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(19)

(54) IMPROVEMENTS IN PNEUMATIC TYRE MANUFACTURE

(71) We, DUNLOP LIMITED, a British Company of Dunlop House, Ryder Street, St. James's, London, S.W.1., 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:

The present invention relates to an improved method, and an improved mould, for the manufacture of pneumatic tyres and more particularly to an improved tyre bead retaining ring for the mould of a tyre forming press and method of using the same.

In the manufacture of pneumatic tyres it is usual to surround the bead reinforcement with a surplus of uncured rubber such that the bead diameter in the green tyre (by which is meant the uncured tyre carcass) is slightly smaller than the bead diameter of the finished tyre. The mould of the tyre forming press utilising an inflatable diaphragm to shape the tyre includes a fixed lower part and an upper part which moves vertically relative to the lower part as the press is closed or opened. Each part of the mould includes a bead ring in the form of an annular flange projecting towards the other part of the mould and each of these rings seats a respective one of the beads of the tyre during the moulding process.

In the majority of moulds in current use each bead retaining ring has been of fixed dimensions, the diameter of the ring being equal to the diameter of the bead of the finished tyre. It will thus be seen that when the tyre is in the green state its beads are of slightly smaller diameter than the bead retaining rings of the mould and have to be force fitted therover during mould closure. There is a danger that in so doing the rubber of the tyre at the bead and the ply cords or wires which extend tangentially from opposite sides of the bead reinforcement radially through the tyre walls may be displaced relative to the bead reinforcement or core. This in turn may cause localised alteration of the shape of the tyre in cross-section so that even though the beads may remain circular the tread may become non-circular under inflatuion pressure. there is also a danger that by being improperly located prior to being forced over the associated ring a bead will be deformed and in the finished tyre the cured rubber layer covering the bead reinvorcement will be unequally distributed around the bead with the result that the bead will be unsymmetrical.

There are prior art proposals for varying the diameter of a bead support ring in a mould, but the variation has been effected mechanically. An object of the invention is to automate the ring-diameter variation function and make it responsive to the application of curing pressure to the interior of the mould, so that the desired variations of ring diameter occur reliably and automatically as a result of operation of the mould.

It will be clear that herein and in the appended claims references to the support ring and its diameter are to the annular seating surface which contacts the radially inner periphery of a tyre bead rather than to any flange projecting therefrom alongside the bead formation.

In accordance with one aspect of the present invention there is provided in a method of manufacturing a pneumatic tyre in a mould by opening the mould, placing at least one of the beads of a green tyre over a support ring, closing the mould, forcing the green tyre into close contact with the mould and heating the green tyre to cure it, the improvement comprising reducing initially the diameter of said at least one support ring by application of a biasing force so as to facilitate tyre bead placement thereover, locating said bead over the ring, and expanding the ring to a predetermined rela-

tively enlarged diameter by overcoming the biasing force with curing pressure within the tyre.

The expansion of the ring is preferably simultaneous with the application of curing pressure to the tyre in the closed mould.

The method preferably includes inflating a diaphragm within the green tyre to apply said curing pressure, the diaphragm being secured to means which cam against movable portion of said ring.

In accordance with another aspect of the present invention there is provided a mould for the manufacture of a pneumatic tyre having a support ring for a bead of the tyre which ring is variable in dimensions between a fully expanded condition in which the outer periphery of the ring is substantially uninterrupted and is of diameter substantially equal to the diameter of the bead of the finished tyre and a retracted condition in which the dimensions of the ring are reduced sufficiently to permit the unobstructed mounting thereover of the bead of the green tyre and means to bias the ring to its retracted condition and to be overcome by curing pressure in operation of the mould whereby the ring adopts is expanded condition automatically upon application of curing pressure within the mould and automatically resumes its retracted condition when curing pressure is relieved.

Preferably the ring is formed of segments having radially inwardly tapering rear surfaces and radially outwardly tapering wedge elements interposed between adjacent pairs of segments and slidably engaging said inwardly tapering rear surfaces, the segments and wedge elements all have arcuate radially outer surface which lie on a common circle when the ring is fully expanded radially inward movement of the wedge elements permitting a closer grouping of the segments as they move radially inwardly to reduce the area of the ring in its retracted condition.

Preferred embodiments of the invention will now be described with reference to the accompanying drawings, in which :-

Figure 1 is a plan view of a retractable bead retaining ring in accordance with the present invention.

Figure 2 and *3* are radial sectional elevations of a tyre forming mould having bead retaining rings in accordance with the invention, each being taken in the line III-III of Figure 1 and showing the ring of Figure 1 respectively in the retracted and the expanded condition, and

Figures 3A and *3B* are detail views taken on the lines A-A and B-B, respectively, Figure 3.

