(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 257 865**
A2

(12) EUROPEAN PATENT APPLICATION

(21) Application number: **87306923.1**

(51) Int. Cl.4: **B29D 30/02**

(22) Date of filing: **05.08.87**

(30) Priority: **19.08.86 GB 8620094**

(43) Date of publication of application:
02.03.88 Bulletin 88/09

(84) Designated Contracting States:
AT BE CH DE ES FR GB IT LI LU NL SE

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(54) Tyre construction method.

(57) A method of manufacturing a solid tyre from plastics materials comprises the steps of positioning an inflated hollow annular membrane 16 within a mould 10, 11 to define a space between the exterior of the membrane 16 and the interior of the mould 10, 11, said space having the required shape of an outer casing 18 of the tyre to be produced, filling the space with a settable resilient plastics material which has relatively hard wearing properties, setting the material, and then injecting into the hollow membrane 16 a second settable resilient plastics material which is relatively soft, to form an inner core 19 for the finished tyre.

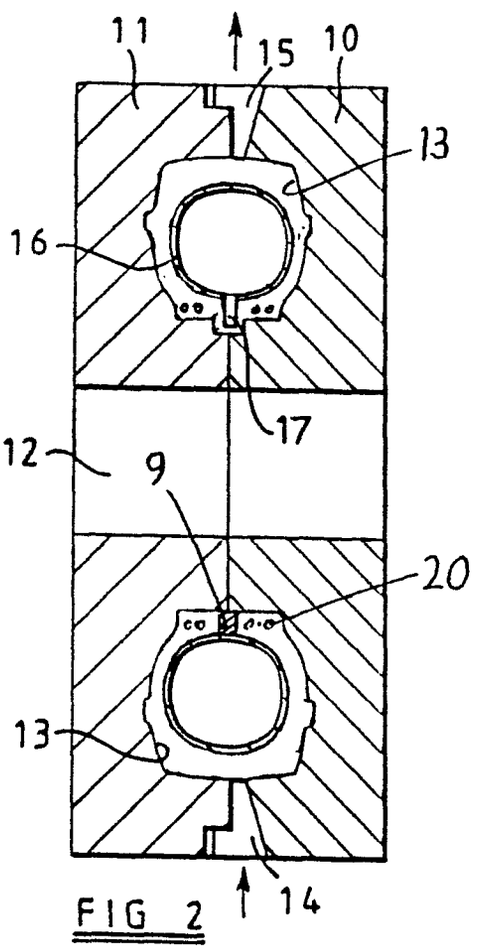

FIG 2

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"Tyre Construction Method"

This invention relates to solid types for vehicles. The expression solid tyre is to be taken to mean tyres which do not rely upon a volume of air under pressure contained within a cavity to maintain the tyre in its correct shape during use. The invention is primarily concerned with solid tyres for vehicles such as fork-lift trucks, cranes or other mechanical handling equipment or other vehicles not generally used on highways and in which non-puncturing characteristics are particularly important.

The advantages of solid tyres are well known in that they do not need to be filled with air under pressure and are thus free from maintenance. They also do not puncture. This is particularly important in factories, or other environments where objects liable to damage the tyres may be present.

Many solid tyres are made as one piece, from natural or synthetic rubbers, with or without fabric or fibre reinforcements. However, it is common knowledge that tyres made of these materials tend to mark floors, and in situations such as hospitals and the food industry this is undesirable. The use of certain plastics materials can overcome this problem, but many plastics materials which are acceptable, in that they do not leave marks, are rather too hard, whereas softer plastics materials wear relatively quickly.

This problem may be overcome by forming the tyre from an outer casing of a relatively hard-wearing resilient plastics material which is moulded over an inner core of a softer resilient plastics material. However, such two-part tyres may be difficult to manufacture, and the present invention sets out to provide a convenient and efficient method of manufacturing such a two-part solid tyre.

According to the invention there is provided a method of manufacturing a solid tyre from plastics material, characterised by the steps of locating a hollow annular element within an annular cavity in a mould to define a space between the exterior of the element and the interior of the mould, said space having the desired shape of an outer tyre casing to be produced, filling said space with a first settable resilient plastics material which has relatively hard wearing properties, setting the first plastics material, filling the interior of the hollow annular element with a second settable resilient plastics material which is relatively soft, and setting the second plastics material to form an inner core of the tyre.

Preferably, the hollow annular element is formed of flexible material, the annular shape of the element being sustained, before said space is filled with the first plastics material, by the supply of fluid under pressure to the interior of the element.

In this context the term "fluid" is to be interpreted as including liquids or gases, although in the preferred arrangement a gas, usually air, is used.

Conveniently the flexible hollow element may be supplied with said fluid under pressure, and sealed, before being positioned within the annular cavity of the mould.

