(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
15 January 2009 (15.01.2009)

PCT

(10) International Publication Number
WO 2009/007790 A1

(51) International Patent Classification:
B29D 30/06 (2006.01) *B29C 35/02* (2006.01)
B29D 30/72 (2006.01)

(21) International Application Number:
PCT/IB2007/052768

(22) International Filing Date: 11 July 2007 (11.07.2007)

(25) Filing Language: Italian

(26) Publication Language: English

(71) Applicant *(for all designated States except US)*: **PIRELLI TYRE S.P.A.** [IT/IT]; Viale Sarca 222, I-20126 Milan (IT).

(72) Inventors; and
(75) Inventors/Applicants *(for US only)*: **SECCHI, Mario** [IT/IT]; c/o Pirelli Tyre S.p.a., Viale Sarca, 222, I-20126 Milano (mi) (IT). **BOLZONI, Roberto** [IT/IT]; c/o Pirelli Tyre S.p.a., Viale Sarca 222, I-20126 Milano (mi) (IT).

(74) Agent: **BRASCA, Marco**; c/o Bugnion S.p.a., Viale Lancetti, 17, I-20158 Milano (IT).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, MT, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report*

(54) **Title:** PROCESS AND APPARATUS FOR VULCANIZATION AND MOULDING OF VEHICLES TYRES

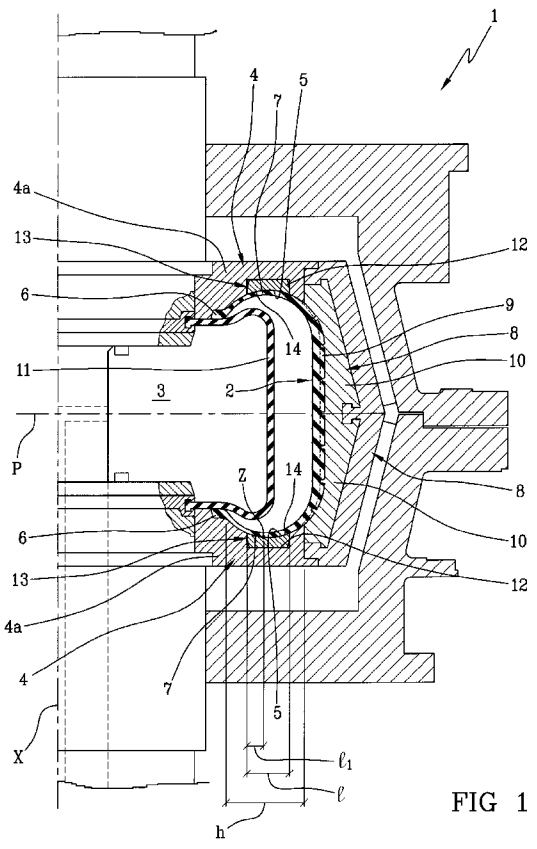

FIG 1

(57) **Abstract:** The present invention refers to an apparatus and process for moulding and vulcanization of vehicle tyres. The apparatus for moulding and vulcanization of vehicle tyres comprises a mould (1) for forming a moulding cavity (3) having a conformation corresponding to the outside conformation to be given to the vulcanized tyre and comprising a pair of shells (4) axially opposed and each having a working surface (5). The working surface (5) has an annular development and is predisposed to operate on the beads (6) and on the sidewalls (7) of a raw tyre (2) to be vulcanized. The working surface (5) of at least one of the shells (4) also has an annular groove (12) developing along its own annular development. A annular insert (13) is removably mounted in the annular groove (12) and has a moulding face (14) opposite the moulding cavity (3) whose moulding face (14) bears graphic marks (15) to imprint on the sidewall (7) of the tyre (2).

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"Process and apparatus for vulcanization and moulding of vehicle tyres"

The present invention relates to an apparatus and a process for moulding and vulcanizing of tyres.

Preferably, the object of the invention is an apparatus and a process for moulding and vulcanizing of tyres for vehicle wheels.

A tyre for vehicle wheels generally comprises a carcass structure including at least one carcass ply having respectively opposite end flaps in engagement with respective annular anchoring structures, integrated into the regions usually identified as "beads", which have an inner diameter substantially corresponding to a so-called "fitting diameter" of the tyre on a respective mounting rim.

Associated with the carcass structure is a belt structure comprising one or more belt layers, located in radial superposed relationship with each other and with the carcass ply, having textile or metallic reinforcing cords with a crossed orientation and/or substantially parallel to the circumferential extension direction of the tyre. A tread band is applied to the belt structure at a radially external position, which tread band too is made of elastomeric material like other semifinished products constituting the tyre.

To the side surfaces of the carcass structure, which each extends from one of the side edges of the tread band to the respective annular structure anchoring to the beads, respective sidewalls in elastomeric material are applied in an axially external position, which can also be previoulsy manufactured as drawn or extruded profiles.

Subsequently to building of the green tyre carried out through assembly of the respective components, moulding and vulcanisation treatment is carried out that aims to cause structural stabilisation of the tyre through cross-linking of the elastomeric compositions and also to imprint a desired tread pattern on the tread band.

The moulding and vulcanization treatment also makes it possible to imprint possible distinctive graphic marks at the tyre sidewalls. For example, said graphic marks may consist of wording that includes the brand of the tyre and/or of the manufacturer, its technical characteristics (tyre dimensions, maximum load, rotation direction, etc.), initials indicating compliance with regulatory specifications and/or ornamental motifs.

To this end the negative of the motifs to be imprinted on the tyres is hollowed from the mould cheeks by milling.

US Patent 5,382,402 discloses a mould shell with notches

corresponding to the shape of the marks on the tyre sidewall. The notches contain removable inserts that reproduce the mark to be obtained on the tyre and can be made to slide inside the notch to make marks in relief or recess.

US Patent 7,021,914 discloses a tyre mould with a moulding face and a ventilation structure. The ventilation structure has a hole that opens onto the moulding face. An insert is removably placed in the hole to form part of the moulding face and delimits the micro-slot which allows venting. The insert may have the shape of a letter to imprint on the tyre sidewall.

The Applicant has addressed the problem of how to make the aesthetic appearance of the tyre sidewall more attractive, perceiving that the tyre sidewall can bear more than just technical information.

In fact the Applicant perceived that, since the sidewall is one of the most visible parts of the tyres, it has a high suggestive power that can influence the decisions of consumers.

The Applicant therefore has addressed the problem to improve the tyre moulding and vulcanization process with special focus on creating ornamental and/or decorative motifs on the sidewall.

The Applicant has addressed the problem of increasing

the versatility of the vulcanization moulds, especially regarding the possibility of making different graphic marks on the tyre sidewalls using substantially the same mould.

Furthermore, the Applicant has addressed the problem of minimizing the costs of producing the aforesaid ornamental and/or decorative motifs.

The Applicant has also addressed the problem of improving the quality and definition of the aforesaid graphic marks.

According to the present invention, the Applicant has found that by producing a negative of the aforesaid graphic marks on an annular insert to be mounted subsequently on a respective cavity obtained in the mould, it is possible to improve the quality of the graphic marks imprinted on the tyre sidewall while reducing the costs of the moulding and vulcanization process.

More specifically, according to a first aspect, the present invention relates to tyre moulding and vulcanization apparatus which includes: a mould for forming a moulding cavity having the shape that corresponds to the external conformation to be applied to the vulcanized tyre and including a pair of shells axially opposite each other, both having a working

surface; said working surface having an annular development and being predisposed to work on the beads and sidewalls of a green tyre to be vulcanized, where the working surface of at least one of the shells has an annular groove that develops along the annular development of said working surface and an annular insert removably mounted in the annular groove; said annular insert having a moulding face opposite the moulding cavity and having graphic marks to be imprinted on the tyre sidewall.

