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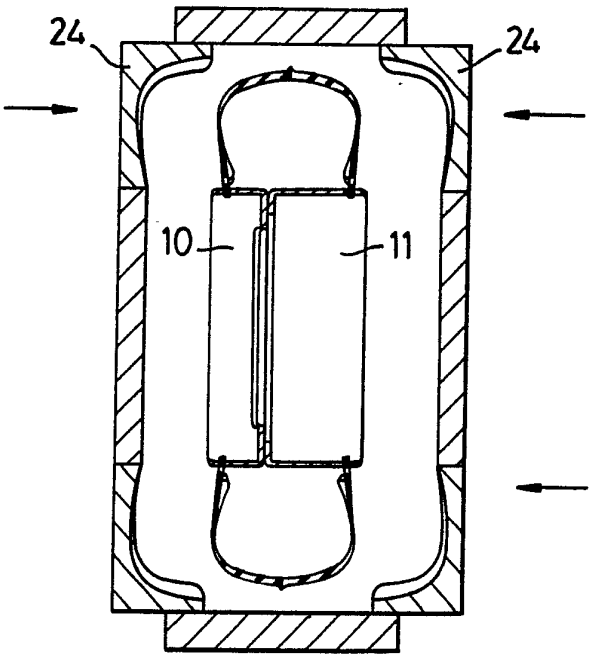
**(54) Title:** PNEUMATIC TYRE AND WHEEL ASSEMBLY




**(57) Abstract**

In a method for the manufacture of a tyre and wheel 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). With the wheel rim portions axially spaced apart components (18, 19, 20) of a tyre are applied around the wheel portions, the wheel portions 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 portions (10, 11) have annular grooves (15) which provide positive safe location of the tyre beads.

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## + DESIGNATIONS OF "SU"

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# 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.

One 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 support members each having a substantially cylindrical support surface, bringing the support members axially together in an operation in which the assembled components are expanded to a generally toroidal form, locating the expanded and shaped tyre in a mould and subjecting the tyre to heat and pressure in the mould characterised in that the expanded and shaped tyre is located in the mould while bead formations of the tyre remain mounted on respective support members.

Said support members preferably have respective cylindrical bead seat regions and said components may be applied in such manner that respective bead formations overlie the bead seat regions.

Each said support member may be provided with a respective tyre bead location groove in which a respective tyre bead is located whereby the tyre components may be so applied to the support members that they are

secured against subsequent axial movement relative to said support members.

The support members may be wheel rim portions. In this case each rim portion may be subjected to a balancing operation before components of a pneumatic tyre are applied thereto.

Temporary support means may be provided to prevent damage to the support members when supporting tyre components during pressurisation and cure.

The said support structure may further comprise a radially expandable and contractible building mandrel arranged to lie, when in a radially expanded condition, between said support members and said building mandrel may provide, when in a radially expanded condition between the support members, a substantially cylindrically shaped surface for the support of intervening portions of tyre components applied around the support members. Upon completion of application of tyre components around the support members and the building mandrel, the building mandrel may be contracted radially inwards to allow the support members to be moved axially towards one another,

Subsequent to assembly of components of a pneumatic tyre around the support members said components may be surrounded by temporary support means for support of at least sidewall portions of the tyre as the components are expanded and shaped. The temporary support means may be removed after shaping and assembly to a breaker package.

The expanded and shaped tyre components may be subject to heat and pressure in a mould which is pre-provided with additional sidewall components.

The expanded and shaped tyre components may be subject to heat and pressure in a mould which is pre-provided with external components of the tyre.

In accordance with another aspect of the present invention there is provided a wheel structure for use in a tyre and wheel assembly constructed by the method of the present invention, the wheel structure 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, the wheel structure being characterised in that said rim surface is the radially outermost cylindrical surface of the wheel.

The wheel structure may be further characterised in that the rim surface is not bounded at either axial end by a radially outwardly extending disc.

Said tyre bead location means may be an annular groove, which may be of dove-tail cross section.

The wheel structure may comprise a pair of annular rim portions provided with means 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 remainder 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 '0' 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 (18,19,20) of a tyre to a support structure (12) which comprises a plurality of axially separated support members (10,11) each having a substantially cylindrical support surface (13), bringing the support members (10,11) axially together in an operation in which the assembled components (18,19,20) are expanded to a generally toroidal form, locating the expanded and shaped tyre in a mould (23) and subjecting the tyre to heat and pressure in the mould (23), characterised in that the expanded and shaped tyre is located in the mould (23) while bead formations (30) of the tyre remain mounted on respective support members (10,11).

