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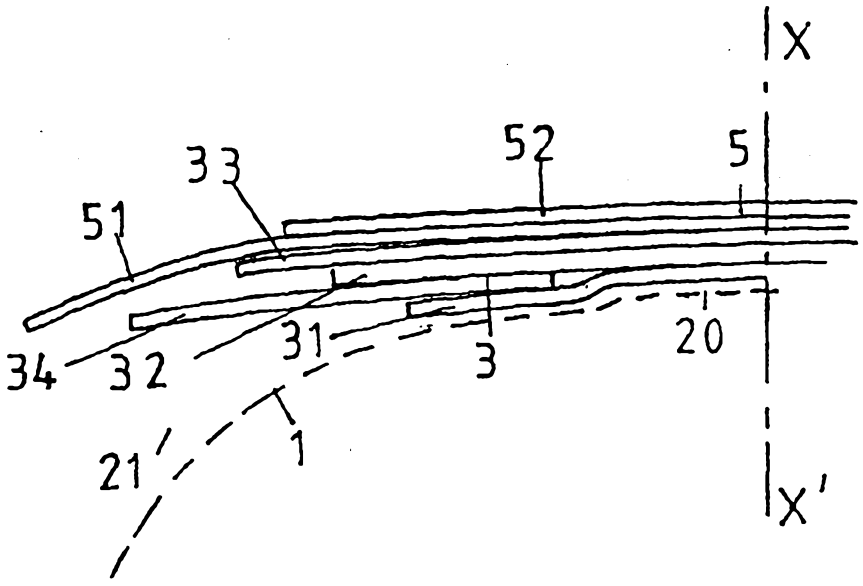
(57) Abstract

The invention concerns a tyre for a heavy vehicle, comprising at least a casing reinforcement (1), whereon is mounted radially external a crown reinforcement (3) consisting of at least three plies (31, 32, 33) called working plies and formed with inextensible wire cords, crisscrossed from one ply (31, 32) to the next (32, 33) forming with the circumferential direction angles α, α_1, α_2 ranging between 15° and 35°. At least a half–ply (34) consisting of inextensible wire cords and having a length L', is, on either side of the equatorial plane XX', arranged between the edges of at least two radially adjacent working plies (31, 32; 32, 33), the cords of said half–ply (34) forming with the circumferential direction an angle β greater in absolute value than 25° and greater in absolute value than the widest angle formed by the elements of the two working plies by a quantity ranging between 5° and 15°.



A TYRE FOR HEAVY MACHINERY

The invention relates to a tyre having a radial carcass reinforcement which is intended to be fitted on a heavy vehicle such as a transport vehicle or construction machinery. It relates more particularly to the crown reinforcement of such a tyre.

The construction-vehicle tyre shown in Figure 1 comprises, as is known *per se*, a carcass reinforcement (1) composed of a single ply of inextensible metal cables made of steel, which is anchored within each bead to a bead wire (2) to form an upturn (10), the end of which is substantially located at the level of the greatest axial width of the carcass reinforcement. Said carcass reinforcement is radially surmounted by a layer (20) and profiled members (21) of rubber mix, then by a crown reinforcement (3) composed firstly of two plies (31) and (32) referred to as working plies and secondly radially of two so-called protective plies (51) and (52). The working plies are formed of inextensible metal cables made of steel, which are parallel to each other within each ply (31, 32) and are crossed from one ply (31) to the next (32), forming angles which may be between 15° and 45° with the circumferential direction. The axial widths of said working plies are generally between 60% and 80% of the maximum axial width of the carcass reinforcement (1). The protective plies (51, 52) are generally formed of elastic metal cables made of steel, which are parallel to one another within each ply (51, 52) and are crossed from one ply (51) to the next (52), also forming angles which may be between 15° and 45°. The widths of said protective plies (51, 52) are usually less than the width of the widest working ply. Finally, the cables of the radially outer working ply (32) are usually crossed with the cables of the radially inner protective ply (51). The crown reinforcement is itself surmounted by a tread (4) which is joined to the two beads (7) by the two sidewalls (6).