According to another aspect, the present invention entails a tyre moulding and vulcanization process, comprising the phases of: preparing a mould to form a moulding cavity corresponding to the external shape of the vulcanized tyre and comprising a pair of axially opposed shells; each of these shells having a working surface with an annular development and predisposed to work on the beads and sidewalls of a green tyre to be vulcanized; obtaining, on at least one of the working surfaces, an annular groove that runs along the annular development of said working surface; preparing an annular insert including a moulding face having graphic marks to imprint on one sidewall of the tyre; removably mounting the annular insert into the annular groove with the moulding face opposite the moulding cavity;

introducing a green tyre to be vulcanized into the moulding cavity; closing the mould to predispose the working surfaces to work on the beads and sidewalls of the green tyre to be vulcanized; pressing the green tyre against the working surfaces to imprint the graphic marks on the tyre sidewall and apply heat to the green tyre.

Using the removable annular insert makes it possible to avoid making the graphic marks directly on the shells that, due to their intrinsic shape, are difficult to work by means of traditional milling methods.

Moreover, making the aforesaid graphic marks on the annular inserts enables the attainment of a higher precision and quality of the marks and therefore, among other things, a more defined outline in the designs imprinted on the tyre. In fact working the annular insert will be simplified and more precise because it is done separate from the context of the shell.

The present invention, in at least one of the above-mentioned aspects, can also have one or more of the preferred characteristics described below.

Preferably the graphic marks on the moulding face of the annular insert are obtained by photoengraving.

In alternative, the graphic marks on the moulding face of the annular insert are obtained by spark erosion.

Both of the aforesaid techniques make it possible to obtain on the insert, and subsequently on the tyre, complex and well-defined graphic marks at relatively low costs.

Moreover, preferably the annular insert has seats for auxiliary inserts.

The possibility of introducing auxiliary inserts, which also have graphic marks to imprint on the tyre, in the annular insert increases the number of decorative combinations.

According to one embodiment, the annular insert is made of aluminum.

In alternative the annular insert is made of steel.

According to an embodiment variation, the annular insert is made of plastic.

Regardless of the specific choice, the material must in any case be able to withstand vulcanization temperatures.

Furthermore, the apparatus includes devices for locking the annular insert into the annular groove.

Preferably, the apparatus includes devices for adjusting the depth of the position of the annular insert into the annular groove.

Preferably, in an operative configuration, the moulding face of the annular insert projects beyond a surface of

the shell adjacent to said moulding face by a higher thickness of about 0.5 mm.

Preferably, in an operative configuration, the moulding face of the annular insert projects beyond a surface of the shell adjacent to said moulding face by a lower thickness of about 2 mm.

Preferably, in an operative configuration, the moulding face of the annular insert has a recess of a higher thickness of about 0.5 mm into a surface of the shell adjacent to said moulding face.

Preferably, in an operative configuration, the moulding face of the annular insert has a recess of a lower thickness of about 2 mm into a surface of the shell adjacent to said moulding face.

The above-mentioned adjustment makes it possible to easily vary the thickness of the graphic marks and/or the depth of the same in the tyres without having to change the annular insert.

Preferably, the annular insert is positioned in correspondence to an area of maximum axial width of the moulding cavity.

This area corresponds to the maximum cord of the tyre. Therefore the depth variation of the graphic marks located in correspondence to the maximum axial width makes it possible to accurately check said maximum cord

with precision.

Preferably, the ratio between one radial dimension of the annular insert and the height of the tyre sidewall is greater than about 0.3.

Moreover the ratio between one radial dimension of the annular insert and the height of the tyre sidewall is less than about 0.7.

Preferably, a first portion of a radial dimension of the annular insert is positioned radially internal to an area of maximum axial width of the moulding cavity; the ratio between the aforesaid first portion and the radial dimension of the annular insert is greater than about 0.1.

Moreover, a first portion of a radial dimension of the annular insert is positioned radially internal to an area of maximum axial width of the moulding cavity; the ratio between said first portion and the radial dimension of the annular insert is less than about 0.4.

According to an embodimente, the annular insert has tapered sidewalls introduced in the annular groove and facing the sidewalls of said annular groove.

Preferably the tapered sidewalls form an angle to the respective sidewalls of the annular groove of more than 5°.

Moreover, the tapered sidewalls form an angle to the

respective sidewalls of the annular groove of less than about 10°.

The tapering of the insert towards the bottom of the annular groove serves mainly to avoid the generation of stresses generation of stresses due to dilation of the materials during the heating of the mould.

Moreover, preferably between the moulding face of the annular insert and the shell there are vent gaps for the air in fluid communication having a delimited space between the tapered sidewalls of said annular insert and the sidewalls of said annular groove.

The presence of said space makes it possible to improve the venting of air that stays trapped between the tyre and the mould.

Moreover, preferably each mould shell is made in one piece.

The realization of a single piece makes the mould more rigid and therefore also ensures the proper shape of the vulcanized tyre and of the imprinted graphic marks.

Preferably, the phase of preparing an annular insert includes: making graphic marks on the moulding face previous to mounting said annular insert into the annular groove.

Making the insert and executing the graphic marks on it separately from the cheeks lends greater versatility to

the mould-building processes, ensures greater precision and speed in the execution of the graphic marks to be imprinted on the tyress and minimizes the mould production costs.

According to an embodiment, the phase of preparing an annular insert includes: making graphic marks on the moulding face by means of photoengraving.

In alternative, the annular insert preparation phase includes: making graphic marks on the moulding face by spark erosion.

Moreover, preferably the phase of preparing an annular insert includes: making seats for auxiliary inserts on the moulding face of the annular insert.

More preferably, the annular insert preparation phase includes: making seats for auxiliary inserts on the moulding face of the annular insert before mounting the annular insert inside the annular groove.

Even more preferably, the annular insert preparation phase includes: making seats for auxiliary inserts on the moulding face of the annular insert; installing the auxiliary inserts in the seats of the moulding face of the annular insert before mounting said annular insert inside the annular seat.

Moreover, preferably the phase of mounting an annular insert includes: adjusting the depth of the annular

insert in the annular groove.

Moreover, preferably after the phase of applying heat to a green tyre, the following phases are executed: opening the mould; removing the vulcanized tyre; replacing the annular insert with a new annular insert to imprint different graphic marks on the sidewall of a subsequent tyre; introducing a subsequent green tyre to be vulcanized in the moulding cavity; closing the mould to prepare the working surfaces to work on the beads or sidewalls of said subsequent green tyre to be vulcanized; pressing said subsequent green tyre against the working surfaces to impress the graphic marks on the tyre sidewall and applying heat to said subsequent green tyre.

The possibility of easily and rapidly substituting the annular insert enables the creation of tyre samples with different graphic marks to be submitted, for example, for final approval.

It is therefore possible to run appearance trials on prototype vulcanized coverages by using the cheeks with various types of annular inserts.

It is even possible to vary the design of the graphic layout (wording and aesthetic motifs) on already-built cheeks or on a range of products not yet completed.

If it is desired to change the range of products,

replacing the annular insert will make it possible to totally recuperate the cheeks.

Additionally, rapid replacement is possible with the previously prepared annular inserts in cases of breakdown, breakage, small defects in appearance resulting from using the cheeks at the factories.

The mould can be built modularly. In fact, while the cheek profile is being made, the annular insert can be realized simultaneously on another machine or at the premises of an outside supplier.

Further characteristics and advantages will become clearer by the detailed description of a preferred, but not exclusive, method of execution of an apparatus and process for moulding and vulcanization of vehicle tyres, according to this invention.