2. A method as claimed in claim 1, characterised in that said support members (10,11) have respective cylindrical bead seat regions (15) and said components (18,19,20) are applied in such manner that respective bead formations (30) overlie the bead seat regions (15).

3. A method as claimed in claim 2, characterised in that each said support member (10,11) is provided with a respective tyre bead location groove (15) in which a respective tyre bead (30) is located whereby the tyre components (18,19,20) may be so applied to the support members (10,11) that they are secured against subsequent axial movement relative to said support members (10,11).

4. A method as claimed in any one of the preceding claims, characterised in that the support members are wheel rim portions (10,11).

5. A method as claimed in claim 4, wherein each rim portion (10,11) is subjected to a balancing operation before components (18,19,20) of a pneumatic tyre are applied thereto.

6. A method as claimed in any one of the preceding claims, characterised in that temporary support means is provided to prevent damage to the support members (10,11) when supporting tyre components (18,19,20) during pressurisation and cure.

7. A method as claimed in any one of the preceding claims, characterised in that said support structure further comprises a radially expandable and contractible building mandrel (12) arranged to lie, when in a radially expanded condition, between said support members (10,11).

8. A method as claimed in claim 7, characterised in that said building mandrel (12) provides, when in a radially expanded condition between the support members (10,11), a substantially cylindrically shaped surface for the support of intervening portions of tyre components (18,19) applied around the support members (10,11).

9. A method as claimed in claim 7 or claim 8, characterised in that upon completion of application of tyre components (18,19) around the support members (10,11) and the building mandrel (12), the building mandrel (12) is contracted radially inwards to allow the support members (10,11) to be moved axially towards one another,

10. A method as claimed in any one of the preceding claims characterised in that subsequent to assembly of components (18,19,20,30) of a pneumatic tyre around the support members (10,11) said components (18,19,20,30) are surrounded by temporary support means (21) for support of at least sidewall portions of the tyre as the components (18,19) are expanded and shaped.

11. A method as claimed in claim 10, characterised in that the temporary support means (21) are removed after shaping and assembly to a breaker package.

12. A method as claimed in any one of the preceding claims characterised in that the expanded and shaped tyre components (18,19,20,30) are subject to heat and pressure in a mould (24) which is pre-provided with additional sidewall components.

13. A method as claimed in any one of the preceding claims characterised in that the expanded and shaped tyre components (18,19,20,30) are subject to heat and pressure in a mould (24) which is pre-provided with external components of the tyre.

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

15. Wheel structure for use in a tyre and wheel assembly constructed by the method of any one of the preceding claims, the wheel structure comprising a radially outwardly facing rim surface (13) of a substantially cylindrical form, said rim surface (13) being provided with tyre bead location means (15) for restraint of relative movement between said wheel structure (10,11) and immediately adjacent parts (30) of a tyre when assembled therewith, characterised in that said rim surface (13) is the radially outermost cylindrical surface of the wheel.

16. Wheel structure as claimed in claim 15 characterised in that said rim surface (13) is not bounded at either axial end (14) by a radially outwardly extending disc.

17. Wheel structure according to claim 15 or claim 16, characterised in that said tyre bead location means is an annular groove (15).

18. Wheel structure as claimed in claim 17, characterised in that said groove (15) is of dove-tail cross section.

19. Wheel structure according to any one of claims 15 - 18 characterised in that it comprises a pair of annular rim portions (10,11) provided with means (17,26) whereby the two rim portions (10,11) may be secured together to form an assembled wheel.

