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(54) RECAPPED PNEUMATIC TIRE

(71) We, UNIROYAL GmbH (formerly known as Uniroyal AG), a corporation organized under the laws of the District Court of Aachen, West Germany, 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 recapped pneumatic tires and to a method of effecting such recapping.

It is well known that most pneumatic vehicle tires, following wearing of the tread profile, can be made reusable by a recapping process. In a typical recapping process the remnants of the original tread, no longer considered usable, are removed or stripped by peeling, roughening or any other suitable procedure. The stripped surface of the tire is penetrated in a known manner and a new tread is placed around the tire circumference. The tread is then vulcanized to establish a firm connection with the old tire body and simultaneously provided with a new tread profile.

In a recapping process for belted tires, particular care must be taken in removing the residue of old unusable tread to prevent or minimize damage to the constituents of the original belt, especially the rubber in which reinforcing elements of the belt are embedded, otherwise it may be necessary to rebuild the original belt on the used tire body. If desired a thin rubber ply can be applied onto the stripped surface of the used tire body to serve as a protective or compensating ply and thereafter the new tread is applied.

Generally a recapped tire, with or without a reinforcing belt, is incapable of performing at the same level as the original new tire. This is due to several known factors such as inadequate bonding between the new tread and the original used tire body. Consequently, there is a tendency for the recapping material to separate from the original used tire body, especially at high speeds.

It is thus desirable to provide an improved recapped tire construction for steel cord belted tires and a method for recapping steel cord belted tires that furnishes an improved bond between the recap components and the used tire body.

According to the present invention a method of recapping a worn pneumatic tire having a radial carcass and a first circumferential reinforcement belt formed with steel cords each having an angle between 10 and 30° with the mid-circumferential plane, comprises the steps of stripping the unusable tread from the tire to form a circumferential recapping surface that maintains the first reinforcement belt intact, winding an unvulcanized second reinforcement belt of rubberized textile cord material which is shrinkable at vulcanization temperature around said recapping surface for at least one full winding tension to stretch the textile cord material by 1 to 5% from its rest state and to provide overlapping end portions, with the textile cord elements being oriented substantially parallel to the mid-circumferential plane of the tire, and applying an unvulcanized tread strip around said recapping surface over the second reinforcement belt and vulcanizing the recap tire components on the recapping surface to provide a firm bond between the recapping surface and the tread strip, the recapping surface and the second reinforcement belt, and the tread strip and the second reinforcement belt.

The invention also extends to a construction for forming a recapped pneumatic tire comprising a used tire body having a radial carcass and a first circumferential reinforcement belt formed with steel cords each making an angle between 10 and 30° with the mid-circumferential plane, a stripped circumferential recapping surface at the periphery of said used tire body, a second reinforcement belt wound under a predetermined tension around said recapping surface for at least one full winding to provide overlapping end portions, said second reinforcement belt being unvulcanized and

including heat shrinkable rubberized textile cord elements having a predetermined shrinkage at vulcanization temperatures, said textile cord elements being oriented substantially parallel to the mid-circumferential plane of the tire, and an unvulcanized tread strip applied around said recapping surface over said second reinforcement belt.

The second reinforcement belt preferably includes windings in spiral arrangement about the recapping surface. If desired, the second reinforcement belt may comprise a strip having a first length of given width which extends for at least one full winding around said recapping surface and an additional predetermined length comprising two axially spaced marginal elements each extending from the end of said first length. In another embodiment the second reinforcement belt may comprise two axially spaced belts each extending for at least one full winding around the recapping surface and each covering a respective marginal edge of the first reinforcement belt.

The heat applied during vulcanization of the new tread shrinks the cord elements of the newly added belt, wherein the cord elements, in the manner of shackles, loop around the original steel belt reinforcement of the used tire body to form an integral combination therewith. The newly added reinforcement belt has an uncured elastomer or rubber layer that bonds firmly to the rubber ply of the newly applied tread during vulcanization, thereby reducing or eliminating the occurrence of any detachment phenomena along the edges of the belt during use of the recapped tire, even at elevated speeds.

In the accompanying drawings in which various embodiments of the invention are illustrated:

Fig. 1 shows, in fragmentary cross section, a recapped pneumatic vehicle according to one embodiment of the present invention;

Fig. 2 is a schematic cut away plan view of the various plies thereof;

Fig. 3 is a schematic side view of a second reinforcement belt incorporated in the tire of Fig. 1; and

Fig. 4 is a schematic perspective view of an alternative form of second reinforcement belt.

Referring now to the drawings a recapped pneumatic tire is generally indicated by reference number 1. The recapped tire 1 includes a used tire body 2 with a radial carcass 3 embedded therein. A belt 5 comprised of two plies 6 and 7 made of steel cord elements having cord angles between 10 and 30° is arranged in the crown area of the used tire body 2. The cord elements of the two plies 6 and 7 are arranged to intersect as suggested by the arrows in Fig. 2.