This description will be given below with reference to the attached drawings, which are provided only by way of an indicative and therefore not limiting example, in which:

- figure 1 shows a schematic view of a diametral section of half of a mould making up a tyre moulding and vulcanization apparatus according to the present invention;
- figure 2 shows a schematic view of a diametral section of a portion of a shell of the mould in figure

1;

- figure 2a shows an embodiment variation of the portion of figure 2;
- figure 2b shows the portion of figure 2a according to a different diametral section;
- figure 3 is a plan view of an annular insert partially visible in figures 2, 2a and 2b;
- figure 3a is a view of the diametral section of the annular insert of figure 3.

In reference to the above-mentioned figures, 1 fully indicates a vulcanization mould pertaining to a moulding and vulcanization apparatus of tyres for vehicle wheels according to the present intervention.

The moulding and vulcanization apparatus is part of an apparatus for making tyres for vehicle wheels, which generally includes devices for forming a green tyre 2 and devices that can transfer the green tyre 2 into a moulding cavity 3 of the vulcanization mould 1. The moulding cavity 3 has a shape corresponding to the outer shape to give to the vulcanized tyre 2. Said devices for forming and transferring the tyre 2 are not shown and are not further described because they can be made in any convenient way.

As seen in figure 1, the mould 1 has a pair of axially opposite shells 4 that can be reciprocally coupled in

correspondence to an equatorial plane "P". Each of the shells 4 include a working surface 5 predisposed to work on the beads 6 and sidewalls 7 of a green tyres 2 to be vulcanized. The working surface 5 therefore presents an annular development that is substantially coaxial to tyre 2.

The shells 4 reciprocally located near each other on the said equatorial plane also define a circumferential portion 8 predisposed to work against a tread band 9 of the tyre 2 to be vulcanized.

In the nonlimiting embodiment shown, the mould 1 is of the sector type.

Each of the two shells 4 have a cheek 4a with a working surface 5 and a plurality of circumferential sectors 10 separable from the cheek 4a and bearing half of the circumferential portion 8. When the mould is closed, the circumferential sectors 10 define, along with the cheeks 4a, the containment walls of the mould cavity 3.

Each of the cheeks 4a is also preferably realized in one piece by fusion and/or machining to remove material.

According to an embodiment variation not shown, the mould 1 is the type having two halves, in other words each of the shells 4 consists of one piece and therefore defines a semi-part of the mould 1. An inside surface of each of the two shells 4 includes the working surface 5

predisposed to work on the beads 6 and sidewalls 7 of the green tyre 2 to be vulcanized and half of the circumferential portion 8 working on the tread band 9. Whether the mould is the sector type or in two halves, the containment walls delimit an inside surface of the mould cavity 3 countershaped to the final shape to be given to the tyre 2.

After being closed in the mould 1, the green tyre 2 is pressed against the containment walls by means of a device designed for that purpose, for example defined by a membrane 11. Subsequent or simultaneous to the pressing phase, heat is applied to the tyre 2 pressed against the containment walls.

By effect of pressing, appropriate reliefs disposed on the sectors 10 and on the shells 4 determine the formation of a desired tread pattern on the tread band 9 of the tyre 2, and a plurality of graphic marks on the sidewalls 7 of the tyre 2. The heat applied determines the cross-linking of the elastomeric material which the tyres 2 is made of. When this cycle is finished, the mould 1 is opened and the moulded and vulcanized tyre 2 is removed from it.

On the working surface 5 of at least one of the two shells 4, and preferably both, a annular groove is obtained 12, which extends continuously along the whole

annular development of the working surface 5 and is predisposed to receive a respective annular insert 13. This annular insert 13 is fully visible in figures 3 and 3a.

The annular insert 13 is removably mounted in the annular groove 12 and has a moulding face 14 that, when the annular insert 13 is installed in the annular groove 12, is opposite the moulding cavity 3. The moulding face 14 has graphic marks 15 to imprint on the sidewall 7 of the vulcanized tyre 2. As shown by ways of examples only in figure 3, these graphic marks 15 could be words describing the brand of the tyre and/or its manufacturer, technical characteristics (tyre dimensions, maximum load, rotation direction, etc.), initials indicating compliance with regulatory specifications and/or ornamental motifs. The ornamental motifs can be defined by various textures to give the sidewall of the tyre 2 a particular look, for example with an opaque or glossy finish.

Said graphic marks 15 appear as a negative on the moulding face 14 in such a way that they are imprinted as a positive on the sidewall of the tyre 2. The graphic marks 14 are delimited by reliefs and matching recesses shaped on the said moulding face 14.

These reliefs/recesses can have thicknesses/depths from

a few tenths of a millimeter to a few millimeters and are preferably realized by photoengraving and/or spark erosion and/or mechanical removal of the material.

The annular insert 13 is therefore made of a material that can withstand the vulcanization temperatures without being altered and furthermore can be worked according to the aforementioned techniques. Preferably, the annular insert 13 is made of steel, aluminum or plastic.

As shown in figure 2, 2a and 2b, the annular groove 12 has a constant width "w" or radial dimension along its own circumferential development.

The width "l" or radial dimension of the annular insert 13 is also constant along its own circumferential development (figures 3 and 3a).

Preferably (figure 1), the ratio between the radial dimension "l" of the annular insert 13 and the height "h" of the sidewall 7 of the tyre 2 is from about 0.3 to about 0.7.

As illustrated in more detail in figures 2, 2a and 2b, the annular groove 12 has a bottom wall 16 that is flat and perpendicular to an "X" axis of the mould 1 and the tyre 2; it also has cylindrical sidewalls 17a, 17b perpendicular to the bottom wall 16.

With reference to the diametral section of figure 2, the

annular insert 13 has a back wall 18 that is flat and opposite the moulding face 14 and it can be pressed against the bottom wall 16 of the annular groove 12. The moulding face 14 has a substantially concave shape which, besides imprinting the graphic marks, gives the proper curve to the sidewall 7 of the tyre 2.

The annular insert 13 also has sidewalls 19a, 19b that are tapered, or reciprocally converging, from the moulding face 14 to the back wall 18.

In more detail, each of the sidewalls 19a, 19b has a cylindrical portion 20a, 20b perpendicular to the back wall 18 and a portion 21a, 21b that is slanted or truncated conical.

As shown in figure 2, when the insert 13 is mounted in the annular groove 12, the radially more external cylindrical portion 20b lies parallel to and facing the lateral wall 17b radially more external to the annular groove 12. At the same time the radially more internal cylindrical portion 20a lies parallel to and facing the lateral wall 17a radially more internal to the annular groove 12.

The height "h_a" or axial dimension of the radially more internal cylindrical portion 20a is preferably from about 3 mm to about 5 mm.

The height "h_b" or axial dimension of the radially more

external cylindrical portion 20b is preferably between about 3 mm and about 5 mm.

Preferably, when the tyre 2 is being heated and the mould 1 reaches a temperature of about 200 °C, each of the cylindrical portions 20a, 20b remains distanced from its own lateral wall 17a, 17b at a distance ranging from about 0.2 mm to 0.3 mm to delimit the air vent gaps. Additional gaps can be obtained between the moulding face 14 and the shell 4 by making axial grooves on the cylindrical portions 20a, 20b and/or on the sidewalls 17a, 17b of the annular groove 12.

The air remaining trapped between the tyre 2 and the mould 1 can thereby flow in the space delimited by the tapered sidewalls 19a, 19b of the annular insert 13 and the sidewalls 17a, 17b of the annular groove 12 to then be expelled through further channels (not shown here) which communicate with the aforesaid space.

Furthermore, a radially more internal edge 22a of the back wall 18 of the annular insert 13 is distanced from a respective radially more internal edge 23a of the annular groove 12 at a distance ranging from about 1 mm to about 2 mm.

Likewise, a radially more external edge 22b of the back wall 18 of the annular insert 13 lies distanced from a respective radially more external corner 23b of the

annular groove 12 at a distance ranging from about 1 mm to about 2 mm.