Preferably said space is filled with said first plastics material at a pressure which is not greater than the pressure of said fluid within the flexible hollow element.

Spacers may be located between the exterior of the hollow annular element and the interior of the mould to locate the hollow element within the mould.

There may be provided in the mould an aperture for the escape of air from the said space as it is filled with said first plastics material.

After said first plastics material has set, an outlet opening is preferably formed through the first plastics material and the wall of the hollow annular element for the escape of said fluid from the interior of the hollow element as it is filled with said second plastics material.

The hollow annular element may be provided with an inlet passage which extends to the exterior of the outer casing formed by setting of the first plastics material, through which passage the second plastics material is injected into the interior of the hollow annular element.

Reinforcement may be located in said space between the hollow annular element and the interior of the mould before the space is filled with said first plastics material.

The invention includes within its scope a solid tyre when manufactured by any of the methods referred to above.

A preferred form of the invention will now be described by way of example with reference to the accompanying drawings in which:

Figure 1 is a side view of a mould used in the construction of a tyre in a method according to the invention,

Figure 2 is a cross-sectional view on the line 2-2 in Figure 1, and

Figure 3 is a cross-sectional view of a typre, to a larger scale, during a further stage in production.

Figures 1 and 2 show a two-part mould 10, 11 of generally cylindrical form, having a central aperture 12. Defined between the two mould parts 10, 11 is an annular cavity 13 having the shape of the exterior of a tyre to be produced. As best seen in Figure 2, the cross-sectional shape of the cavity includes portions defining an outer peripheral wall and two side walls for the tyre, as well as an inner peripheral bead section for fitting into a wheel rim. A tread pattern may be formed on the peripheral surface of the mould cavity, so as to form a corresponding tread pattern on the outer periphery of the finished tyre.

The mould parts provide lower and upper slots 14, 15 at diametrically opposite positions. The lower slot 14 forms an entry opening for material to fill the mould and the upper slot 15 forms an outlet for the escape of air, as the material enters.

Located within the mould cavity 13 is a hollow annular element in the form of an inflatable annular membrane 16 of rubber or other suitable flexible material. The membrane 16 is spaced from the inner walls of the mould cavity 13 by spacers 9 which are preferably formed of a similar plastics material to that from which the outer portion of the tyre is to be moulded. The membrane has a closable inlet valve 17 comprising a passage through which the membrane can be inflated with air (or other fluid) under pressure. The mould parts define a socket to receive the projecting part of the valve 17.

For convenience, the membrane will normally be inflated before it is positioned in the mould cavity, but the invention does not exclude the possibility of the membrane being inflated after it has been introduced into the mould. In this case the valve 17 must project out of the mould.

When the mould has been assembled with the inflated membrane within it, the space around the membrane in the interior of the mould is filled with a first settable plastics material in liquid form, the liquid being injected into the mould through the lower slot 14, and air escaping from the mould through the upper slot 15. The liquid plastics is introduced under a pressure which is not greater than the air pressure within the membrane 16, so that there is no tendency for the pressure to compress the membrane. The plastics material is then set, usually by curing.

The plastics material is of a kind which, when cured, has the resilient hard-wearing characteristics required for the exterior cover of the tyre. A suitable material is a polyurethane composition based on a toluene diisocyanate/polytetramethylene ether glycol prepolymer corss-linked with 4-4 methylene bis orthochlorinaline. This may conveniently be cured at 100° C over an appropriate period. After curing, the mould parts are separated and the moulded outer casing containing the inflated membrane is removed.

As seen in Figure 3, the outer casing 18 completely surrounds the membrane 16 but the valve 17 extends through the bead wall of the outer casing. (The projecting portion of the valve 17 may be coated with grease or other separting agent, before location of the membrane within the mould, to prevent it becoming encased in the first plastics material.) The interior of the hollow membrane 16 is then opened to the atmosphere by drilling a small hole 8, for example about 3 mm in diameter, through the outer casing 18 and membrane 16 at a position diametrically opposite to the valve 17.

A second settable plastics material in liquid form is then injected into the interior of the membrane 16 through the valve 17 and, as it enters, air is expelled from the membrane through the aforementioned hole 8 until the interior of the membrane is completely filled with the plastics material, to form the core 19. Emergence of the liquid plastics from the hole 8 indicates when the membrane is completely filled, and the hole is then sealed, for example with a small plastics plug. The second plastics material is then set, usually by curing.

A suitable plastics material for the core is a polyurethane, being in one example a quasi-prepolymer based on a toluene diisocyanate, a mixture of low molecular weight polyols and some oils extension. In one example, the polyurethane mixture was preblended in the ratio 1:1 by volume. However other ratios can be used. This material was introduced into the interior of the membrane at 30° C. The assembly can be heated or may be transferred to a circulating air oven operating at 35° to 40° C to cure the inner core over a period of forty eight hours.