Referring first to Figure 2 and 3, the tyre forming mould illustrated comprises, as is well known per se, a lower, part 10 and an upper part 11 which is displaced vertically relative to the lower part 10 as the tyre forming press, in which the mould is incorporated, is opened and closed. Prior to the closure of the mould a green tyre, or tyre carcass 12 of uncured rubber is located between the parts 10 and 11 of the mould and as the part 11 of the mould is brought down towards the part 10 a diaphragm 13 is expanded within the toroidal carcass 12 by inflation. Opposite axia, ends 14 and 15 of the diaphragm 13 are clamped between elements 26, 29 and 28, 30 respectively, movable with the mould parts 10 and 11. Prior to closure of the mould part 11 relative to the mould part 10 air pressure within the diaphragm 13 is increased (shaping pressure) so that the following closure of the mould the outer surface of the green tyre 12 is brought into close contact with the mould parts 10 and 11 and with a tread forming pattern (not shown) positioned against the radially outer periphery of the green tyre 12. Thereafter, with the mould closed, pressure within the diaphragm 13 is greatly increased (moulding pressure) and water at hih temperature is caused to flow within the diaphragm 13 to cause the rubber of the green tyre 12 to cure. After sufficient time has elapsed with the mould closed for the green tyre 12 to be fully cured moulding pressure within the diaphragm 13 is relieved and the mould part 11 is raised relative to the part 10. the diaphragm 13 is subsequently withdrawn from the interior of the finished tyre as the upper clamping elements 26, 29 are raised on a piston rod 27. The tyre is now removed from the press. The tyre forming operation thus far described in conventional and no more detailed explanation is considered necessary since the process has been in use for many years and is familiar to those skilled in the art.

As is also well know *per se* the bead formations 16 and 17 of the green tyre 12 are located in the mould to surround and seat on respective bead support rings 18 and 19 respectively of the upper and lower parts of the mould. However, in accordance with the present invention these bead support rings 18 and 19 are not fixed. Annular flanges extend from one mould part towards the other, but each is made up of a plurality of segments 20 amd wedges 21 Figure 1) each capable of limited radial movement with respect to the associated part 10 or 11 of the mould. The bead retaining rings 18 and 19 of the two mould parts are of similar construction and each comprises a plurality of segments 20 having radially inwardly tapering rear surfaces 22. These are in sliding engagement with radially outwardly tapering surfaces 23 of wedges 21 each interposed between an adjacent pair of the segments 20. All of the segments 20 and

wedges 21 of each bead support ring 18 and 19 have arcuate radially outer surfaces 24 and 25 which, in the fully expanded condition of the ring 18 or 19, lie on a common circle which is of diameter substantially equal to the predetermined bead diameter of the finished tyre.

Each of the segments 20 and wedges 21 making up each bead support ring 18 and 19 is guided by a key and key-way for radial movement so that radially inward movement of the wedges 21 permits radially inward movement of the segments 20 resulting in a closer grouping of the elements of ech bead support ring such that its total area is reduced. The key 42 fixed by bolts 39 to the upper press part 11 is shown in cross-section in Figure 3A, this running in a keyway 43 extending radially of an upper mould part wedge 21. Keys 142 are also fixed to the undersides of the segments 20 and wedges 21 of the lower mould part and run in radial keyways 143 in the lower mould part.

