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(71) Applicant
Holroyd Associates Limited

(Incorporated in the United Kingdom)

Hindley Business Centre, Platt Lane, Hindley, Wigan, Lancashire, WN2 3PA, United Kingdom

(72) Inventors
Eric Holroyd
Colin Holroyd

(74) Agent and/or Address for Service
Dearing Lambert & Co
PO Box 8, 107-109 High Street, Ibstock, Leicester, LE6 1LJ, United Kingdom

(54) Pneumatic tyre and wheel assembly

(57) In a method for the manufacture of a tyre and wheel assembly the tyre carcass is built on a pair of annular wheel rim portions 10, 11 each having a substantially cylindrical shape at a radially outermost portion (13), Fig 1.

With the wheel rim portions 10, 11 axially spaced apart components 18, 19, 20 of a tyre are applied around the wheel rim portions, which are moved together to facilitate deformation of the component parts to a toroidal shape and tread and breaker components are then applied to result in an integral tyre and wheel assembly. Preferably the wheel rim portions 10, 11 have annular grooves (15), Fig 1, which provide positive safe location of the tyre beads.

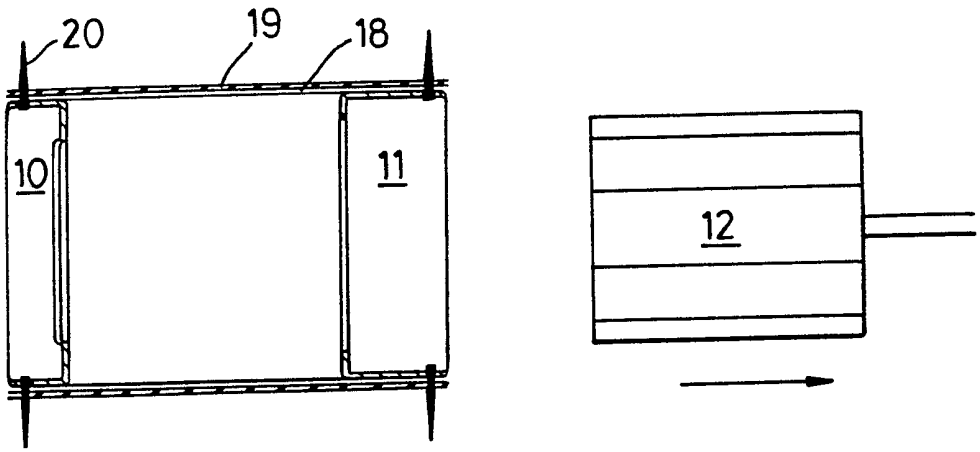

Fig. 5

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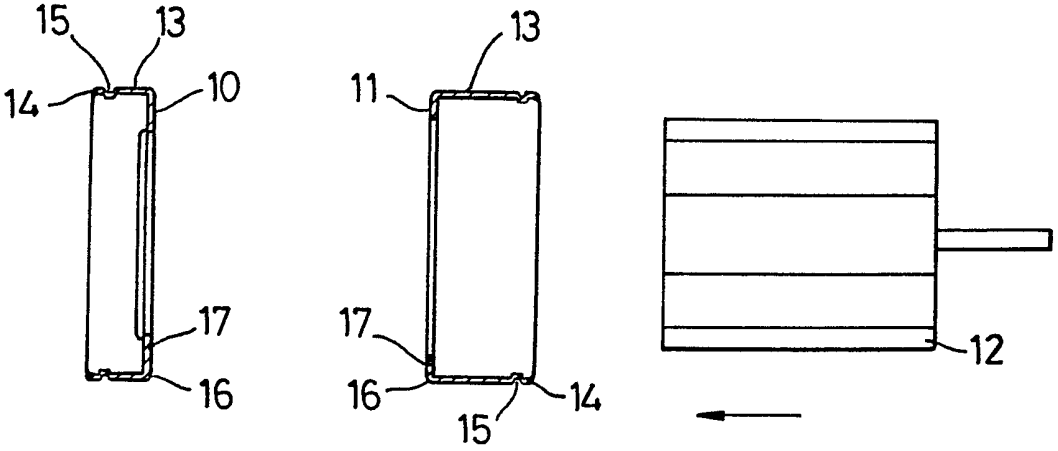