The desired physical properties of the outer casing 18 in this example are as follows:

Hardness: Shore "A" = 80 A
Elongation = 800%

The desired physical properties of the inner core 19 are as follows:

Hardness: Shore "A" = 28 A
Elongation = 380%

Reinforcement may be incorporated in the outer casing during the moulding stage and this is particularly desirable in the bead region of the tyre. For example, as shown in Figure 3, the reinforcement may be in the form of steel wires 20 embedded in the bead portion and extending around the inner periphery of the tyre.

Other materials for the outer casing or for the inner core may be selected according to requirements. Injection moulding or blow moulding techniques can be used for filling the mould and producing the inner core.

Claims

1. A method of manufacturing a solid tyre from plastics material, characterised by the steps of locating a hollow annular element (16) within an annular cavity (13) in a mould (10,11) to define a space between the exterior of the element and the interior of the mould, said space having the desired shape of an outer tyre casing to be produced, filling said space with a first settable resilient plastics material which has relatively hard wearing properties, setting the first plastics material, filling the interior of the hollow annular element (16) with a second settable resilient plastics material which is relatively soft, and setting the second plastics material to form an inner core of the tyre.

2. A method according to Claim 1, characterised in that the hollow annular element (16) is formed of flexible material, the annular shape of the element being sustained, before said space is filled with the first plastics material, by the supply of fluid under pressure to the interior of the element.

3. A method according to the Claim 2, characterised in that the flexible hollow element (16) is inflated by a supply of gas under pressure to the interior thereof.

4. A method according to Claim 2 or Claim 3, characterised in that the interior of the flexible hollow element (16) is supplied with said fluid under pressure, and sealed, before being positioned within the annular cavity (13) of the mould (10,11).

5. A method according to any of Claims 2 to 4, characterised in that said space is filled with said first plastics material at a pressure which is not greater than the pressure of said fluid within the flexible hollow element (16).

6. A method according to any of Claims 1 to 5, characterised in that spacers are located between the exterior of the hollow annular element (16) and the interior of the mould to locate the hollow element within the mould.

7. A method according to any of Claims 1 to 6, characterised by providing in the mould an aperture (15) for the escape of air from the said space as it is filled with said first plastics material.

8. A method according to any of Claims 1 to 7, characterised by the step, after said first plastics material has set, of forming an outlet opening (8) through the first plastics material and the wall of the hollow annular element (16) for the escape of said fluid from the interior of the hollow element as it is filled with said second plastics material.

9. A method according to any of Claims 1 to 8, characterised in that the hollow annular element (16) is provided with an inlet passage (17) which extends to the exterior of the outer casing (18) formed by setting of the first plastics material, through which passage the second plastics material is injected into the interior of the hollow annular element.

10. A method according to any of Claims 1 to 9, characterised in that reinforcement (20) is located in said space between the hollow annular element and the interior of the mould before the space is filled with said first plastics material.