The radially more internal truncated conical portion 21a with its respective radially more internal sidewall 17a of the annular groove 12 delimits an angle "θ_a" ranging from about 5° to about 10°.

Likewise the radially more external 21b truncated conical portion with the respective radially more external sidewall 17b of the annular groove 12 delimits an angle "θ_b" ranging from about 5° to about 10°.

The apparatus also includes devices 24 that can lock the annular insert 13 in the annular groove 12 after being inserted into it.

In a preferred embodiment (figure 2), the locking devices 24 comprise 25 screws in through-holes 26 obtained through a wall 27 of the shell 4. The holes 26 lead to the bottom wall 16 of the annular groove 12 in such a way that a distal end 28 of each screw 25 is engaged to a corresponding seat 29 obtained in the back wall 18 of the annular insert 13. The head 30 of each screw 25 is preferably seated in a housing 31 obtained on the face of the wall 27 opposite the annular groove 12.

Preferably, the apparatus also includes devices 32 that can adjust the axial position of the moulding face 14.

Preferably, this adjustment is achieved by modifying the depth of the annular insert 13 in the annular groove 12.

According to one embodiment (figure 2b), these adjustment devices 32 are defined by adjustment screws or dowels inserted in threaded through-holes 33 obtained through the wall 27 of the shell 4. The threaded holes 33 lead to the bottom wall 16 of the annular groove 12 so that one distal end 34 of each screw or dowel 32 is engaged to the back wall 18 of the annular insert 13. After adjusting the position of the aforesaid distal end 34 by rotating the screw/dowel 32, the annular insert 13 is locked against the distal ends 34 by tightening the clamping screws 25.

According to another embodiment not shown here, the clamping screws also have the function of adjusting the depth of the annular insert 13.

According to another embodiment (figure 2a), one or more spacers 35 are inserted between the bottom wall 16 of the annular groove 12 and the back wall 18 of the annular insert 13; the annular insert 13 is then locked against the spacers 35 by tightening the clamping screws 25.

Instead of using the spacers it is also possible to vary the axial position of the moulding face 14 by adopting annular inserts 13 having the same graphic marks 15 but

with different thicknesses.

Regardless of the particular solution adopted, the moulding face 14 can be moved axially to create a projection or a recess on the working surface 5a of the shell 4 adjacent to the annular groove 12 and to the moulding face 14.

In an operative configuration (figures 2a and 2b), the moulding face 14 of the annular insert 13 projects beyond the working surface 5a adjacent to said moulding face 14 of a thickness "s", measured along an axial direction, ranging from about 0.5 mm to about 2 mm. The annular insert 13 therefore generates a respective cavity in the sidewall 7 of the tyre 2, the bottom surface of which bears the graphic marks 15.

In a different operative configuration (figure 2), the moulding face 14 of the annular insert 13 is recessed from the working surface 5a adjacent to said moulding face 14 of a thickness "s" ranging from about 0.5mm to about 2 mm, so that it defines a relief on the tyre 2. The surface of the relief axially external to the relief bears the graphic marks 15.

This adjustment also makes it possible to accurately check the maximum cord of the tyre 2, i.e. the maximum width of the tyre 2.

In fact, preferably, the annular insert 13 is positioned

in correspondence to an area of maximum axial width "z" of the moulding cavity 3, i.e. the area corresponding to the maximum cord of the vulcanized tyres 2. Given the curvature of the sidewall 7, the area of maximum axial width "z" coincides substantially with a circumference that in the diametral section of figure 1 corresponds to a point "z".

More in detail, according to one embodiment, a first portion "l_1" of the radial dimension "l" of the annular insert 13 is located in a position radially internal to the area of maximum axial width "z" of the moulding cavity 3 and the ratio between said first portion "l_1" and the radial dimension "l" of the annular insert 13 is preferably between about 0.1 and about 0.4. In other words, the annular insert 13 extends prevalently on a portion of the mould 1 radially external to the area of maximum axial width "z".

Seats 36 can also be made in the moulding face 14 of the annular insert 13 to accommodate auxiliary inserts 37, each having its own moulding face 38 opposite the cavity 3 when the auxiliary insert 37 is mounted in the respective seat 36 (figure 2b). The moulding face 38 of the auxiliary insert 37 can also have graphic marks to imprint on the tyre 2.

The annular insert 13 can be obtained, for example, by

fusion, moulding and/or removal of material. The graphic marks 15 and seats 36 (if any) for the auxiliary inserts 37 are made on the moulding face 14 before placing the annular insert 13 in the respective annular groove 12 of the shell 4.

Specifically, the seats 36 are obtained, for example, by removing material or directly by moulding.

According to one embodiment, the graphic marks 15 are made by photoengraving.

Photoengraving is a work technique for removing material from a surface. The surface is covered with a protection layer that reproduces the geometric shapes to be obtained. This layer proofs the covered areas of the surface, which is then immersed in or sprayed with an acid substance that etches the unprotected parts, thereby removing the material.

In alternative the graphic marks 15 are made by spark erosion.

Spark erosion is a work process that consists of removing material from a piece by using electric sparks as a working means. This technique works all materials that are conductors of electricity, no matter how hard they are. The working action occurs by bringing the tool/electrode near the workpiece, after filling the working tub with a liquid dielectric. The electrode is

powered with a positive polarity in relation to the piece so that the negatively charged material undergoes more erosion. When the electrode and the piece are sufficiently close to each other, sparks are triggered between them that erode the piece in a way that is complementary to the shape of the electrode.

In accordance with one embodiment, the graphic marks 15 can also be made by working with milling machines.

To vulcanize and mould the tyre 2, preworked and preassembled annular inserts 13 (i.e. having the chosen graphic marks and auxiliary inserts) are mounted in the respective annular groove(s) 12 of the mould 1. Either the annular inserts 13 are chosen of the suitable thickness or the depth of the respective annular groove 12 is adjusted.

The green tyre 2 closed in the mould 1 is pressed against the containment walls and heat is applied.

After vulcanization is completed, the mould is opened to remove the vulcanized tyre 2 and introduce a subsequent one to be vulcanized.

If it is necessary to obtain different decorations and/or wording on the sidewall 7 of the subsequent tyre 2, it is sufficient to substitute the annular insert 13 with a new annular insert 13 bearing different graphic marks and/or auxiliary inserts and repeat the above

process.

CLAIMS

1. Apparatus for moulding and vulcanizing tyres, comprising:

a mould (1) for forming a moulding cavity (3) having a conformation corresponding to the outside conformation to be given to the vulcanized tyre and comprising a pair of shells (4) axially opposed and each having a working surface (5); said working surface (5) having an annular development and being predisposed to operate on beads (6) and sidewalls (7) of a green tyre (2) to be vulcanized,

wherein the working surface (5) of at least one of the shells (4) has an annular groove (12) developing along the annular development of said working surface (5) and an annular insert (13) removably mounted in the annular groove (12); said annular insert (13) having a moulding face (14) opposite the moulding cavity (3) and having graphic marks (15) to imprint on the sidewall (7) of the tyre (2).

2. Apparatus according to claim 1, wherein the graphic marks (15) on the moulding face (14) of the annular insert (13) are obtained by photoengraving.

3. Apparatus according to claim 1, wherein the graphic marks (15) on the moulding face (14) of the

annular insert (13) are obtained by spark erosion.

4. Apparatus according to claim 1, wherein the annular insert (13) has seats (36) for auxiliary inserts (37).

5. Apparatus according to claim 1, wherein the annular insert (13) is made of aluminum.

6. Apparatus according to claim 1, wherein the annular insert (13) is made of steel.

7. Apparatus according to claim 1, wherein the annular insert (13) is made of plastic.

8. Apparatus according to claim 1, also comprising devices (24) for locking the annular insert (13) into the annular groove (12).