Fig. 1

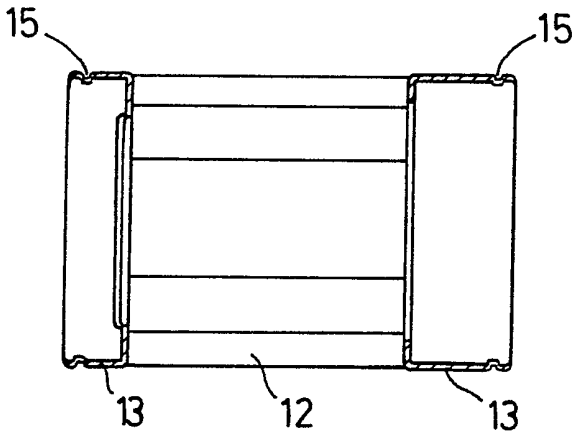

Fig. 2

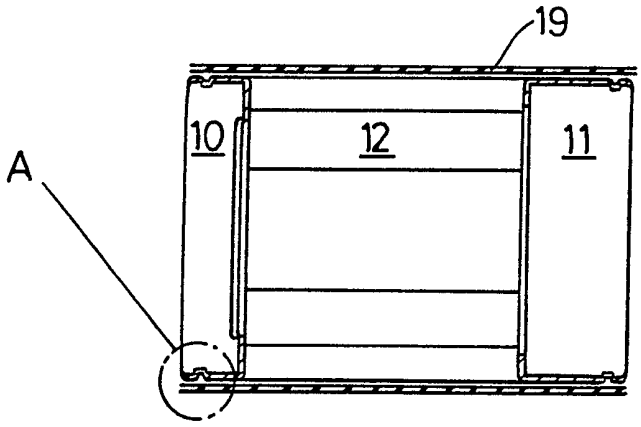

Fig. 3

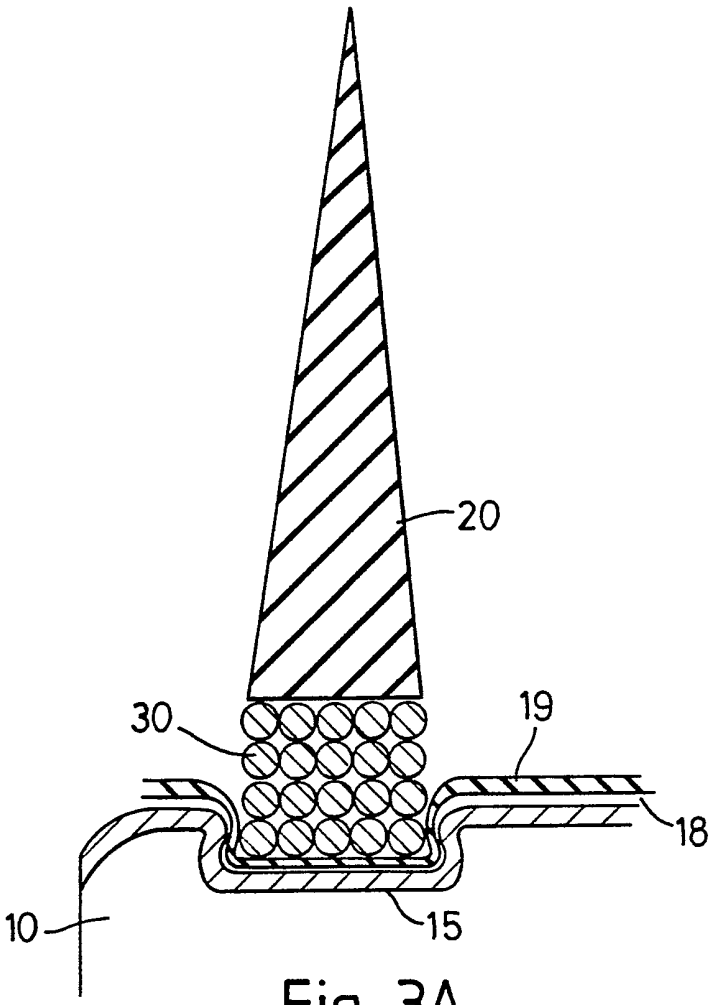

Fig. 3A

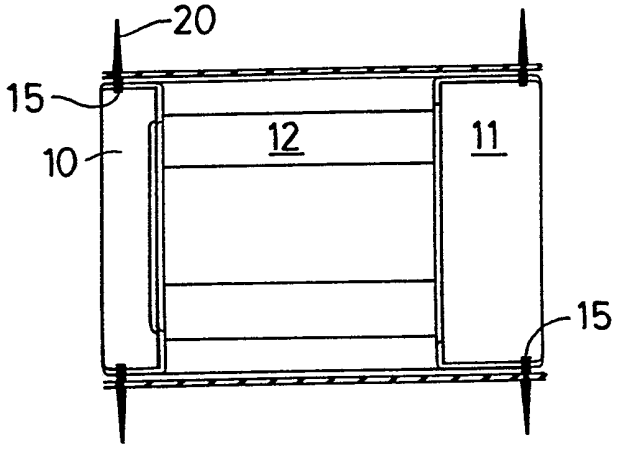

Fig. 4

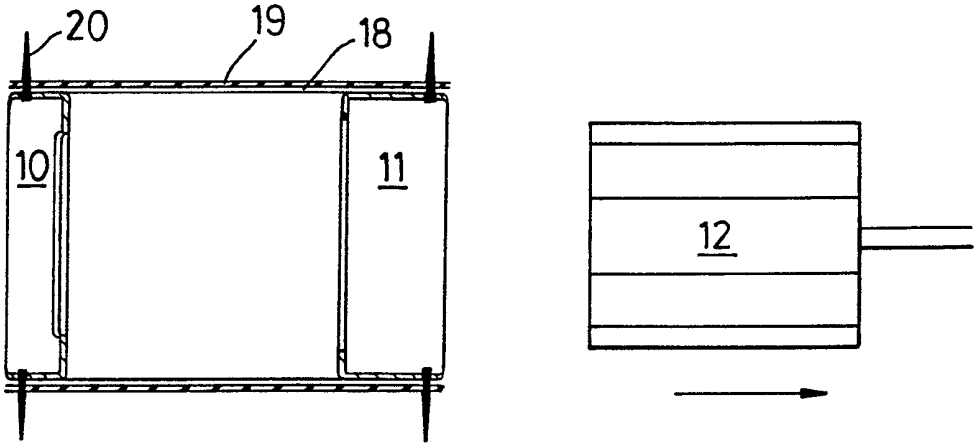

Fig. 5

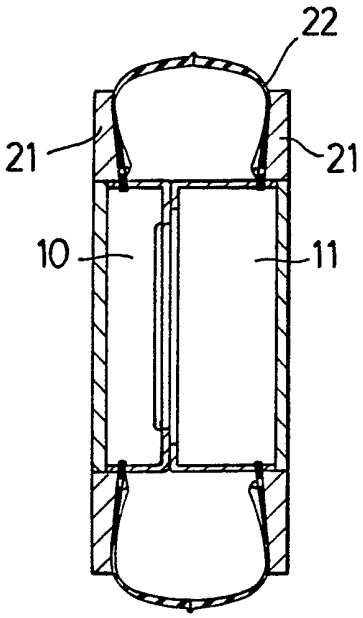

Fig. 6

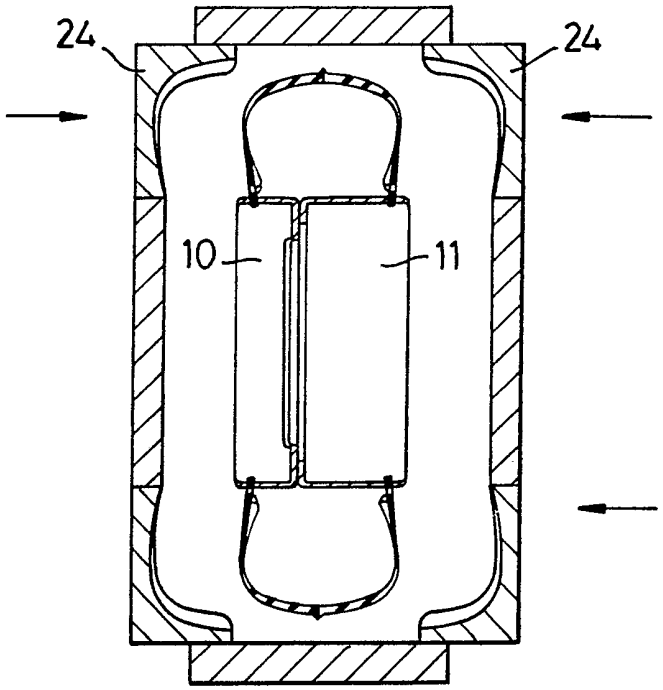

Fig. 7

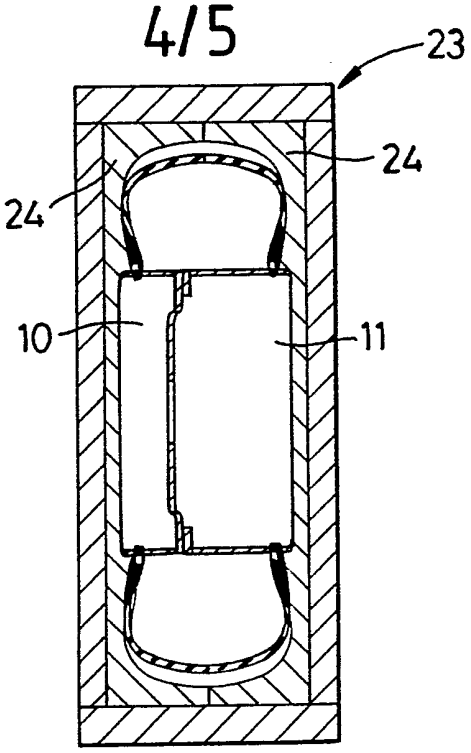

Fig. 8

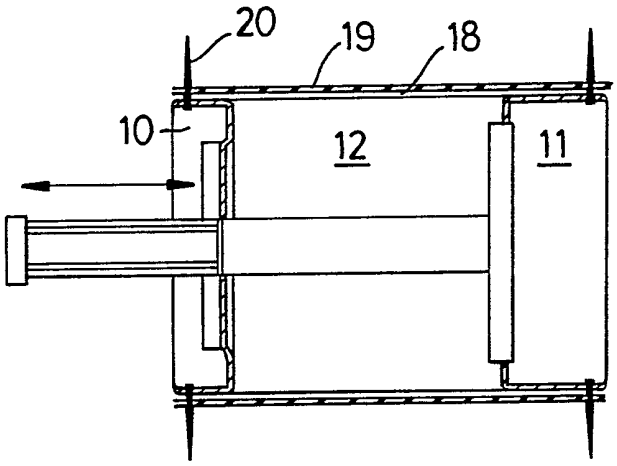

Fig. 10

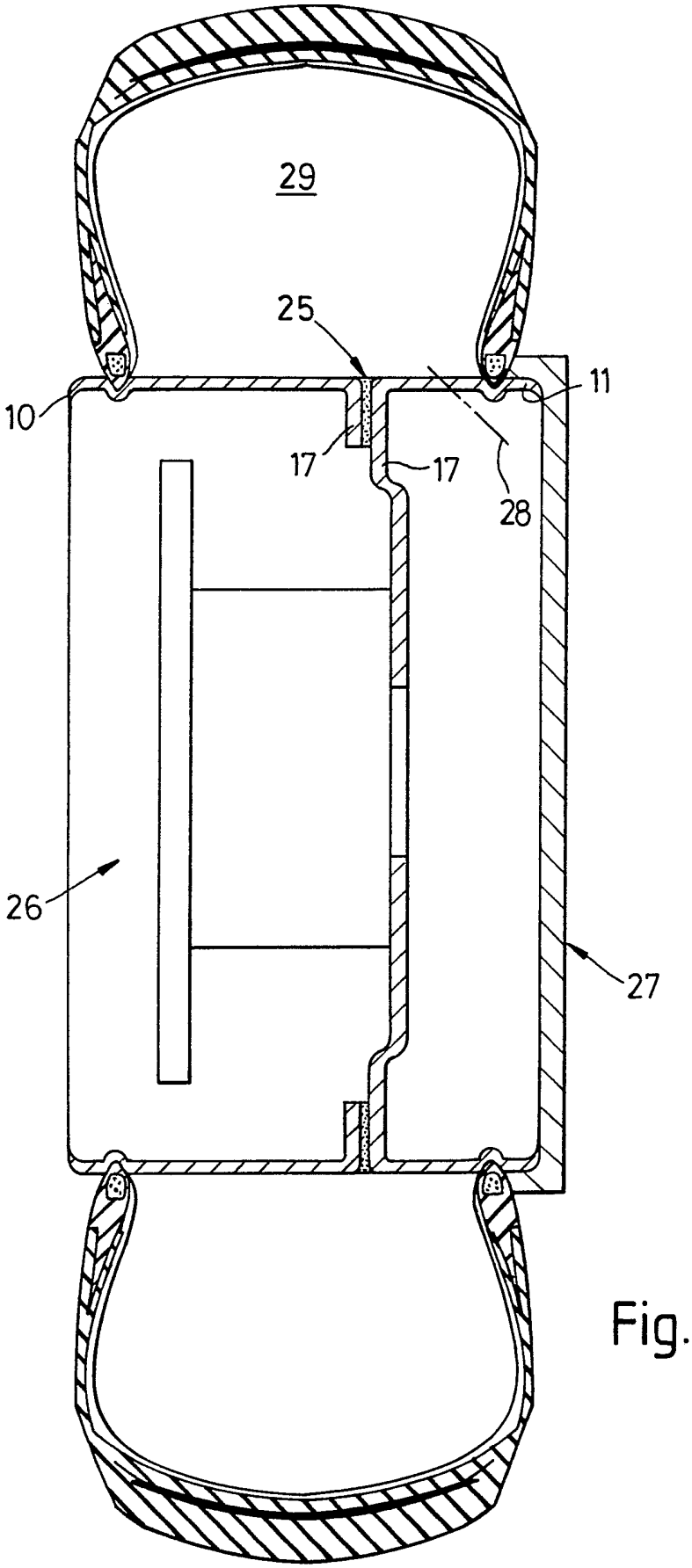

Fig. 9

PNEUMATIC TYRE AND WHEEL ASSEMBLY

This invention relates to manufacture of a pneumatic tyre and wheel assembly and an improved wheel for a tyre and wheel assembly.

Conventionally the construction of a pneumatic tyre involves assembling around a generally cylindrically shaped former a so-called "green cover" comprising layers of vulcanisable rubber, bead wires and layers of reinforcement material. The thus formed green cover is then expanded into association with an outer breaker and tread package. It is then removed from the former and inserted in a mould where it is subjected to heat and pressure