As is known, the crown reinforcements of radial tyres, and more particularly large-dimension tyres, are subjected to great deformation, which causes longitudinal and transverse shearing stresses between the edges of two crossed plies (the longitudinal shearing is greater than the transverse shearing when the cables of crossed plies form small angles with the circumferential direction), at the same time as a delamination stress, a radial stress which tends to separate the edges of the two plies radially. Said

stresses are due first and foremost to the inflation pressure of the tyre, which means that the so-called belting pressure between the carcass reinforcement and the crown reinforcement tends to cause the circumferential expansion of said crown reinforcement; next they are due to the load borne by the tyre when travelling, with a contact surface being produced between the ground and the tyre; then finally to the drifting of the tyre when travelling. Said shearing stresses generate fissures in the rubber mix adjoining the end of the shortest ply, which fissures spread within said mix and adversely affect the life of a crown reinforcement, and therefore of the tyre.

A clear improvement in the endurance was obtained by using in the crown reinforcement at least one protective crown ply having an axial width greater than the width of the axially widest working ply.

Another solution, as noted in French Patent 2 421 742, consists in more favourably distributing the stresses causing separation between working crown plies, following the drifting of the tyre, by multiplying the number of working plies, for example by using four working plies of reinforcement elements crossed from one ply to the next, forming angles which may be between 15° and 35° with the circumferential direction and by distributing the reinforcement elements used in the conventional two working plies over the four working plies such that the latter each have the same thickness and the same rigidity in extension measured perpendicular to the reinforcement elements of the ply.

Multiplication of the working plies is not without its drawbacks, particularly at the centre of the reinforcement where the number of plies has a very great influence on the flexural strength of the crown of the tyre. The invention proposes increasing the resistance to separation between working plies of a crown reinforcement having (a) widened protective ply (plies) and thus improving the endurance of such a crown reinforcement for a tyre for construction machinery, without increasing the number of working plies at the centre of the reinforcement.

The tyre according to the invention, comprising at least one radial carcass reinforcement anchored within each bead to at least one bead wire, forming an upturn, said reinforcement being surmounted radially to the outside by a crown reinforcement formed of at least three so-called working plies and formed of inextensible metal reinforcement

elements which are parallel to each other within each ply and are crossed from one ply to the next, forming angles α, α' of between 15° and 35° with the circumferential direction, is characterised in that at least one half-ply, formed of inextensible metal reinforcement elements and of width L', on either side of the equatorial plane, is arranged radially between the edges of at least two radially adjacent working plies, the axially outer and inner ends of said half-ply being located, respectively axially to the outside of the end of the widest working ply and axially to the inside of the end of the least wide working ply, at distances at least equal to the amount L'/5, the reinforcement elements of said half-ply forming with the circumferential direction an angle ß, which is firstly greater in absolute value than 25°, and secondly is greater in absolute value than the largest angle formed by the elements of the two working plies by a quantity of between 5° and 15°.

Preferably, a half-ply is arranged between the two working plies closest to the carcass reinforcement. Whether there be one or two half-plies, the reinforcement elements of each half-ply are advantageously crossed with the reinforcement elements of the working ply radially to the inside of said half-ply and closest radially to the carcass reinforcement.

The widths of the working plies of the crown reinforcement, which are generally unequal, are such that the working ply radially to the inside of each half-ply is less wide than the ply radially to the outside of said half-ply.

In the case of the presence, on either side of the equatorial plane, of two half-plies arranged between the edges of two radially adjacent working plies of the working reinforcement of three plies, the second half-ply is formed of the same metal reinforcement elements as those of the first half-ply, said elements preferably being crossed with the elements of said first half-ply.