9. Apparatus according to claim 1, also comprising devices (32) for adjusting the depth of the position of the annular insert (13) into the annular groove (12).

10. Apparatus according to claim 9, wherein, in one operative configuration, the moulding face (14) of the annular insert (13) projects beyond a surface (5a) of the shell (4) adjacent to said moulding face (14) by a higher thickness (s) of about 0.5 mm.

11. Apparatus according to claim 9, wherein, in one operative configuration, the moulding face (14) of the annular insert (13) projects beyond a surface (5a) of the shell (4) adjacent to said moulding face (14) by a

lower thickness (s) of about 2 mm.

12. Apparatus according to claim 9, wherein in one operative configuration, the moulding face (14) of the annular insert (13) is recessed with respect to a surface (5a) of the shell (4) adjacent to said moulding face (14) by a higher thickness (s) of about 0.5 mm.

13. Apparatus according to claim 9, wherein, in one operative configuration, the moulding face (14) of the annular insert (13) is recessed from a surface (5a) of the shell (4) adjacent to said moulding face (14) by lower thickness (s) of about 2 mm.

14. Apparatus according to claim 1, wherein the annular insert (13) is positioned in correspondence to an area (z) of maximum axial width of the moulding cavity (3).

15. Apparatus according to claim 1, wherein the ratio between a radial dimension (l) of the annular insert (13) and the height (h) of the sidewall (7) of the tyre (2) is more than about 0.3.

16. Apparatus according to claim 1, wherein the ratio between a radial dimension (l) of the annular insert (13) and the height (h) of the sidewall (7) of the tyre (2) is less than about 0.7.

17. Apparatus according to claim 1, wherein a first portion (l_1) of a radial dimension (l) of the annular

insert (13) is located in a position radially internal to an area (z) of maximum axial width of the moulding cavity (3); the ratio between said first portion (l_1) and the radial dimension (l) of the annular insert (13) is more than about 0.1.

18. Apparatus according to claim 1, wherein a first portion (l_1) of a radial dimension (l) of the annular insert (13) is located in a position radially internal to an area (z) of maximum axial width of the moulding cavity (3); the ratio between said first portion (l_1) and the radial dimension (l) of the annular insert (13) is less than about 0.4.

19. Apparatus according to claim 1, wherein the annular insert (13) has tapered sidewalls (19a, 19b) inserted in the annular groove (12) and facing sidewalls (17a, 17b) of said annular groove (12).

20. Apparatus according to claim 19, wherein the tapered sidewalls (19a, 19b) make an angle (θ) with the respective sidewalls (17a, 17b) of the annular groove (12) which is greater than about 5°.

21. Apparatus according to claim 19, wherein the tapered sidewalls (19a, 19b) make an angle (θ) with the respective sidewalls (17a, 17b) of the annular groove (12) which is smaller than about 10°.

22. Apparatus according to claim 19, wherein,

between the moulding face (14) of the annular insert (13) and the shell (4), there are vent holes for the air in fluid communication with a space delimited between the tapered sidewalls (19a, 19b) of said annular insert (13) and the sidewalls (17a, 17b) of said annular groove (12).

23. Apparatus according to claim 1, wherein each shell (4) of the mould (1) is made of one piece.

24. Process for moulding and vulcanization of tyres, comprising the phases of:

preparing a mould (1) for forming a moulding cavity (3) corresponding to the outside shape of the vulcanized tyre and comprising a pair of shells (4) axially opposed; each of said shells (4) having a working surface (5) with an annular development and predisposed to operate on beads (6) and on sidewalls (7) of a green tyre (2) to be vulcanized;

obtaining on at least one of the working surfaces (5) an annular groove (12) developing along the annualr development of said working surface (5);

preparing an annular insert (13) comprising a moulding face (14) having graphic marks (15) to imprint on a sidewall (7) of the tyre (2);

removably mounting the annular insert (13) in the annular groove (12) with the moulding face (14) opposite

the moulding cavity (3);

introducing a green tyre (2) to be vulcanized in the moulding cavity (3);

closing the mould (1) to predispose the working surfaces (5) to operate on the beads (6) and the sidewalls (7) of the green tyre (2) to be vulcanized;

pressing the green tyre (2) against the working surfaces (5) to imprint the graphic marks (15) on the sidewall (7) of the tyre (2) and apply heat to the green tyre (2).

25. Process according to claim 24, wherein the phase of preparing an annular insert (13) comprises:

making the graphic marks (15) on the moulding face (14) before mounting said annular insert (13) in the annular groove (12).

26. Process according to claim 24, wherein the phase of preparing an annular insert (13) comprises:

making graphic marks (15) on the moulding face (14) by photoengraving.

27. Process according to claim 24, wherein the phase of preparing an annular insert (13) comprises:

making graphic marks (15) on the moulding face (14) by means of spark erosion.

28. Process according to claim 24, wherein the phase of preparing an annular insert (13) comprises:

making seats (36) for auxiliary inserts (37) in the moulding face (14) of the annular insert (13).

29. Process according to claim 28, wherein the phase of preparing an annular insert (13) comprises:

making seats (36) for auxiliary inserts (37) in the moulding face (14) of the annular insert (13) before mounting the annular insert (13) in the annular groove (12).

30. Process according to claim 28, wherein the phase of preparing an annular insert (13) comprises:

making seats (36) for auxiliary inserts (37) in the moulding face (14) of the annular insert (13);

installing the auxiliary inserts (37) in the seats (36) of the moulding face (14) of the annular insert (13) before mounting said annular insert (13) in the annular seat (12).

31. Process according to claim 28, wherein the phase of mounting an annular insert (13) comprises:

adjusting the depth of the annular insert (13) in the annular groove (12).

32. Process according to claim 24, wherein, after the phase of applying heat to the green tyre (2), the following phases are carried out:

opening the mould (1);

removing the vulcanized tyre (2);

replacing the annular insert (13) with a new annular insert (13) to imprint different graphic marks (15) on the sidewall (7) of a subsequent tyre (2);

introducing a subsequent green tyre (2) to be vulcanized in the moulding cavity (3);

closing the mould (1) to predispose the working surfaces (5) to work on the beads (6) and sidewalls (7) of said subsequent green tyre (2) to be vulcanized;

pressing said subsequent green tyre (2) against the working surfaces (5) to imprint graphic marks (15) on the sidewall (7) of the tyre (2), and

applying heat to said subsequent green tyre (2).