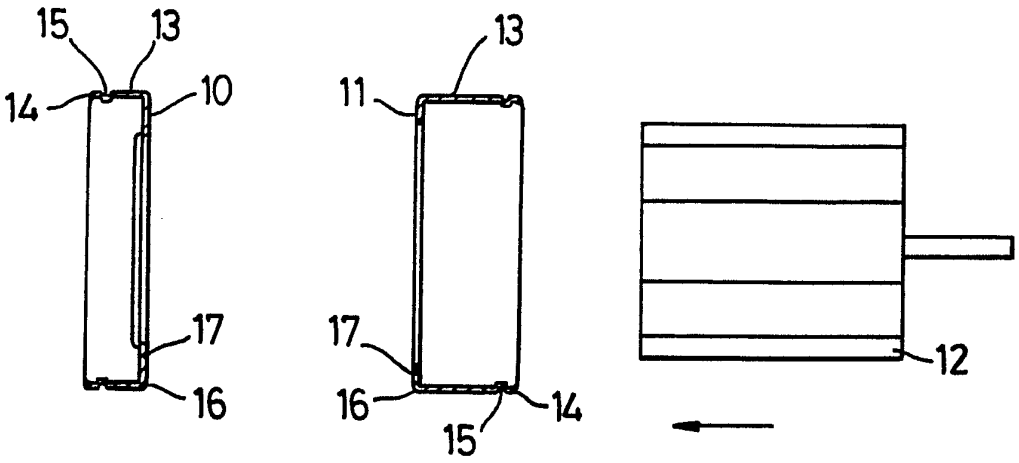


Fig. 1

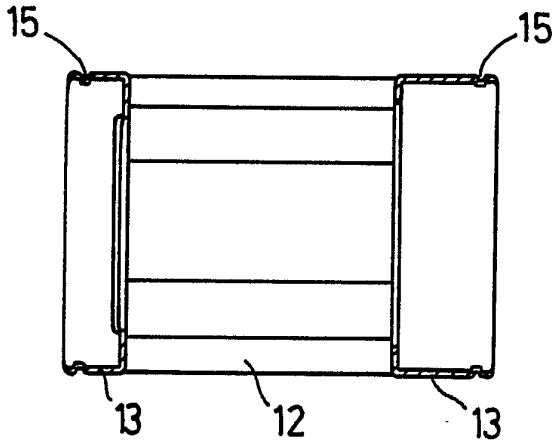


Fig. 2

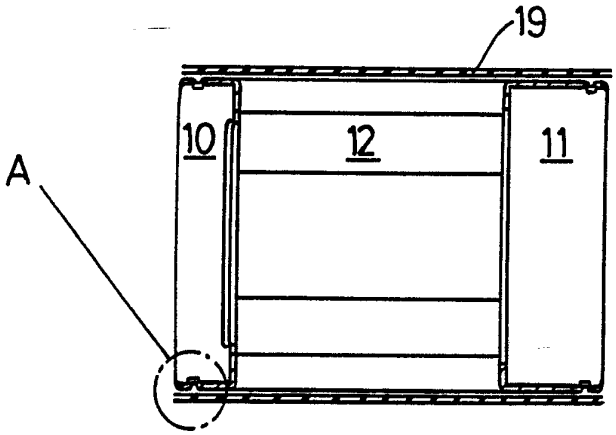


Fig. 3

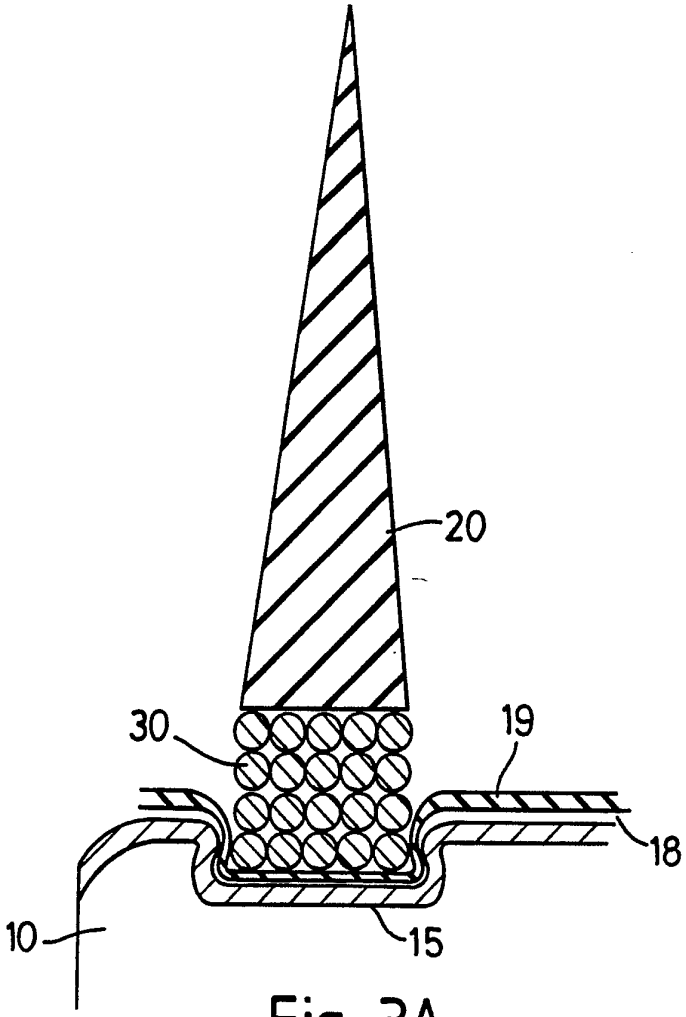


Fig. 3A

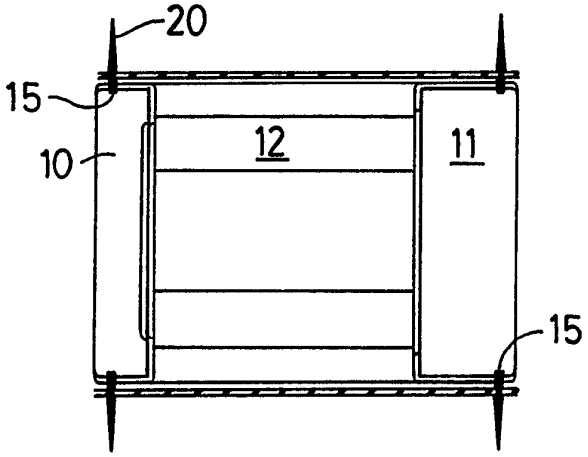


Fig. 4

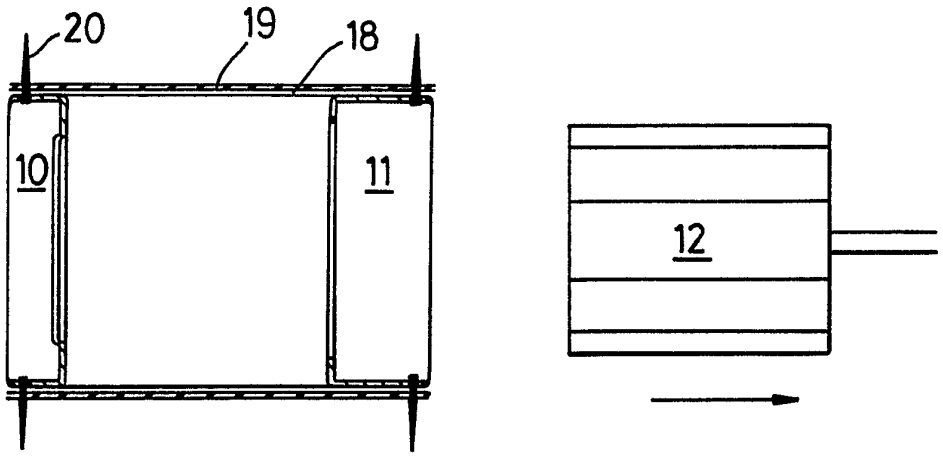


Fig. 5

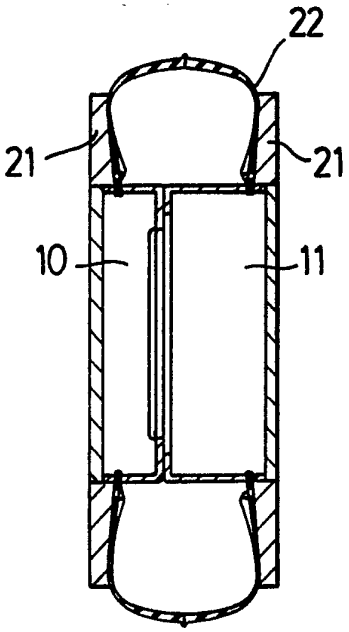


Fig. 6

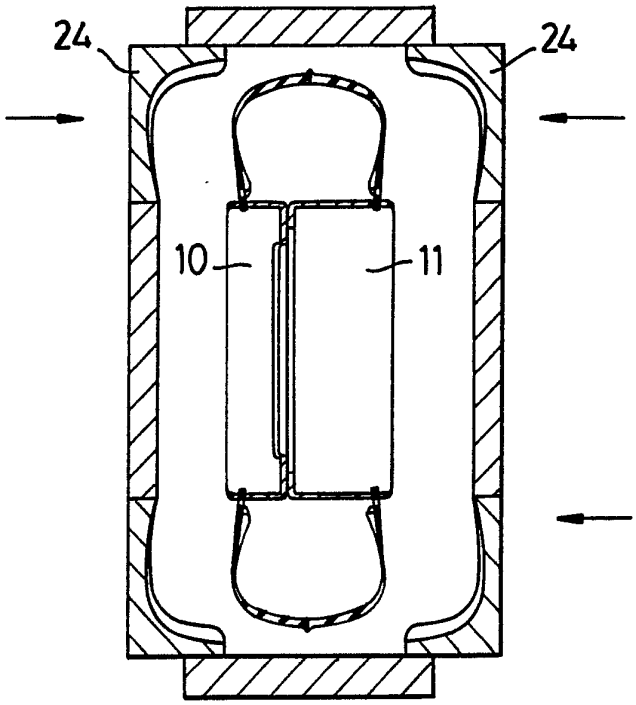


Fig. 7

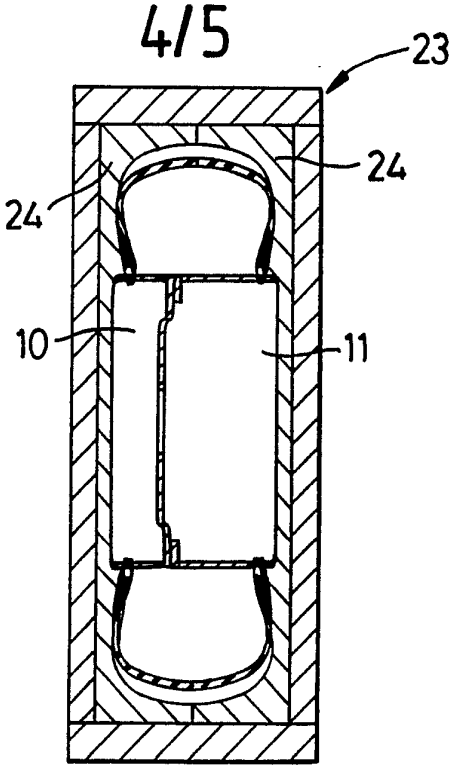


Fig. 8

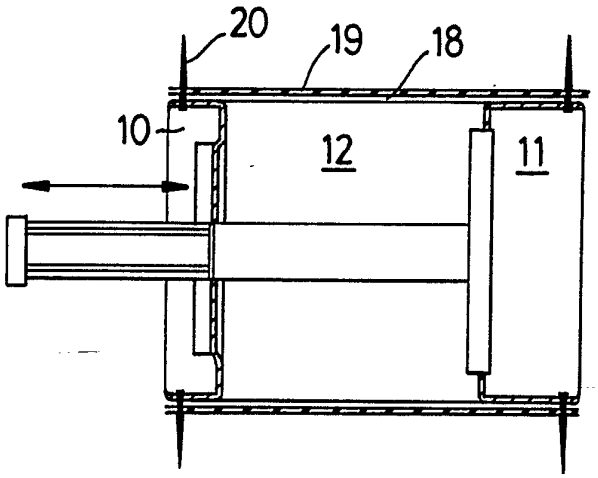


Fig. 10

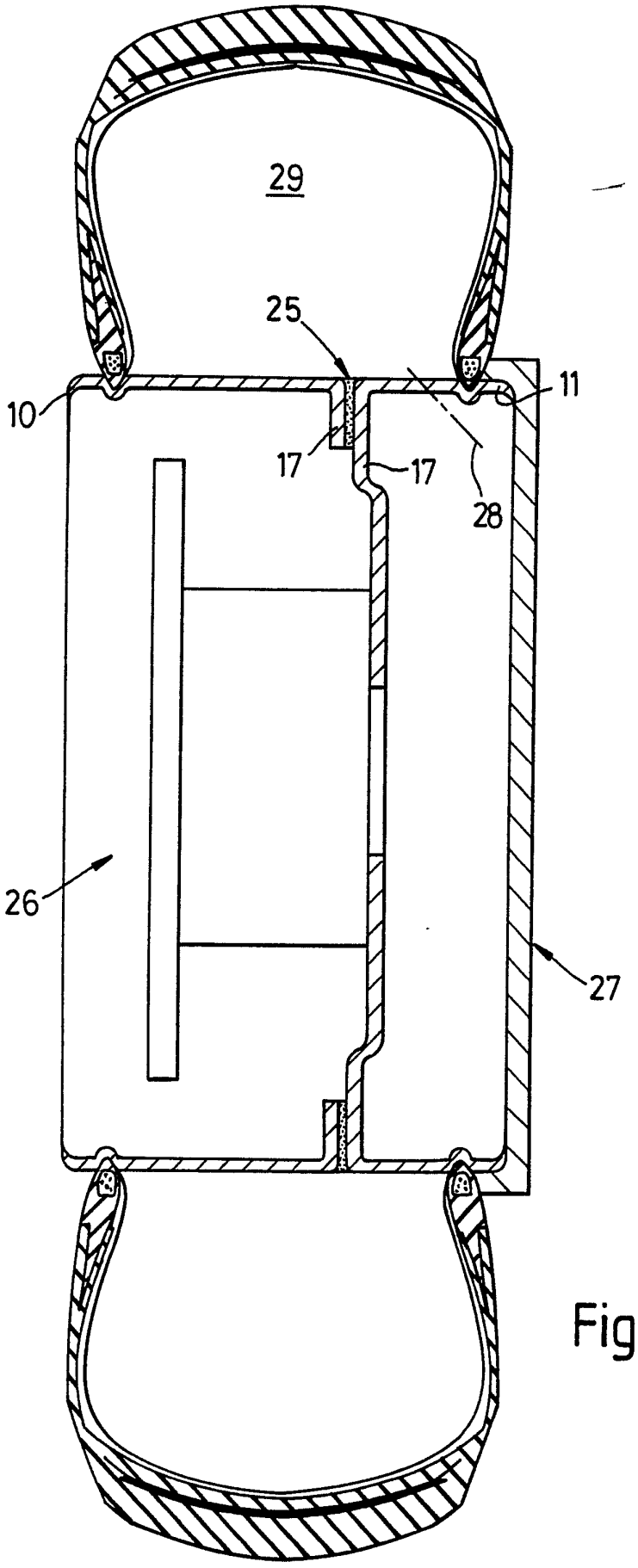


Fig. 9

# INTERNATIONAL SEARCH REPORT

International Application No PCT/GB 91/01093

## I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)[6]

According to International Patent Classification (IPC) or to both National Classification and IPC