The working ply, as is known *per se*, is surmounted radially by a protective reinforcement composed of two plies of elastic metal reinforcement elements. One of said protective plies, preferably the radially inner ply, has an axial width greater than the greatest axial width of the working plies, whereas the width of the second protective ply has a width of a value which lies between the values of the widths of the working plies.

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

- Figure 1 shows a diagram, viewed in meridian section, of a crown reinforcement for a construction-vehicle tyre, in accordance with the prior art,

- Figure 2 shows a diagram, viewed in meridian section, of a first variant of the crown reinforcement according to the invention, and

- Figure 3 shows a diagram, still in meridian section, of a second variant of a crown reinforcement according to the invention.

The tyre P according to the invention, the crown reinforcement of which is shown in Figure 2, is a tyre for construction machinery. Of large dimensions, the H/S form ratio of said tyre is equal to 0.80, H being the height of the tyre on its rim and S the maximum axial width of the tyre, when the latter is mounted on its operating rim and inflated to its recommended pressure.

Said tyre P comprises a radial carcass reinforcement composed of a single ply (1) of inextensible metal cables, which is anchored within each bead to at least one bead wire (not shown) to form an upturn, the end of which is substantially located on the straight line of greatest axial width of the carcass reinforcement, which straight line is parallel to the axis of rotation. The carcass ply (1) is surmounted radially, within its central part, by a layer (20) of rubber mix and, in its lateral parts, by two triangular profiled members (21) formed of the same rubber mix, said profiled members making it possible to compensate for the differences in meridian curvature between the carcass reinforcement and the crown reinforcement. In fact, radially to the outside of said layer and profiled members, there is arranged a working crown reinforcement (3) and a protective reinforcement (5).

The working reinforcement comprises first and foremost three working plies (31), (32) and (33) which are axially continuous and of widths L_{31}, L_{32} and L_{33} respectively, the least wide ply (31), in the case described, being radially closest to the carcass reinforcement

(1) and the widths L_{31}, L_{32} and L_{33} increasing radially from the inside to the outside. Said three widths are equal to 0.5 S_0, 0.55 S_0 and 0.66 S_0, respectively. Said three plies (31), (32) and (33) are formed of inextensible metal cables, which are parallel to each other in each ply and are crossed from one ply (31, 32) to the next (32, 33), forming angles α_1, α_2 and α_3 which are equal to +18°, -24° and +18° respectively with the circumferential direction of the tyre.

Radially between the edges of the least wide ply (31) and the edges of the radially adjacent ply (32) of intermediate width, there are arranged two half-plies (34), formed of the same inextensible metal elements as those forming the plies (31), (32) and (33), said elements being parallel to each other in each half-ply (34) and crossed with the elements of the axially continuous ply (31) closest to the carcass ply (1), forming with the circumferential direction an angle ß, greater than the angles α_1 and α_2 and equal to –33°. The axial width L' of each half-ply (34) is equal to 0.33 S_0. The axially inner end of the half-ply (34) is located axially to the inside of the end of the ply (31) and at an axial distance from the equatorial plane XX', such that the difference between the axial half-width of the least wide working ply (31) and said distance is equal to 0.22 L', such that there is an overlap between the axially inner edge of said half-ply (34) and the edge of the least wide axially continuous ply (31) which is radially to the inside. As for the axially outer end of the half-ply (34), it is axially to the outside of the end of the widest ply (32) and at an axial distance from the equatorial plane XX', such that the difference between said distance and the axial half-width of the widest working ply (32) is equal to 0.37 L'.

The protective reinforcement, which finishes off the crown reinforcement and, radially to the outside of the working reinforcement described above, is formed of two plies (51) and (52) of elastic steel cables. Cables which, under a tensile force equal to the breaking load, have a relative elongation of at least 4% are referred to as elastic, whereas cables are referred to as inextensible when their relative elongation, measured at 10% of the breaking force, is less than 0.2%. The cables of said two plies are crossed from one ply (51) to the next (52), forming angles respectively equal to –24° and +24° with the circumferential direction, the cables of the protective ply (51) closest to the carcass reinforcement being crossed with the cables of the working ply (33) farthest from said carcass reinforcement. The axial width L_{51} of the ply (51) is very much greater than the width L_{33} of the widest working ply, and its end is axially to the outside of the axially

outer end of the half-ply (34), such that said protective ply (51) axially covers all the working plies and inserted half-plies. The width L_{52} of the second protective ply is substantially equal to half the total of the widths L_{32} and L_{33} of the two widest working plies.