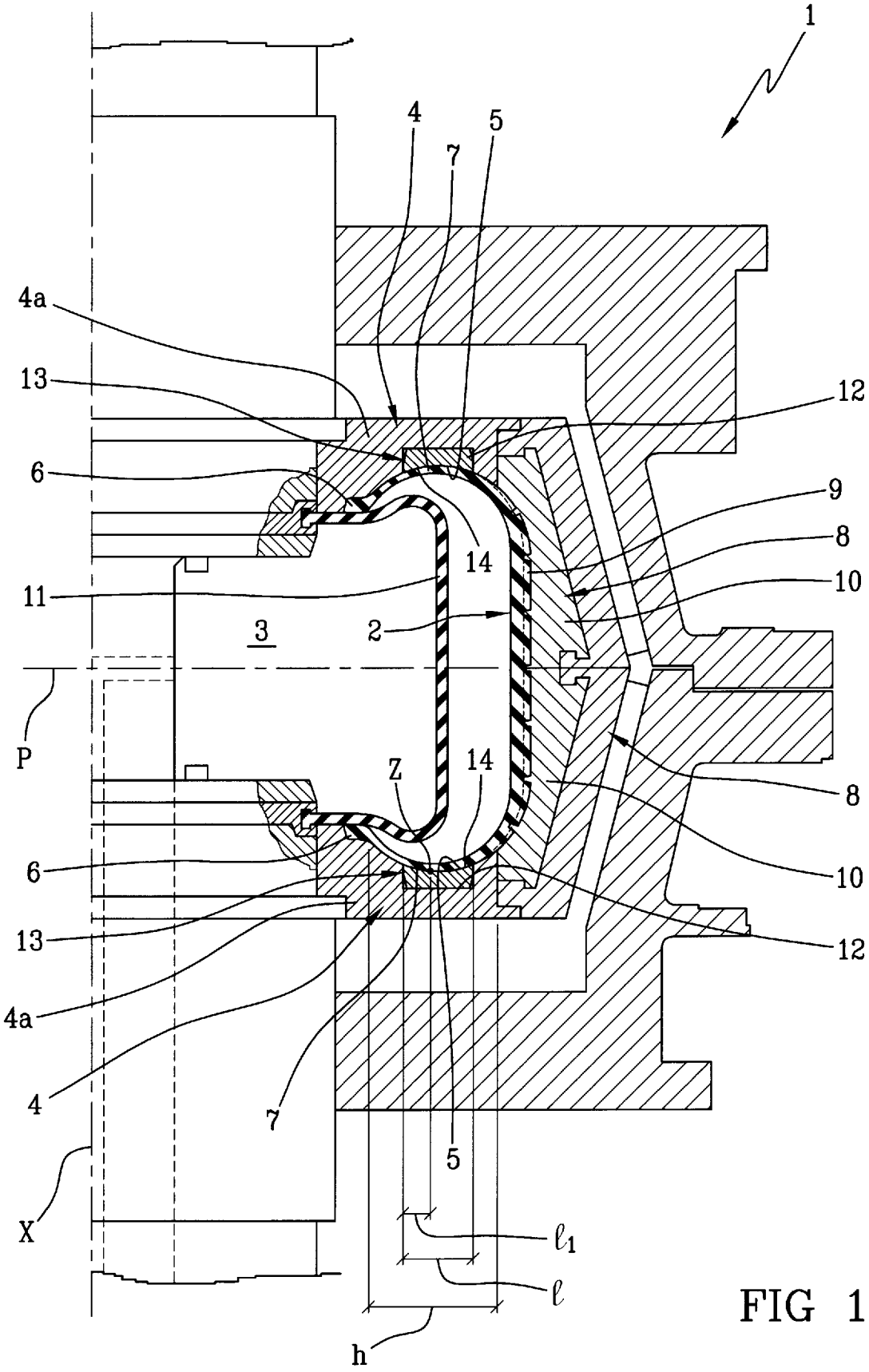


FIG 1

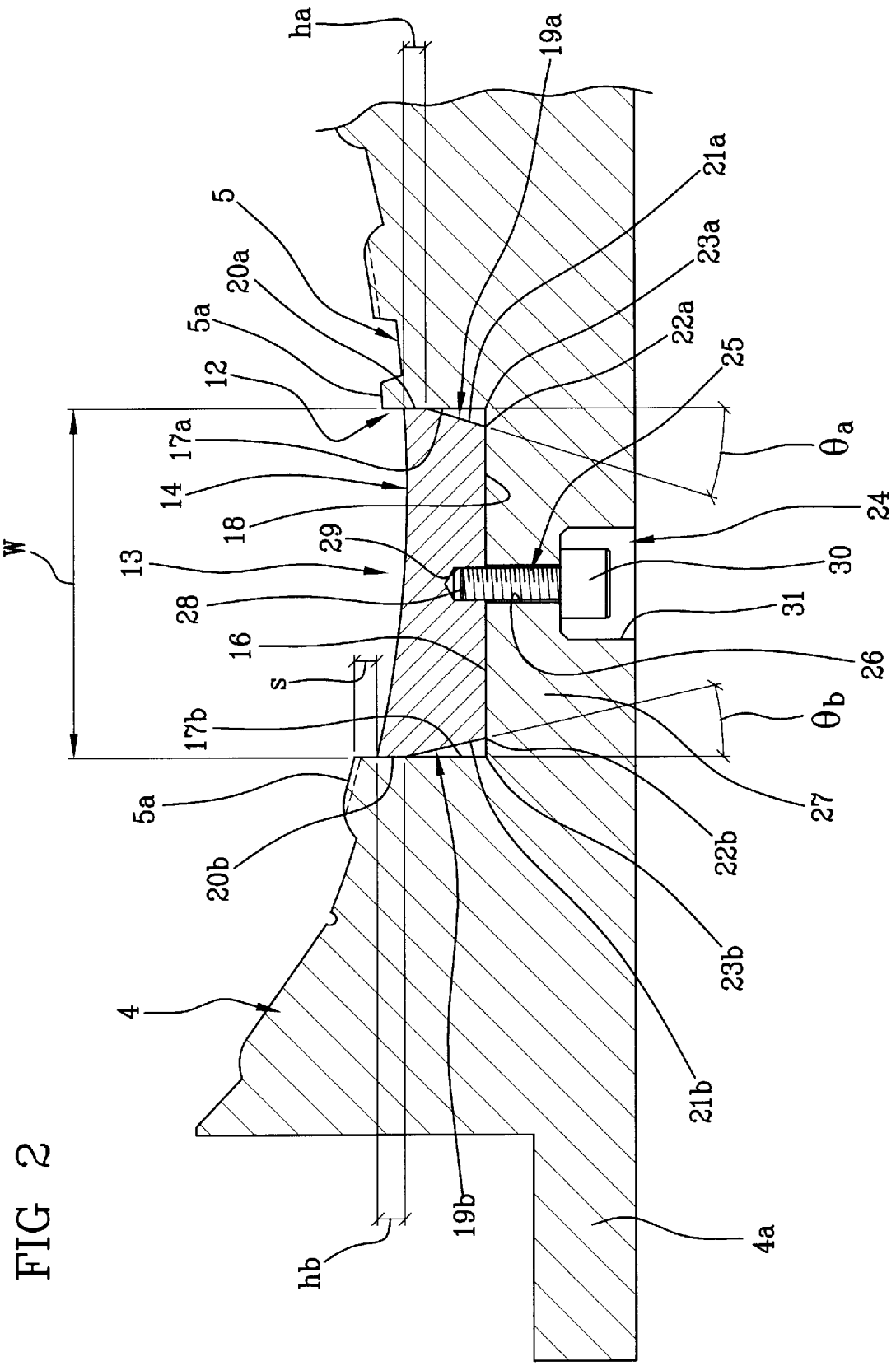

ha
19a
21a
5
23a
20a
22a
5a
25
12
θa
17a
14
24
18
29
W
13
30
28
31
16
26
s
θb
17b
27
5a
22b
20b
23b
4
21b
19b
4a
hb