The tread area of the used tire body 2

is machined prior to recapping in a known manner to remove rubber from the original tread close to the belt 5 as indicated by the dash and dot line 4 in Fig. 1. During the tread removal process, particular care is taken to avoid damaging the cord elements of the outer belt ply 7, otherwise it may be necessary to rebuild the belt 7 onto the used tire body 2. A residue of the old rubber layer may be left over the cord elements of the belt ply 7, as shown in Figure 1.

The exposed area of the used tire body 2 is then treated in a known manner and a tire cord belt 10, comprising two continuous spiral windings 11 and 12 is wound thereon. The tire cord belt 10 is formed of textile cord elements embedded in rubber, and oriented parallel to one another and substantially parallel to the mid-circumferential plane 15 of the tire. Accordingly the cord elements of the tire cord belt 10 form a continuous spiral arrangement of the plies 11 and 12 as best seen in Fig. 3.

The cord belt 10 can be arranged as one or two complete windings although more than two complete windings are also feasible. Irrespective of the number of windings in the belt 10 it is necessary to have the extremities of the belt overlap as indicated at 16 (Fig. 3). Preferably the overlap 16 should be between 10 and 30mm.

The textile cord elements of the tire cord belt 10 must be capable of elastic longitudinal extension by from 1 to 5% of their length in the rest state, and must have a shrinkage capability upon exposure to the heat of vulcanization.

The cord elements of the tire cord belt 10 can be formed in any suitable material such as materials selected from the group of polyamides, rayon polyesters and the like, and preferably a calendered nylon fabric ply. Fiberglass material is also feasible.

A particularly solid bond is achieved between the belt 10 and the used tire body 2 if the lowermost winding 11 of the tire cord belt 10 is in direct contact with the outermost steel belt ply 7 of the tire 1, rather than in contact with a residue of the old rubber layer as shown in Fig. 1. In large size tires, for instance truck tires and other similar large wheel applications, the lowermost winding 11 of the tire cord belt 10 should make direct contact with a recap marking ply provided above the steel reinforcement belt 5.

The tire cord belt 10 is wrapped around the used tire body 2 under tension to permit a firm bond therebetween. The tire cord belt 10 is preferably wrapped symmetrically to the equatorial plane around the steel belt reinforcement 5. The width of the tire cord belt 10 is suitably adjusted to the width of the belt 5 and may amount to between plus or minus 30mm. of the belt width. Preferably the tire cord belt 10

has a width that permits it to extend beyond the edges of the steel belt reinforcement 5 thereby reducing or eliminating the possibility of separation phenomena in the recapped tire even at elevated speeds.

After the tire cord belt 10 is applied to the used tire body 2 the new tread 8 is applied over this assembly in a known manner and a new tread profile is embossed therein during subsequent vulcanization. Since the tire cord belt 10 comprises a rubber mass in which the cord elements are embedded the vulcanization provides particularly strong bonding between the belt 10 and the new tread 8 as neither one has been vulcanized prior to the recapping process.

The extremely firm bonds between the tire cord belt 10 and the used tire body 2, between the tire cord belt 10 and the new tread 8, and between the new tread 8 and the used tire body 2 assures a greater molding accuracy during vulcanization of the new tire components in comparison with prior known tires of this type. Consequently the recapped tire exhibits improved running performance and a lesser degree of wear. Moreover the recapped tire is endowed with properties that were originally nonexistent or partially nonexistent in the used tire when it was in its new condition, such as improved road holding ability and improved travel comfort.

If desired an additional thin rubber ply (not shown) can be applied onto the pretreated used tire body 2 at the surface 4 prior to application of the tire cord belt 10 to serve as a protection or compensation ply of new rubber between the recapping surface and the cord belt 10.

It may also be desirable to use tire cord strips in the marginal zones to cover and firmly bond the belt edges. For example there can be used an integral tire cord strip 20 (Fig. 4) which has a first length of given width extending for one full winding and an additional length comprising two axially spaced narrow margin strips 22 extending from one end of the first length. As further alternative individual axially spaced narrow tire cord strips (not shown) can be used, one overlying each original belt edge.

While a textile cord ply embracing a belt ply on the outside and having cord elements oriented parallel to the equatorial plane is a known arrangement in new tires, the incorporation of a separate unvulcanized tire cord belt, with at least one winding and having overlapping end portions and a separate unvulcanized tread strip in a recapping process for pneumatic tires having steel belts has heretofore not been known. Such an arrangement in a recapped tire having a steel reinforcing belt as disclosed herein serves a double function in providing an im-

proved bond between the used original and the new portions of the tire, and at the same time endows the recapped tire with desirable properties that did not exist with the original tire even when the original tire was in its new state.

