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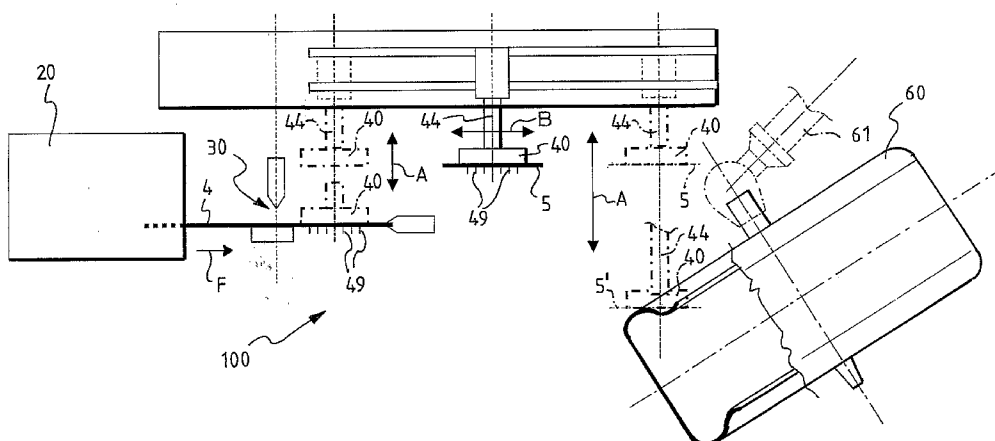
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(54) Title: PROCESS FOR MANUFACTURING TYRES FOR VEHICLE WHEELS



(57) Abstract: A process for manufacturing tyres for vehicle wheels, comprising building, on a toroidal support (60), a carcass structure comprising at least one carcass ply associated, at axially opposite end edges thereof, with annular anchoring structures, the building step of the carcass structure comprises forming at least one reinforcing structure, operatively associated with the annular anchoring structures through deposition on the toroidal support (60) of at least one reinforcing element (5') along a predetermined curvilinear deposition path. The deposition of the at least one reinforcing element (5') comprises the steps of: cutting to size a piece (5) of at least one reinforcing continuous band-like element (4) fed by a feeding device (20) along a predetermined feeding direction (F), deforming the piece (5) obtained according to the curvature of a deposition part of the deposition path intended to receive said piece (5), and depositing the deformed piece at the deposition part. An apparatus (100) for carrying out such a process is also described.

Process for manufacturing tyres for vehicle wheels

DESCRIPTION

The present invention relates to a process for manufacturing tyres for vehicle wheels.

- 5 The invention also relates to an apparatus for the deposition of at least one reinforcing element on a toroidal support, said apparatus being able to be used to carry out the aforementioned process.

10 In the present description and in the subsequent claims, the term "reinforcing element" is used to indicate an element comprising one or more thread-like reinforcing elements, such as textile or metallic cords, incorporated in, or coated with, a layer of elastomeric material.

15 It should also be specified that, in the present description and in the subsequent claims, the term: elastomeric material, is used to indicate a composition comprising at least one elastomeric polymer and at least one reinforcing filler. Preferably, such a composition also comprises additives like, for example, a cross-linking agent and/or a plasticiser. Thanks to the provision of the
20 cross-linking agent, such a material can be cross-linked through heating, so as to form the final product.

A tyre for vehicle wheels generally comprises a carcass structure comprising at least one carcass ply formed from
25 reinforcing cords incorporated in an elastomeric matrix. The carcass ply has end edges respectively engaged with annular anchoring structures, arranged in the areas usually identified with the name "beads" and normally each formed from a substantially circumferential annular insert on
30 which at least one filling insert is applied, in a radially outer position thereof. Such annular structures are commonly referred to as "bead cores" and have the task of keeping the tyre well fixed to the anchoring seat specifically provided in the rim of the wheel, thus

avoiding in operation the radially inner end edge of the tyre coming out from such a seat.

At the beads specific reinforcing structures can be provided having the function of improving the torque transmission to the tyre. The region of the beads, indeed, is particularly active in the transmission of torque from the rim to the tyre when accelerating and when braking and, therefore, the provision of appropriate reinforcing structures in such an area ensures that the torque transmission occurs with the maximum possible reactivity.

In a radially outer position with respect to the carcass ply a belt structure comprising one or more belt layers is associated, said belt layers being arranged radially one on top of the other and having textile or metallic reinforcement cords with crossed orientation and/or with an orientation substantially parallel to the direction of circumferential extension of the tyre.

Between the carcass structure and the belt structure a layer of elastomeric material can be provided, known as "under-belt", having the function of making the radially outer surface of the carcass structure as uniform as possible for the subsequent application of the belt structure.

In a radially outer position with respect to the belt structure a tread band is applied, also made from elastomeric material like other structural elements making up the tyre.

Between the tread band and the belt structure a so-called "under-layer" of elastomeric material can be arranged, said layer having properties suitable to ensure a steady union of the tread band itself.

On the side surfaces of the carcass structure, respective sidewalls of elastomeric material are also applied, each extending from one of the side edges of the tread band up

to the respective annular anchoring structure to the beads.

Conventional manufacturing processes of tyres for vehicle wheels essentially provide for the components of the tyre listed above to be firstly made separately from each other, to then be assembled in a subsequent building step of the tyre.

Nevertheless the current tendency is that of using manufacturing processes that allow the production and storage of semi-finished products to be minimised, or possibly, eliminated.

More specifically, attention has now turned towards process solutions that allow the individual components of the tyre to be made by directly applying them, according to a predetermined sequence, onto the tyre being built on a forming support, typically toroidal or cylindrical.