Figure 3 shows a variant of a crown reinforcement comprising two half-plies (34) respectively located between the working plies (31) and (32) and between the working plies (32) and (33), said working plies (31, 32, 33) being in all points identical to the plies described above. The same applies for the first half-ply (34) relative to the half-ply of Figure 2. As for the second half-ply (34), between the working plies (32) and (33), it is formed of cables identical to those of the first half-ply which form an angle ß of 33° with the circumferential direction, but are crossed with the cables of the first half-ply (34). As for its axial width, it obeys the principles set forth above, taking the precaution, as is known *per se*, of not having two ends of a ply in the same parallel plane.

CLAIMS

1. A tyre for heavy machinery, comprising at least one radial carcass reinforcement (1) anchored within each bead to at least one bead wire, forming an upturn, said reinforcement (1) being surmounted radially to the outside by a crown reinforcement (3) formed of at least three so-called working plies (31, 32, 33) formed of inextensible metal reinforcement elements, which are parallel to each other within each ply and are crossed from one ply (31, 32) to the next (32, 33), forming angles α, α_1, α_2 of between 15° and 35° with the circumferential direction, characterised in that at least one half-ply (34), formed of inextensible metal reinforcement elements and of width L', on either side of the equatorial plane XX', is arranged radially between the edges of at least two radially adjacent working plies (31, 32; 32, 33), the axially outer and inner ends of said half-ply (34) being located, respectively axially to the outside of the end of the widest working ply and axially to the inside of the end of the least wide working ply, at distances at least equal to the amount L'/5, the reinforcement elements of said half-ply (34) forming with the circumferential direction an angle ß, which is firstly greater in absolute value than 25°, and secondly is greater in absolute value than the largest angle formed by the elements of the two working plies by a quantity of between 5° and 15°.

2. A tyre according to Claim 1, characterised in that a half-ply (34) is arranged between the two working plies (31, 32) closest to the carcass reinforcement (1).

3. A tyre according to one of Claims 1 or 2, characterised in that the reinforcement elements of each half-ply (34) are crossed with the reinforcement elements of the working ply (31, 32) radially to the inside of said half-ply (34) and closest radially to the carcass reinforcement (1).

4. A tyre according to Claim 3, characterised in that the widths of the working plies (31, 32, 33) of the crown reinforcement (3) are such that the ply (31, 32) radially to the inside of each half-ply (34) is less wide than the ply (32, 33) radially to the outside of said half-ply (34).

5. A tyre according to Claim 4, characterised in that in the case of the presence, on either side of the equatorial plane XX', of two half-plies (34) arranged between the edges of two radially adjacent working plies (31, 32; 32, 33) of the working reinforcement of three plies (31, 32, 33), the second half-ply (34) is formed of the same metal reinforcement elements as those of the first half-ply (34), said elements of the second half-ply being crossed with the elements of said first half-ply.

6. A tyre according to one of Claims 1 to 5, characterised in that the working reinforcement (31, 32, 33, 34) is surmounted radially by a protective reinforcement (5) composed of two plies (51, 52) of elastic metal reinforcement elements, one of said protective plies (51, 52) having an axial width (L_{51}, L_{52}) greater than the greatest axial width of the working plies.

7. A tyre according to Claim 6, characterised in that the ply (51, 52) having an axial width (L_{51}, L_{52}) greater than the greatest axial width of the working plies is the radially inner protective ply (51), whereas the width of the second protective ply (52) has a width L_{52} which lies between the greatest two widths of the working plies.