Some advantages of the present invention evident from the foregoing description are a recapped tire that, compared with the used tire in its original state, displays an improved road holding ability and improved travel comfort. The recapping process imparts to the tire considerably greater projection against separation phenomena at the belt edges by virtue of an improved bond. Moreover since the tire can be recapped with greater accuracy it provides substantially improved wear resistance and performs more favorably even during high speed travel.

WHAT WE CLAIM IS:—

1. A method of recapping a worn pneumatic tire having a radial carcass and a first circumferential reinforcement belt formed with steel cords each making an angle between 10 and 30° with the mid-circumferential plane, comprises the steps of stripping the unusable tread from the tire to form a circumferential recapping surface that maintains the first reinforcement belt intact, winding an unvulcanized second reinforcement belt of rubberized textile cord material which is shrinkable at vulcanization temperature around said recapping surface for at least one full winding under tension to stretch the textile cord material by 1 to 5% from its rest state and to provide overlapping end portions, with the textile cord elements being oriented substantially parallel to the mid-circumferential plane of the tire, and applying an unvulcanized tread strip around said recapping surface over the second reinforcement belt and vulcanizing the recap tire components on the recapping surface to provide a firm bond between the recapping surface and the tread strip, the recappings surface and the second reinforcement belt, and the tread strip and the second reinforcement belt.

2. A method according to claim 1, in which the second reinforcement belt is wound to be symmetrical with respect to the mid-circumferential plane of the tire.

3. A method according to claim 1 or claim 2 in which the second reinforcement belt is wound in spiral arrangement for at least two full windings around said recapping surface.

4. A method of recapping a pneumatic tire substantially as herein described with reference to Figures 1 to 3 of the accompanying drawings or to these Figures as modified by Figure 4 of the accompanying drawings.

5. A construction for forming a pneu-

matic tire comprising a used tire body having a radial carcass and a first circumferential reinforcement belt formed with steel cords each making an angle between 10 and 30° with the mid-circumferential plane, a stripped circumferential recapping surface at the periphery of said used tire body, a second reinforcement belt wound under a predetermined tension around said recapping surface for at least one full winding to provide overlapping end portions, said second reinforcement belt being unvulcanized and including heat shrinkable rubberized textile cord elements having a predetermined shrinkage at vulcanization temperatures, said textile cord elements being oriented substantially parallel to the mid-circumferential plane of the tire, and an unvulcanized tread strip applied around said recapping surface over said second reinforcement belt.

6. A construction according to claim 5 in which the second reinforcement belt extends in spiral arrangement around said recapping surface for at least two full windings.

7. A construction according to claim 5 or claim 6 in which the second reinforcement belt has a width in the range of the width of the first reinforcement belt $\pm$ 30 mm.

8. A construction according to any one of claims 5 to 7 in which the overlapping end portions of said second reinforcement belt overlap by approximately 10 to 30 mm.

9. A construction according to any one of claims 5 to 8 in which the textile cords of said second reinforcement belt are formed of rayon, nylon or fiberglass.

10. A construction according to any one of claims 5 to 9 in which the second reinforcement belt comprises a strip having a first length of given width which extends for at least one full winding around said recapping surface and an additional predetermined length comprising two axially spaced marginal elements each extending from the end of said first length.

11. A construction according to any one of claims 5 to 9 in which the second reinforcement belt comprises spaced, unconnected marginal strips overlapping the marginal edges of said first reinforcement belt.

12. A construction according to any one

of Claims 5 to 11 in which the first reinforcement belt comprises two plies and wherein the angular orientation of cords in one of said plies intersects with the annular orientation of cords in the other said ply.

13. A construction according to any one of claims 5 to 12 in which a residue of used tire rubber is left on said used tire body between said first reinforcement belt and said stripped circumferential recapping surface.

14. A construction according to any one of claims 5 to 12 in which the first reinforcement belt is exposed at the stripped circumferential recapping surface such that said first and second reinforcement belts are in contact.

15. A construction according to any one of claims 5 to 14 in which the rubberized textile cord elements of the second reinforcement belt are longitudinally elongated by 1 to 5% with respect to their rest position to establish said predetermined winding tension around said recapping surface.

16. A construction according to any one of claims 5 to 12 in which the second reinforcement belt is disposed on said tire body symmetrically with respect to the mid-circumferential plane of said tire.

17. A construction for forming a recapped pneumatic tire, substantially as herein described with reference to Figures 1 to 3 of the accompanying drawings or to those Figures as modified by Figure 4 of the accompanying drawings.

18. A recapped pneumatic tire when made by a method according to any one of the claims 1 to 4.

19. A recapped pneumatic tire when made by vulcanising a construction according to any one of claims 5 to 16 in a tread-profile-forming mould.

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