to vulcanise the material of the cover, tread and breaker. The resulting tyre is either force-fitted on an integral wheel structure or "clamped" between the two parts of a so-called "split rim". Any irregularities in the tyre or wheel (or the manner in which they are assembled) that give rise to out-of-balance forces are counter-acted by a balancing operation and use of balance weights.

Although these methods have been used extensively for many years they have the defect that when removed from the former and transferred to the mould, and while in the mould, the bead regions of the cover are unsupported and are liable to deformation from the truly round shape. Force-fitting of the tyre subsequent to manufacture is liable to damage it in the bead seat regions especially if the beads are imperfectly round. An imperfectly round bead will not make a good air seal with a bead seat of a split rim. In the past, manufacturing tolerances have been such that minor irregularities or the need for their correction by balancing operations have been acceptable. However modern developments lead to a requirement for a higher quality tyre. Labour-intensive fitting and balancing operations are less and less acceptable and the mounting of tubeless tyres on split rims, often by insufficiently expert personnel, has never been entirely satisfactory.

It is well known that damage and injury resulting from deflation of a tyre while in service can be mitigated if the tyre can be prevented from dismounting from the wheel. A wheel of the "split rim" type offers a solution, but the problem of an adequate air seal when the tyre and wheel are manufactured separately has been insurmountable. In the use of integral wheels, much ingenuity has been expended on techniques for preventing separation of the tyre from the wheel, but all have had to take account of the fact that the tyre and wheel assembly must be such that the

tyre can be initially mounted on the wheel in the first place. In practice this means that the wheel must have a central well in which part of the periphery of an inextensible bead can be located while a diametrically opposite part is forced over a wheel flange, and most prior art "safety wheels" have proposed a "well filler" which is wrapped around the wheel in the well after the tyre has been fitted, thereby preventing either bead of the tyre from re-entering the well so that the tyre can separate from the wheel.

A principal object of the present invention is to manufacture a tyre and wheel as a unitary assembly. This will secure a number of advantages, of which the following are considered important: (a) the green carcass is not dismounted from what it has been built on to locate it in a mould so that potential distortion is avoided. (b) there is no necessity to mount the tyre on the wheel subsequent to manufacture of the tyre. Because no provision is necessary whereby the tyre can be mounted on the wheel subsequent to manufacture of the tyre the wheel need not be designed - e.g. to have a central well - so that a tyre can be mounted on it and in consequence the wheel can be so designed that the tyre cannot be dismounted from the wheel. This permits provision of a wheel of less complex shape and dispenses with devices such as well-fillers to prevent dismounting of the tyre in service.