Int.Cl. 5 B29D30/08 ; B29D30/20 ; B29D30/36 ; B29D30/06

## II. FIELDS SEARCHED

**Minimum Documentation Searched[7]**

| Classification System | Classification Symbols |
|---|---|
| Int.Cl. 5 | B29D ; B60B |

**Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched[8]**

## III. DOCUMENTS CONSIDERED TO BE RELEVANT[9]

| Category ° | Citation of Document, [11] with indication, where appropriate, of the relevant passages [12] | Relevant to Claim No.[13] |
|---|---|---|
| A | DE,A,2 157 076 (CONTINENTAL GUMMI-WERKE) May 24, 1973 see the whole document | 1,4,14, 15 |
| A | DE,A,3 206 171 (CONTINENTAL GUMMI-WERKE) August 25, 1983 see the whole document | 1,4,14, 15 |
| A | GB,A,794 779 (KRONPRINZ AKTIENGESELLSCHAFT) May 7, 1958 see the whole document | 1,4,14, 15 |
| A | EP,A,313 506 (HOLROYD) April 26, 1989 see the whole document | 12,13 |
| A | FR,A,2 236 673 (DUNLOP LIMITED) February 7, 1975 see page 1; figures 5,6 | 19 |

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## IV. CERTIFICATION

| Date of the Actual Completion of the International Search | Date of Mailing of this International Search Report |
|---|---|
| 13 SEPTEMBER 1991 | 03. 10. 91 |
| **International Searching Authority** | **Signature of Authorized Officer** |
| EUROPEAN PATENT OFFICE | SUENDERMANN R.O. |

# ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO.

GB 9101093
SA 49253

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on
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13/09/91

| Patent document cited in search report | Publication date | Patent family member(s) | Publication date |
|---|---|---|---|
| DE-A-2157076 | 24-05-73 | None | |
| DE-A-3206171 | 25-08-83 | None | |
| GB-A-794779 | | CH-A- 348619 | |
| | | DE-B- 1133648 | |
| | | FR-A- 1149739 | |
| | | NL-C- 106737 | |
| | | NL-A- 206908 | |
| EP-A-313506 | 26-04-89 | AU-A- 2412888 | 27-04-89 |
| | | JP-A- 1237126 | 21-09-89 |
| | | US-A- 4983239 | 08-01-91 |
| FR-A-2236673 | 16-01-75 | AU-A- 7104874 | 15-01-76 |
| | | BE-A- 817511 | 04-11-74 |
| | | DE-A- 2433171 | 30-01-75 |
| | | JP-A- 50160888 | 26-12-75 |
| | | LU-A- 70501 | 28-11-74 |
| | | NL-A- 7409130 | 14-01-75 |
| | | SE-A- 7409093 | 13-01-75 |