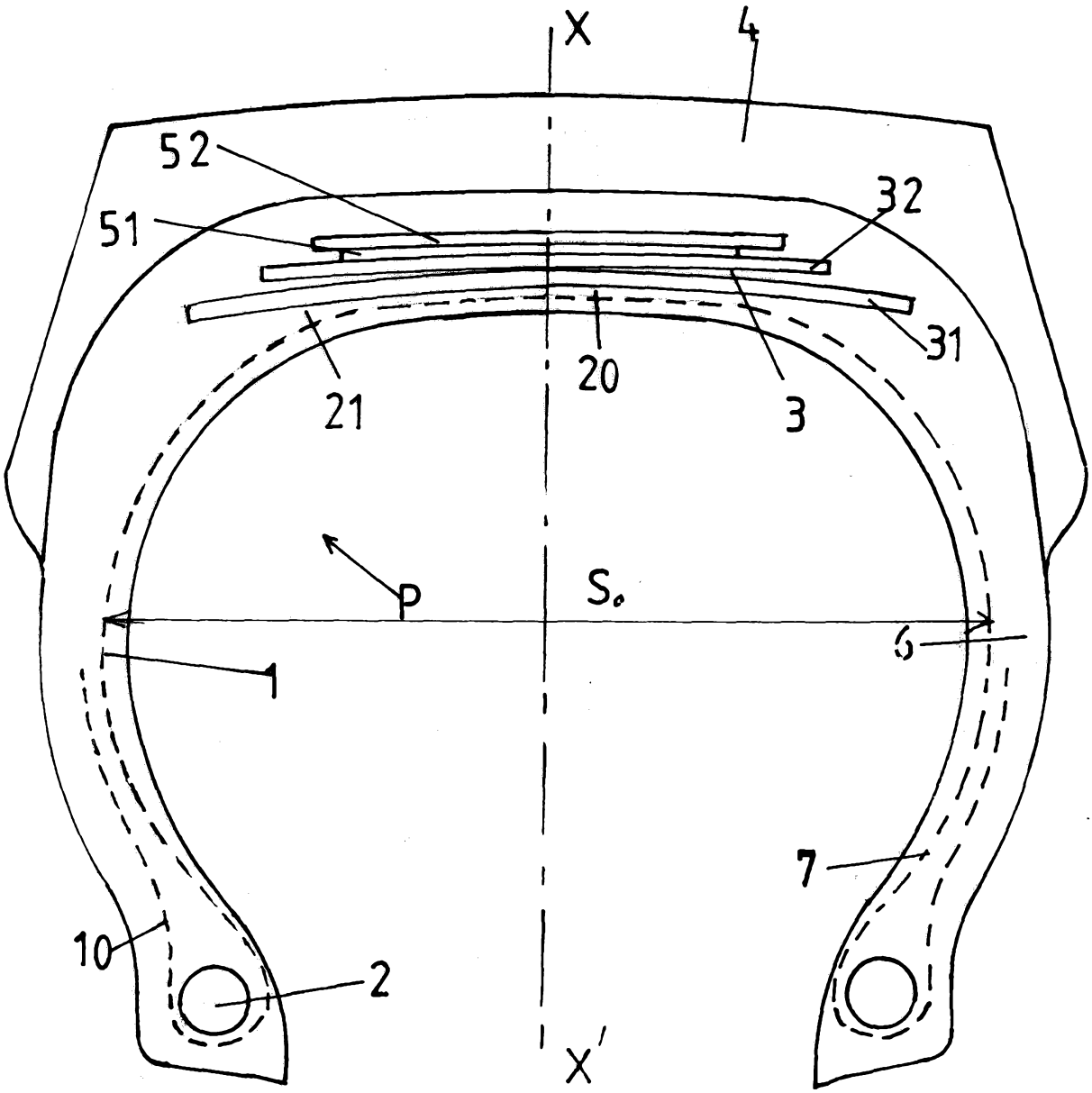


FIG 1

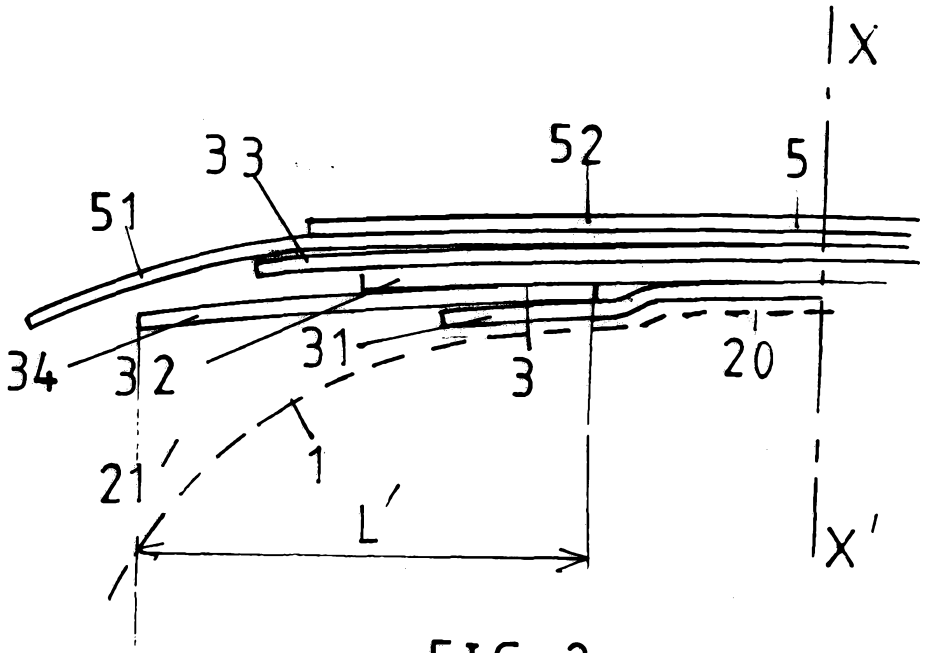