In accordance with one aspect of the present invention there is provided a method for the manufacture of a pneumatic tyre which comprises applying components of a tyre to a support structure which comprises a plurality of axially separated wheel rim portions having respective, cylindrical bead seat regions whereby respective bead formations of the tyre overlie the bead seat regions, bringing said wheel rim portions axially together in an operation in which the assembled components of the tyre are expanded and shaped to a generally toroidal form, locating the expanded and shaped tyre in a mould while said bead formations remain mounted on said wheel rim portions and subjecting the tyre to heat and pressure in the mould.

The said building mandrel preferably provides, when in a radially expanded condition between the rim portions, a substantially cylindrically shaped surface for the support of intervening portions of the component parts applied around the annular rim portions. In this arrangement upon completion of application of tyre components around the rim portions and the building mandrel, the building mandrel is contracted radially inwards

to allow the annular rim portions to be moved axially towards one another.

Each said rim portion is preferably provided with a tyre bead location groove in which a respective tyre bead is located whereby the tyre components may be so applied to the rim portions that they are secured against subsequent axial movement relative to said rim portions.

The or each annular rim portion may be subjected to a balancing operation before component parts of a pneumatic tyre are applied thereto.

The expanded and shaped tyre components may be subjected to heat and pressure in a mould which is pre-provided with the external components of the tyre (i.e. those not included in the flat build).

In the method of the invention it is envisaged that when the component parts of a tyre have been assembled in a substantially cylindrical form and expanded and shaped to bring them into association with a breaker package, temporary support means shall be provided to support said component parts and in particular portions thereof which will lie in sidewall regions of the finished tyre. The method may further comprise removing said temporary support means after the operation of shaping and assembly to a breaker package. With the tyre structure so formed still supported on the wheel portions the method may further provide that mould parts are positioned around the tyre structure for a subsequent process of pressurisation and heating to cure vulcanisable components of the tyre. The mould parts for supporting sidewall portions of the tyre structure when inflated may be pre-provided with additional pre-formed sidewall components and chafers. A mould part for supporting the breaker passage may be pre-provided with a tread package.

The invention further teaches that temporary wheel support means may be provided during pressurisation and cure. There is thereby avoided any need to provide the wheel structure with a strength for withstanding vulcanisation which is greater than that which it needs to possess during normal in-service use of the resulting tyre and wheel assembly.

The method of the invention may further comprise subjecting annular rim portion to a static or dynamic balancing operation before component parts of a pneumatic tyre are applied thereto.

The present invention further provides a wheel structure for use in a tyre and wheel assembly comprising a radially outwardly facing rim surface of a substantially cylindrical form, said rim surface being provided with tyre bead location means for restraint of relative movement between said wheel structure and immediately adjacent parts of a tyre when assembled

therewith, said rim surface being the radially innermost cylindrical surface of the wheel.

In a preferred form of the wheel structure said rim surface is not bounded at either axial end by a radially outwardly extending flange.

Said tyre bead location means may be an annular groove. The groove may have a dove-tail cross-sectional shape as considered in a longitudinal plane containing the (major) axis of the rim surface.

The wheel structure may comprise a a pair of annular rim portions provided with means (such as respective disc portions) whereby the two rim portions may be secured together to form an assembled wheel. Sealing means such as a sealing compound or a sealing member (e.g. a gasket) may be provided between the two rim portions to facilitate provision of an airtight tyre and wheel assembly. One of the rim portions or other portions of the wheel structure may be provided with an opening for location of an air inflation valve of a kind known per se and arranged to facilitate maintenance of a desired inflation pressure within the tyre throughout its useful working life.

Embodiments of the present invention will now be described, by way of example only, with reference to the accompanying diagrammatic drawings, in which:

Figures 1 to 9 are each longitudinal cross-sectional views in planes containing the major axis of a wheel structure and show sequential stages in the manufacture of a pneumatic tyre and wheel assembly,

Figure 3A is a detail on an enlarged scale of the encircled area marked "A" in Figure 3, and

Figure 10 shows in more detail apparatus of the kind shown in Figures 4 and 5.

In the initial stages of manufacture of a pneumatic tyre component parts of the tyre are wound onto a support structure which comprises two axially spaced-apart annular wheel portions 10, 11 and an expandable and contractible building mandrel 12 between the wheel portions (see Figure 1).

