, the spacing between the circumferential rib 2 and the stress-mitigating rib 5 may be too large and as a result the function of the stress-mitigating rib may not be developed.

According to the invention, the widths of the main groove 1, isolation groove 6 and stress-mitigating rib 5 are measured in a direction perpendicular to the edge line of the circumferential rib in the tread of tire.

In Figs. 4 and 5 are partly shown other embodiments of the stress-mitigating rib 5. In the embodiment of Fig. 4, a part of the stress-mitigating rib 5 is connected to the corresponding portion of the edge line of the convex part 3 of the circumferential rib 2. In the embodiment of Fig. 5, the stress-mitigating rib 5 is continuous in the circumferential direction of the tread. In either case, the effect of diminishing the stress is the same as in the embodiment of Fig. 3. In these embodiments, the width W_1 of the main groove 1 may be considered to be the distance between the adjoining circumferential ribs 2 irrespective of the presence of the stress-mitigating rib 5.

The railway wear was actually tested with respect to the tires of the prior art and the invention to obtain the following results.

1. Tire of the prior art:
   Size: 10.00R20, 14 PR rib type
   Construction: number of main grooves = 4
2. Tire of the invention:

The size, construction of belt and carcass ply, shape and number of main grooves 1 in the tread were the same as used in the tire of the prior art except that a stress-mitigating rib 5 was arranged near the apex of the convex part 3 in each circumferential rib 2 and opposite thereto as shown in Fig. 3. The size of the stress-mitigating rib 5 was as follows:

$l/P = 0.90$ ($P = 10$ mm, $l = 9$ mm)
$B/W_1 = 0.17$ ($W_1 = 12$ mm, $B = 2$ mm)
$W_2/W_1 = 0.04$ ($W_2 = 0.5$ mm)
$h_1/H = 0.41$ ($h_1 = 6$ mm, $H = 14.6$ mm)

Test conditions:

Vehicle	:	large-sized truck
Load	:	maximum load
Inner pressure	:	7.25 kg/cm²

Test contitions—continued

Road course	:	high speed road 70%, general road 30%
Speed	:	80 km/hr for high speed road, 40 km/hr for general road
Travelling distance	:	35,000 km
Mounting position for tire:		front wheel (the tires were changed between its right and left positions every 5,000 km.)

Test result:

The degree of railway wear was measured to obtain a result expressed by h and w in Fig. 2 as shown in the following table.

	h (stepwise height)	w (width)
Tire of the prior art	1.7 mm	5.0 mm
Tire of the invention	0.3 mm	0.5 mm

As seen from the above data, the railway wear in the tire of the invention is considerably less than the railway wear in the tire of the prior art.

According to the invention, there is provided a tread pattern capable of effectively diminishing the stress applied to the convex part of a zigzag circumferential rib opposite to the main groove in a rib-type tire and effectively suppressing the propagation of railway wear when continuously travelling at a high speed for a long time.

WHAT WE CLAIM IS:—

1. A heavy duty pneumatic radial tire having a tread pattern formed in a tread divided into a plurality of continuous or discontinuous zigzag circumferential ribs along the widthwise direction of the tire by at least two zigzag main grooves extending circumferentially of the tread, the width of each said circumferential rib being at least 10% of the tread width measured in the direction perpendicular to the circumferential direction of the tire, wherein a stress-mitigating rib is arranged adjacent the apex of each convex part of the circumferential ribs extending toward the main grooves in the widthwise direction of the tire, the said stress-mitigating rib being substantially parallel to the edge of the said convex part and spaced from the said circumferential rib through an isolation groove, the width of the stress-mitigating rib being less than the width of the main groove, and the depth of the said isolation groove being at least 30% of the depth of the main groove.