FIG 2

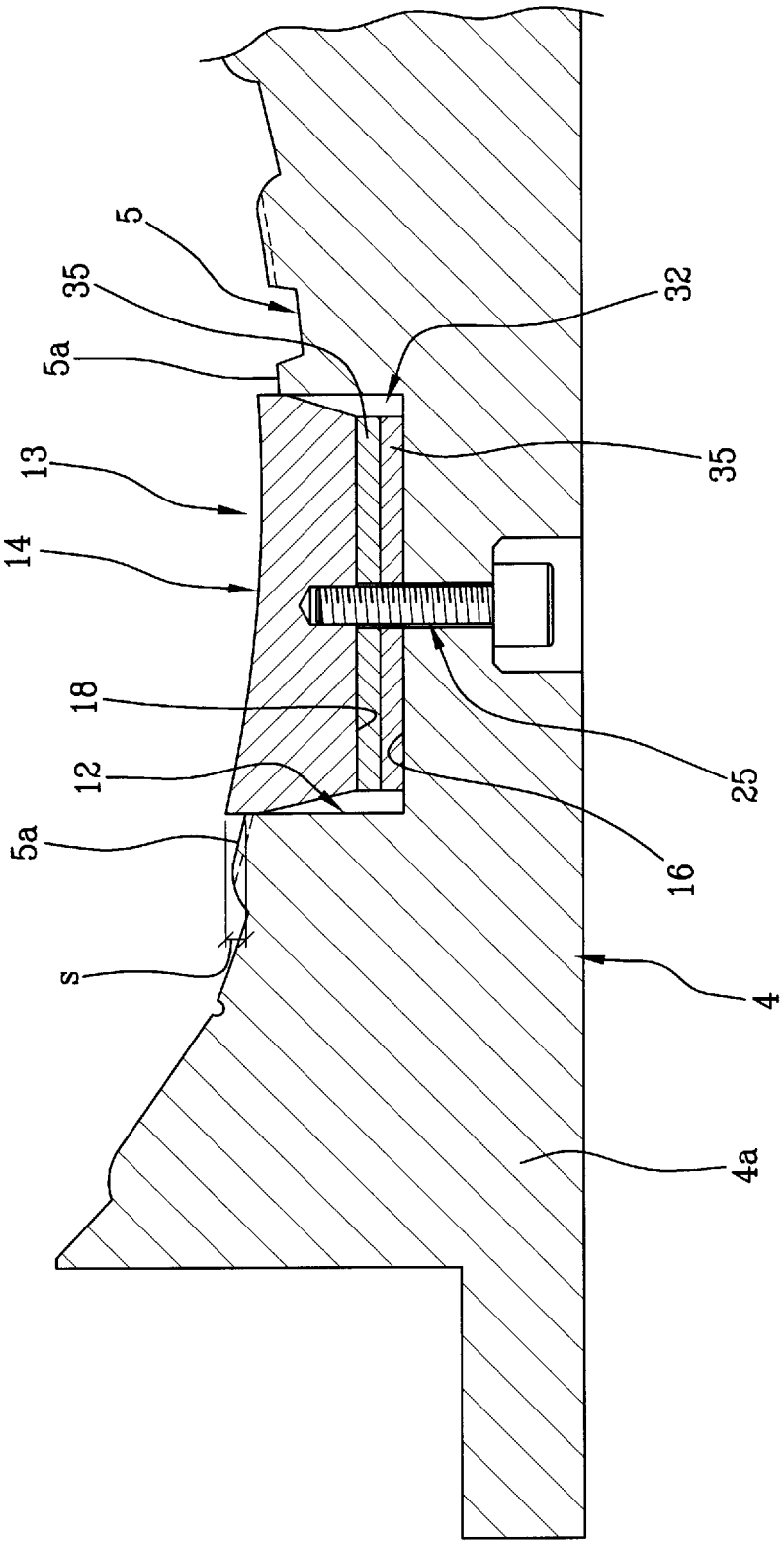


FIG 2a

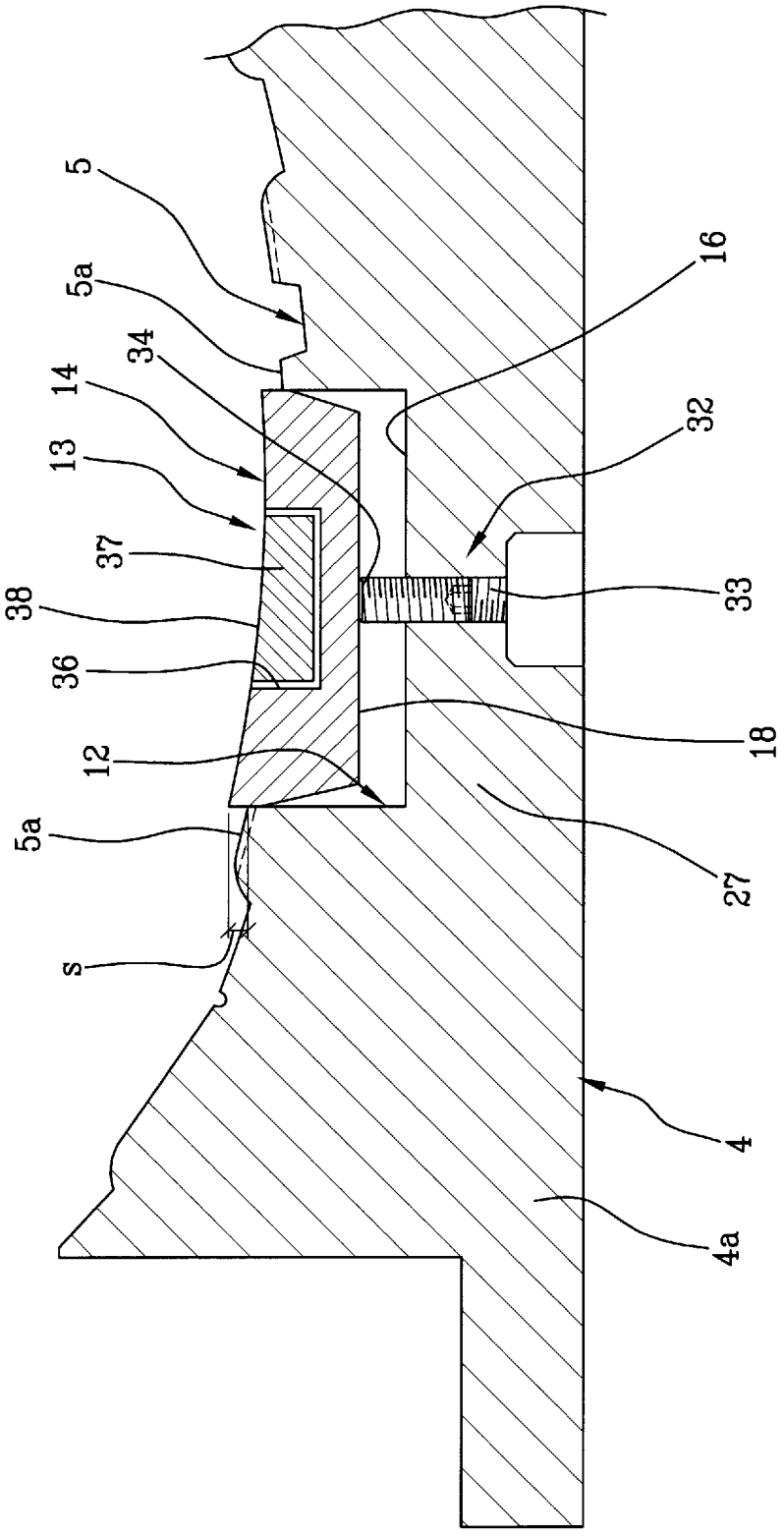


FIG 2b

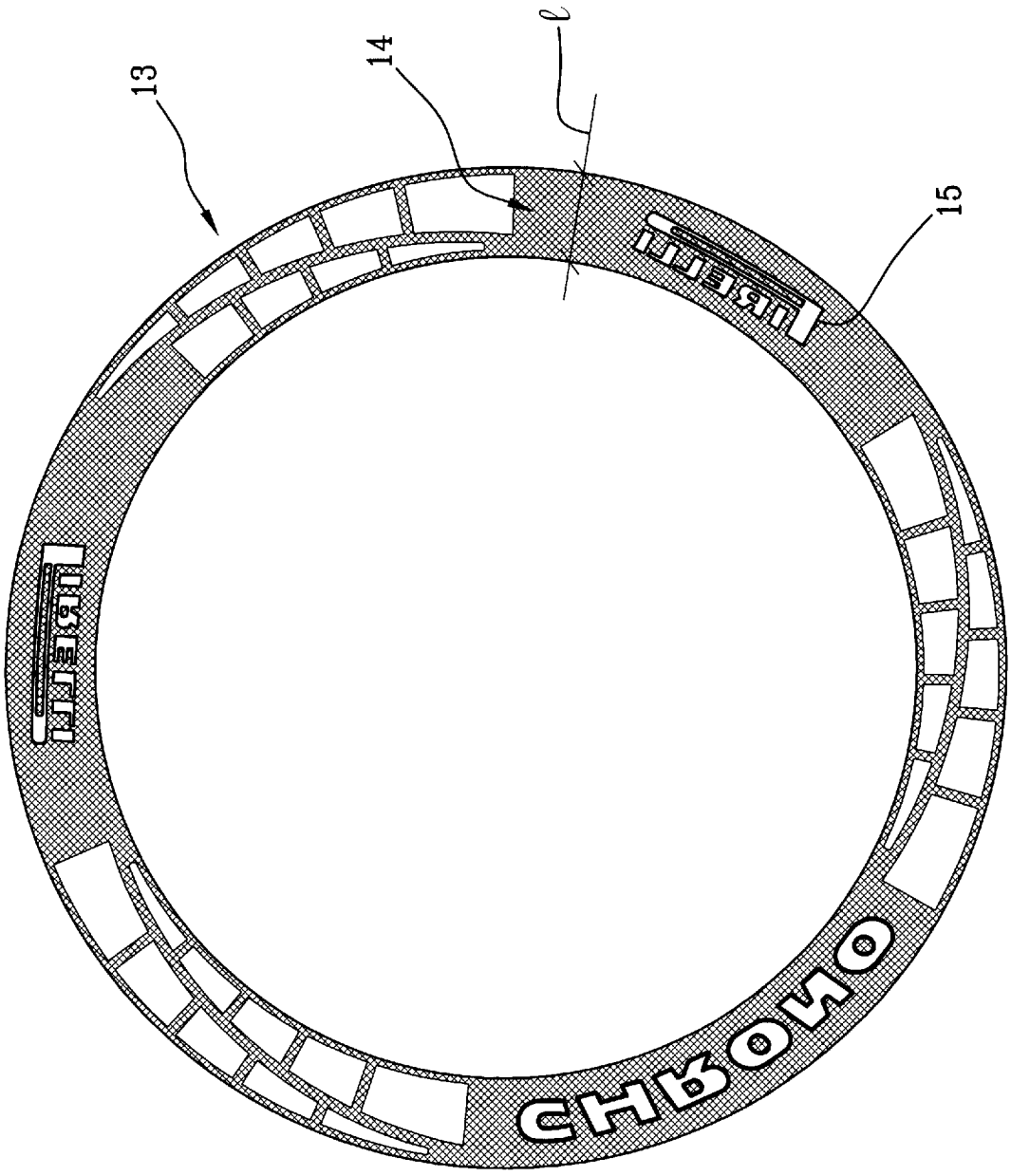
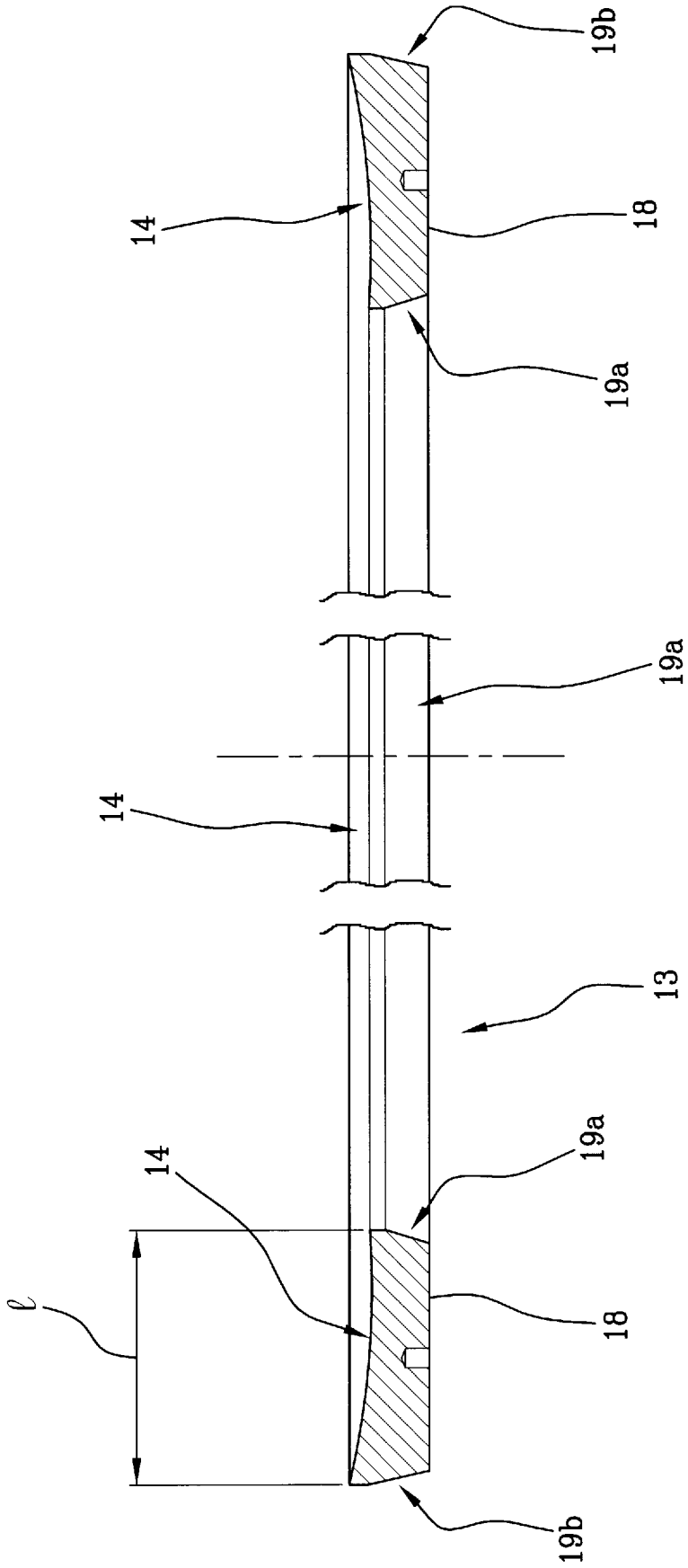


FIG 3

FIG 3a



INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2007/052768

A. CLASSIFICATION OF SUBJECT MATTER
INV. B29D30/06 B29D30/72 B29C35/02

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B29C B29D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 61 019314 A (TOYO TIRE & RUBBER CO) 28 January 1986 (1986-01-28) abstract; figures 1-3	1-32
Y	JP 63 264308 A (YOKOHAMA RUBBER CO LTD) 1 November 1988 (1988-11-01) abstract; figure 1	1-32
Y	GB 2 341 339 A (DUNLOP TYRES LTD [GB]) 15 March 2000 (2000-03-15) page 3, line 4 - page 4, line 3 page 6, line 5 - page 7, line 18 page 8, lines 4-18; claims 1-3,8; figures 1-7	1-32
Y	JP 01 310913 A (TOYO TIRE & RUBBER CO) 15 December 1989 (1989-12-15) abstract; figures 1-5	1-32

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
17 March 2008	31/03/2008

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Deubler, Ulrich

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2007/052768

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2 296 016 A (BOSTWICK HENRY C) 15 September 1942 (1942-09-15) column 1, lines 1-17 column 1, line 55 - column 2, line 19; claim 1; figures 1-4	1-32
Y	JP 11 333844 A (YOKOHAMA RUBBER CO LTD) 7 December 1999 (1999-12-07) abstract; figures 1-4	1-32

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
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