The two wheel portions 10, 11 are of construction combinable to form a wheel and each has a radially outermost portion 13 in the form of a substantially cylindrically-shaped rim surface. Near to one, outer axial extremity 14 each wheel rim surface 13 is provided with an annular groove 15 of square or dove-tail cross-sectional shape (see Figure 3A), the groove being intended to provide location for at least some of the bead

wires of a tyre bead portion.

Each wheel portion 10, 11 has at its other, inner axial extremity 16 a radially inwardly extending and integrally formed annular disc portion 17. The two disc portions of the wheel portions are provided with bolt holes to facilitate eventual joining together of the disc portions.

For the initial stages of manufacture of a tyre the two wheel portions 10, 11 are each dynamically balanced. Then they are axially spaced apart, as shown in Figure 1, and the building mandrel 12 is advanced axially in a collapsed condition through one of the disc portions to lie between that and the other disc portion. The mandrel is then expanded to a fully expanded condition (see Figure 2) in which it provides between the wheel rim surfaces 13 an intervening substantially smooth and cylindrical building surface of the same diameter as the rim surfaces 13.

A rubber liner 18 and rubberised ply reinforcement layer 19 are then wound around the rim surface and expanded mandrel (see Figure 3). This is then followed by bead 30 and apex 20 application stages (see Figure 4) with the bead regions being aligned with the respective annular bead grooves 15 and secured relative thereto.

Figure 3A illustrates most clearly a preferred method of constructing each bead 30. Each rim portion (the rim portion 10 is illustrated) is formed with dove-tail shaped bead groove 15. The bead 30 is constructed by winding wire into the groove 15 (the wire carrying the layers 18 and 19 into the bottom of the groove) until successive layers form a bead "package" of the desired dimensions. The bead 30, and the ply layers under it, are thus locked to the rim portion 10. A bead filler or apex 20 is then wound around each completed bead 30.

In an alternative method of construction (not illustrated) of each bead 30 some of the turns of wire forming each bead 30 are first wound only over the liner 18, carrying it into the respective groove 15, and thereafter the ply 19 is wrapped around each semi-completed bead 30 before winding the remainer of the wire over the ply 19.

At this stage of build up of the tyre, the so-called green cover stage, the building mandrel is collapsed radially inwardly and then retracted out through one of the wheel rim discs (see Figure 5).

A pair of annular sidewall supports 21, are then provided adjacent axially outwardly facing surfaces of the bead apexes 20 and the two wheel portions 10, 11 are then moved towards one another (see Figure 6) during a shaping and expansion operation in which the tyre cover 22 is deformed to

a substantially toroidal shape under influence of the supports 21 and movement of the wheel portions. Deformation may be assisted by introduction of pressurised gas to within the cover.

Subsequently the supports 21 are retracted and a multi-part mould 23 is assembled around the expanded tyre cover (see Figure 7). The mould 23 comprises two sidewall and tread halves 24 and each is pre-provided with preformed tread, sub-tread and sidewall components of a conventional vulcanisable rubber. On assembly and closure of the mould (see Figure 8) these components inherently tend to adhere to the green tyre cover 22. Internal support (not shown) optionally may be provided within the wheel portions, and heat and pressure is then applied to effect cure of the vulcanisable rubber, typically at a temperature in the order of 150°C for a period in the range 10 to 15 minutes. Conveniently pressurisation is achieved by introducing pressurised nitrogen through a valve hole 28 in one of the wheel rim portions.

Following cure the mould is removed from the resulting tyre and wheel assembly and a seal 25 is then introduced between the wheel discs 17. In this example (see figure 9) the seal is in the form of a rubber gasket but alternative means such as an 'O' ring or a band of elastomeric sealant may be introduced to result in an air-tight seal between the wheel portions when the discs are bolted together.

A wheel hub plate 26 and trim 27 are then applied and the air chamber 29 within the tyre is pressurised to the desired tyre inflation pressure via a conventional valve located in the valve hole 28. Figure 10 shows an arrangement of lead screws and a headstock suitable for controlling axial movement of the wheel rims 10,11 and the mandrel 12.

In the resulting tyre and wheel assembly the tyre bead regions positively locate in the annular grooves so that even in the event of loss of pressurisation there is no significant risk of the tyre separating from the wheel and a dangerous condition arising. Furthermore the method of construction results in a good quality air seal between the tyre bead regions and the wheel.