2. A tire as claimed in Claim 1, wherein the said stress-mitigating rib satisfies the following relations:

$$1/P = 0.06 \text{ to } 0.95$$
$$B/W_1 = 0.10 \text{ to } 0.20$$
$$W_2/W_1 = 0.02 \text{ to } 0.05$$

in which P is the pitch of the zigzag of the said main groove, 1 is the length of the said isolating froove in the circumferential direction of the tread, W_1 s the width of the said main groove, W_2 is the width of the isolation groove, and B is the width of the stress-mitigating rib, W_1, W_2 and B being all measured in a direction perpendicular to the edge of the said circumferential rib.

3. A heavy duty pneumatic radial tire according to Claim 1, substantially as herein described with reference to, and shown in, Figure 3, Figure 4 or Figure 5 of the accompanying drawings.

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3 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 1

FIG.1

PRIOR ART

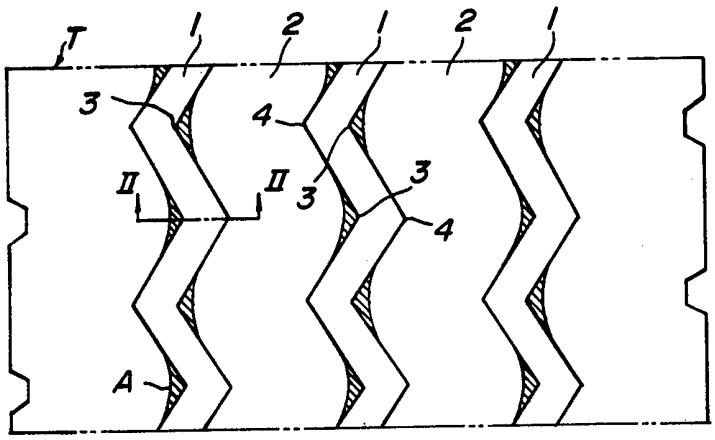

FIG.2

PRIOR ART

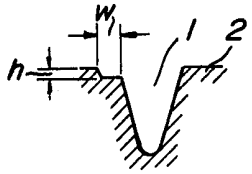

FIG_3

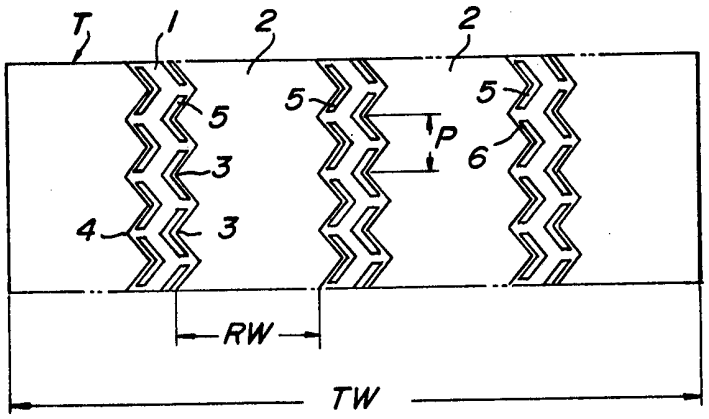

FIG_3a

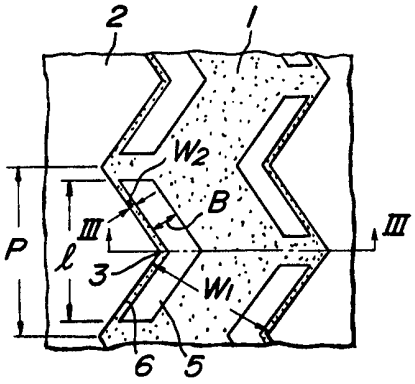

FIG_3b

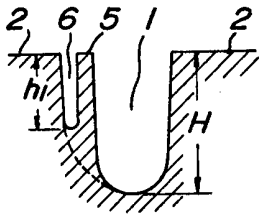

FIG_4

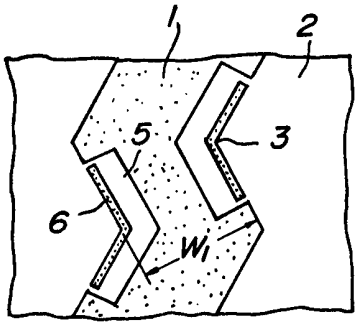

FIG_5