As is conventional, the upper axial end 14 of the diaphragm 13 is supported by a member 26 or a piston rod 27 of the press so as to be vertically dicplaceable. In accordance with the present invention, the lower axial end 15 of the diaphragm 13 is supported by an element 28 which surrounds the piston rod 27 and is vertically displaceable. Secured to the element 26 is a clamping plate 29 which anchors the end 14 of the diaphragm to the element 26. A similar clamping plate 30 is associated with the elements 28 to grip the other end 15 of the diaphragm 13 and in accordance with the present invention the clamping plates 29 and 30 have radially outwardly tapering radially outer peripheral cam surfaces 31 and 32 which slidably engage cam surfaces 33 of the wedges 21 which taper axially inwardly of the mlould. Co-operation of the cam surfaces 31, 32 and 33 ensures that as the diaphragm support elements 26 and 28 are moved apart from the position of Figures 2 to the position of Figure 3 the wedges 21 are displaced radially outwardly of the mould, causing radially outward displacement of the segments 20 until the radially outer surfaces of all of the wedges and segments lie on a common circle (Figure 3) whereupon further radially outward movement of the wedges 21 and segments 20 is prevented by their abutment with fixed fruso-conical surfaces 34 and 35 of the mould. Such radially outward displacement of the segments 20 and wedges 21 of the bead rings 18 and 19 is resisted by strong compression springs 60, 61 located in respective radially extending bores in the segments 20 and wedges 21. Bolts such as 36 and 37 have their ends screw threaded into the mould parts 10 and 11 and the aforesaid compression springs 60, 61 surround the respective bolts and are held in compression either between the head of the bolt and a recess in the wedge element 21 (spring 61, lower part of Figure 2 or 3) or between the associated mould part and the end of a blind bore in the wedge element 21)spring 60, upper part of Figure 2 or 3). The settings of the compression springs 60, 61 are strong enough to ensure that they will not yield to the relatively light air pressure applied to the interior of the diaphragm 13 when the mould is first closed (Figure 2) but such that when pressure within the diaphragm is subsequently increased during curing of the tyre 12 the springs 60, 61 will yield to allow the ring segments 20 and wedges 21 to move radially outwardly to the fully expanded position shown in Figure 3 under the cam action applied to them by the clamping plates 29 and 30 of the diaphragm 13 as the diaphragm supports 26 and 28 move apart under the influence of moulding pressure. When moulding pressure is subsequently relieved the ring wedges 21 and segments 20 are moved back to the retracted position shown in Figure 2 by the springs 60, 61 thereby displacing the diaphragm supports 26 and 28 towards one another to the position shown in Figure 2. The lower bead ring 19 and associated diaphragm support elements 28 are assembled with a component 50 as a lower mould-part sub-assembly screw threaded onto the lower press pat 51 at 38. Upstanding from the lower diaphragm support element 28 is a tubular projection 28A which surrounds a tubular extensions 50A of the component 50. The projection 28A is slidable on the extension 50A and a pressure seal is provided at 52 to prevent loss of pressure from the diaphragm between the projection 28A and extension 50A. Water at high temperature for curing a tyre in the closed mould is introduced at 40 and flows upwardly between the piston rod 27 and extension 50A to discharge into the interior of the diaphragm 13 through ports 41 and 53 in the extension 50A and projection 28A. The outflow path for the water (not shown) is on the diametrically opposite side of the piston rod 27.

WHAT WE CLAIM IS:-

1. In a method of manufacturing a pneumatic tyre in a mould by opening the mould, placing at least one of the beads of a green tyre over a support ring, closing the mould, forcing the green tyre into close contact with the mould and heating the green tyre to cure it, the improvement comprising reducing initially the diameter of said at least one support ring by application of a biasing force so as to facilitate tyre bead placement thereover, locating said bead over the ring, and expanding the ring to a predetermined relatively enlarged diameter

by overcoming the biasing force with curing pressure within the tyre.

2. The method of claim 1, wherein the expansion of the ring is simultaneous with the application of curing pressure to the tyre in the closed mould.

3. The method of claim 1 or claim 2, including inflating a diaphragm within the green tyre to apply said curing pressure, the diaphragm being secured to means which cam against movable portions of said ring.

4. A mould for the manufacture of a pneumatic tyre having a bead diameter which, in the green state of the tyre, is slightly smaller than that of the finished tyre, the mould having a support ring for a bead of the tyre which ring is variable in dimensions between a fully expanded condition in which the outer periphery of the ring is substantially uninterrupted and is of diameter substantially equal to the diameter of the bead of the finishd tyre and a retracted condition in which the dimensions of the ring are reduced sufficiently to permit the unobstructed mounting thereover of the bead of the green tyre and means to bias the ring to its retracted condition and to be overcome by curing pressure in operation of the mould whereby the ring adopts its expanded condition automatically upon application of curing pressure within the mould and automatically resumes its retracted condition when curing pressure is relieved.

5. A mould as claimed in claim 4 wherein the ring is formed of segments having radially inwardly tapering rear surfaces and radially outwardly tapering wedge elements interposed between adjacent paris of segments and slidably engaging said inwardly tapering rear surfaces, the segments and wedge elements all having arcuate radially outer surfaces which lie on a common circle when the ring is fully expanded, radially inward movement of the wedge elements permitting a closer grouping of the segments as they move radially inwardly to reduce the area of the ring in its retracted condition.