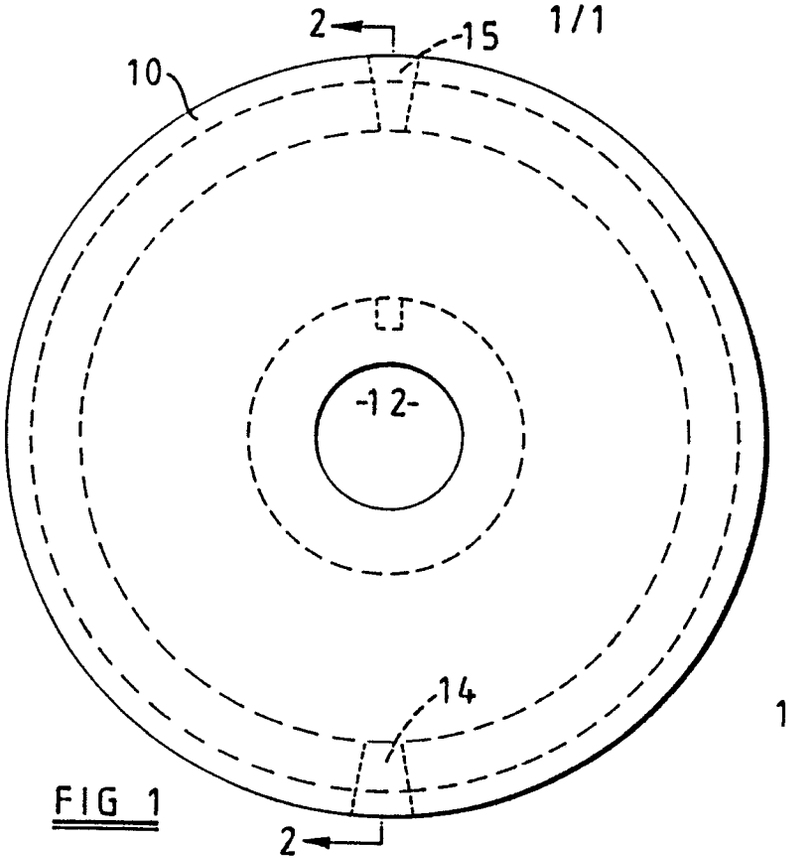

FIG 1

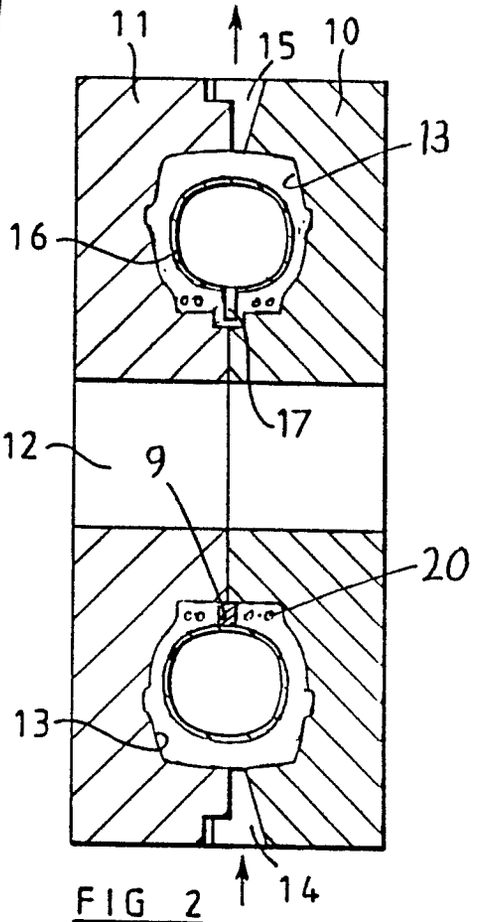

FIG 2

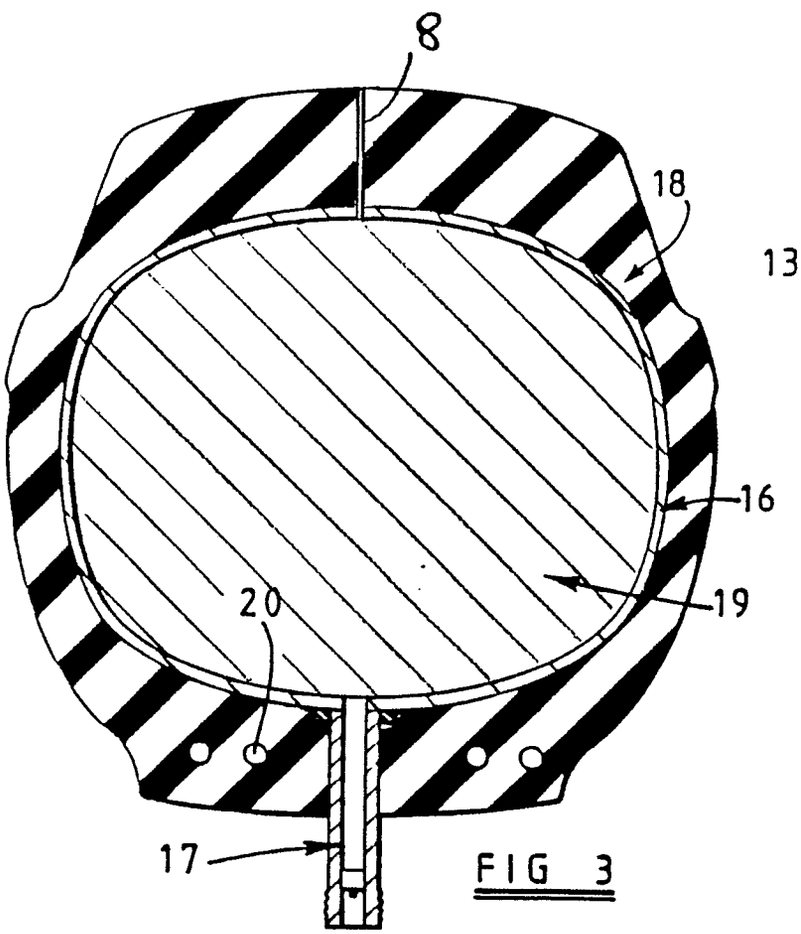

FIG 3