It has been described that the wheel portions are balanced before construction of the tyre and wheel assembly. In consequence it is only any out-of-balance due to the tyre alone which needs to be counteracted in order to provide a well-balanced tyre and wheel assembly.

In the illustrated embodiment the wheel rim portions 10,11 have no radially outwardly extending flanges such as are conventionally provided

to prevent the tyre beads moving off the axial ends of the wheel because such flanges are rendered unnecessary by locking the bead regions of the tyre in the grooves 15. Similarly the wheel illustrated has no tyre mounting well. However it will be understood that the method of the invention may be carried out using the two rim portions of a conventional split-rim wheel having such flanges if desired.

CLAIMS:

1. A method for the manufacture of a pneumatic tyre which comprises applying components of a tyre to a support structure which comprises a plurality of axially separated wheel rim portions having respective, cylindrical bead seat regions whereby respective bead formations of the tyre overlie the bead seat regions, bringing said wheel rim portions axially together in an operation in which the assembled components of the tyre are expanded and shaped to a generally toroidal form, locating the expanded and shaped tyre in a mould while said bead formations remain mounted on said wheel rim portions and subjecting the tyre to heat and pressure in the mould.

2. A method as claimed in claim 1, wherein said structure further comprises a radially expandable and contractible building mandrel arranged to lie, when in a radially expanded condition, between said rim portions.

3. A method as claimed in claim 2, wherein said building mandrel provides, when in a radially expanded condition between the rim portions, a substantially cylindrically shaped surface for the support of intervening portions of the component parts applied around the annular rim portions.

4. A method as claimed in claim 2 or claim 3, wherein upon completion of application of tyre components around the rim portions and the building mandrel, the building mandrel is contracted radially inwards to allow the annular rim portions to be moved axially towards one another,

5. A method as claimed in any one of the preceding claims, wherein each said rim portion is provided with a tyre bead location groove in which a respective tyre bead is located whereby the tyre components may be so applied to the rim portions that they are secured against subsequent axial movement relative to said rim portions.

6. A method as claimed in any one of the preceding claims, wherein the or each annular rim portion is subjected to a balancing operation before component parts of a pneumatic tyre are applied thereto.

7. A method as claimed in any one of the preceding claims wherein temporary support means is provided to prevent damage to the wheel rim portions when supporting tyre components during pressurisation and cure,

8. A method as claimed in any one of the preceding claims wherein subsequent to assembly of components of a pneumatic tyre around the wheel rim portions those components are surrounded by temporary support means for support of at least sidewall portions of the tyre as the component parts are expanded and shaped.

9. A method as claimed in claim 8, wherein the temporary support means are removed after shaping and assembly to a breaker package.

10. A method as claimed in any one of the preceding claims wherein the expanded and shaped tyre components are subject to heat and pressure in a mould which is pre-provided with additional sidewall components.

11. A method as claimed in any one of the preceding claims wherein the expanded and shaped tyre components are subject to heat and pressure in a mould which is pre-provided with external components of the tyre.

12. A method for the manufacture of a pneumatic tyre and wheel assembly substantially as hereinbefore described with reference to and as shown in the accompanying drawings,

13. A pneumatic tyre and wheel assembly manufactured by the method according to any one of the preceding claims.

14. An assembly of a pneumatic tyre and a wheel substantially as hereinbefore described with reference to and as shown in the accompanying drawings.

15. Wheel structure for use in a tyre and wheel assembly comprising a radially outwardly facing rim surface of a substantially cylindrical form, said rim surface being provided with tyre bead location means for restraint of relative movement between said wheel structure and immediately adjacent parts of a tyre when assembled therewith, said rim surface being the radially innermost cylindrical surface of the wheel.

16. Wheel structure as claimed in claim 16 characterised in that said rim surface is not bounded at either axial end by a radially outwardly extending disc.

17. Wheel structure according to claim 15 or claim 16, wherein said tyre bead location means is an annular groove.

18. Wheel structure as claimed in claim 17, wherein said groove is of dove-tail cross section.

19. Wheel structure according to any one of claims 15 - 18 comprising a pair of annular rim portions provided with means whereby the two rim portions may be secured together to form an assembled wheel.

20. Wheel structure substantially as hereinbefore described with reference to and as shown in the accompanying drawings.

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