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

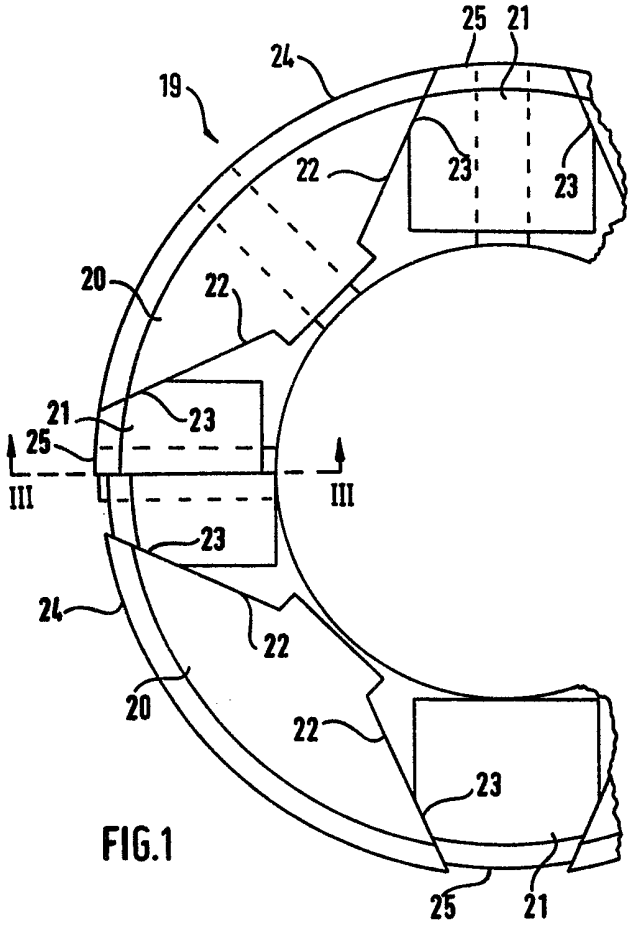

FIG.1

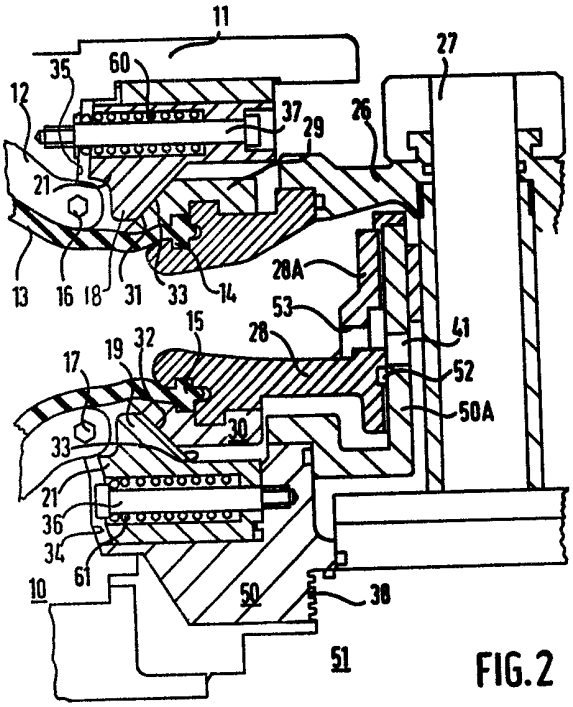
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FIG.2

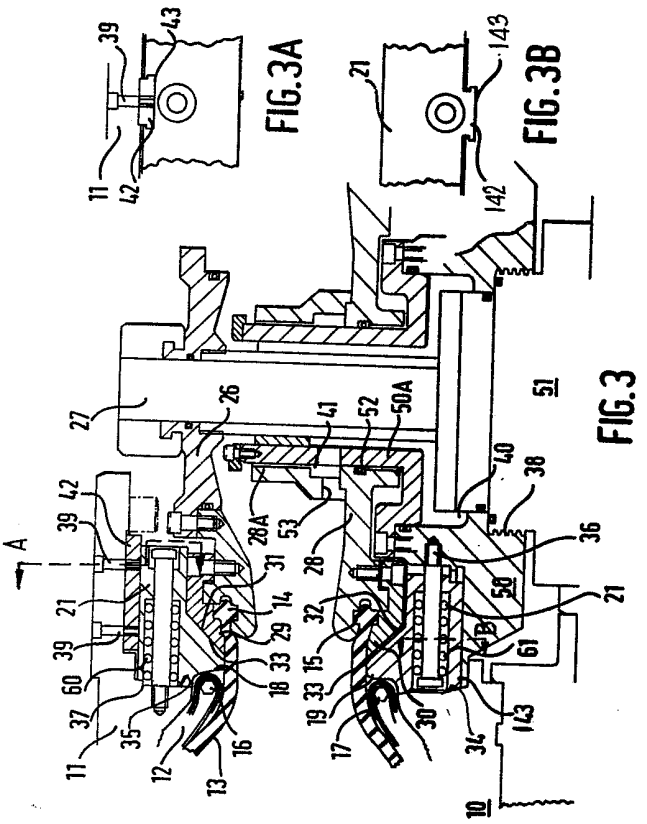
FIG.3A
FIG.3B
FIG.3
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