FIG 2

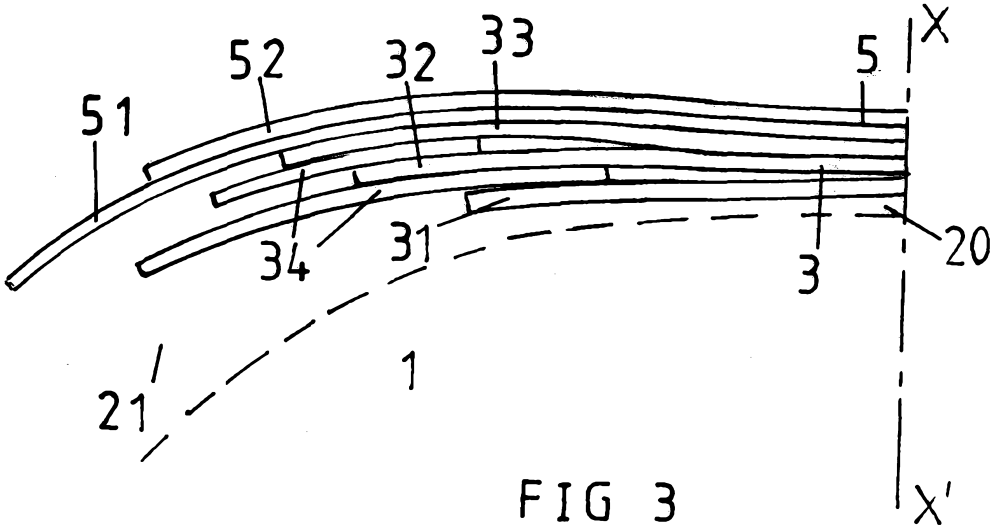


FIG 3