For example, in document WO 01/36185 to the same Applicant, the components of the tyre are made on a toroidal support by sequentially depositing a plurality of reinforcing elements thereon, the reinforcing elements consisting for example of individual rubberised cords or of rubberised cords grouped in parallel in the form of strip-like elements, particularly used in making the carcass and belt structure, and of continuous elongated elements in elastomeric material, particularly used for making the other structural components of the tyre, such as for example tread band, sidewalls, liners, fillers.

Document US 6,355,126 describes for example a method and an apparatus for making a belt layer through deposition on a suitably positioned forming support of band-like pieces cut from a continuous band-like element. The band-like pieces, once cut from the continuous band-like element, are picked up through gripping means and moved to the forming support for deposition.

In EP 1 418 043 A2 a method and an apparatus for forming an

annular elastomeric component of a tyre, in particular an insert for filling the beads, are described. The described method comprises an annular extrusion step of elastomeric material on a forming support and a modelling step, through
5 the action of a modelling extruder on the surface of the forming support, of the material deposited to obtain the desired profile for the component.

In US 6,379,493 B1 a device for the transportation and deposition onto a forming support of a tyre of pieces cut
10 to size of elastomeric material is described, said pieces being in particular intended to form inserts for filling the beads. The device comprises rotatable gripping devices which are movable along a direction essentially tangential to the circumferential surface of the forming drum and
15 which allow each piece to be gripped and deposited in a predetermined position on the forming drum.

With particular reference to the region of the tyre defined at the bead, the Applicant has realised the importance of providing in this region a reinforcing structure, as
20 described with reference to the tyre structure discussed above.

In conventional processes, the reinforcing structure intended to be applied in the region of the bead of the tyre consists of one or more semi-finished products made in
25 the form of reinforced continuous band-like elements. Such band-like elements are made separately from the rest of the components of the tyre and then assembled on the tyre in the building step of the tyre. These band-like elements, in particular, are associated with the tyre in the building
30 step in a side-by-side relationship.

The Applicant has considered the problem of making and applying, on a substantially toroidal forming support, a reinforcing structure comprising one or more reinforcing layers, each of which comprising a plurality of reinforcing
35 elements orientated in a non-circumferential direction, for

example in a substantially radial direction, in the region of the bead of the tyre in a process for producing tyres for example of the type described in document WO 01/36185 mentioned previously.

- 5 The Applicant has verified the possibility of forming on a substantially toroidal forming support a reinforcing structure as described above by applying at least one reinforcing element along a predetermined curvilinear deposition path, said deposition path being defined for
10 example at the region of the bead on a not perfectly planar surface of the forming support.

The Applicant has also verified the possibility of carrying out the aforementioned application while maintaining the maximum possible flexibility in terms of diameter,
15 thickness and inclination of the reinforcing elements, avoiding the formation of possible defects on the tyre, like for example overlapping or undesired spaces between contiguous portions of such reinforcing elements, so as to ensure a deposition according to the design and thus to
20 ensure increasingly high quality and performance levels of the tyre.

The Applicant has found that by depositing, in sequence and in a side-by-side relationship on a toroidal forming support of a tyre a plurality of pieces cut to size from a
25 continuous reinforcing band-like element, along a predetermined deposition path defined at the region of the bead, wherein each of such pieces is deformed before being deposited according to the curvature of the respective deposition part intended to receive it, it is possible to
30 obtain a tyre built substantially without defects in the region of the bead even with complex design geometries of the tyre itself.

The present invention therefore relates, in a first aspect thereof, to a process for manufacturing tyres for vehicle
35 wheels, comprising building on a toroidal support a carcass

structure comprising at least one carcass ply associated, at axially opposite end edges thereof, with annular anchoring structures;

5 wherein the step of building said carcass structure comprises forming at least one reinforcing structure, operatively associated with said annular anchoring structures through deposition on said toroidal support of at least one reinforcing element along a predetermined curvilinear deposition path;

10 wherein the deposition step of said at least one reinforcing element comprises the steps of:

- cutting to size a piece of at least one continuous reinforcing band-like element;

- deforming the piece according to the curvature of a 15 deposition part of the deposition path intended to receive the piece;

- depositing the deformed piece at the deposition part;

- repeating the cutting, deformation and deposition steps for a predetermined number of times, each time changing the 20 deposition part so as to deposit a plurality of pieces in a side-by-side relationship along the deposition path.

Advantageously, the process of the present invention allows, in a process for manufacturing tyres for example of the type described in document WO 01/36185, a reinforcing 25 structure to be made that is substantially homogeneous and uniform at the region of the bead of the tyre. The homogeneity and uniformity of the reinforcing structure is achieved through a sequential deposition in a side-by-side relationship of pieces of a continuous reinforcing band- 30 like element previously deformed according to the curvature of the part of the curvilinear deposition path defined on the surface of the toroidal support and intended to receive from time to time the deformed piece. Such a deformation ensures that the pieces can be positioned side-by-side 35 along the predetermined deposition path without creating overlapping or undesired intermediate spaces. This occurs irrespective of the diameter, the thickness and the

inclination of the pieces.

It is thus possible to make on a toroidal forming support a reinforced tyre at the region of the bead having high quality levels and, consequently, high performance.

- 5 Preferably, in the cutting to size step the continuous reinforcing band-like element is fed by a feeding device along a predetermined feeding direction.

Preferably, in the deformation step the piece is deformed substantially in the plane on which it lies.

- 10 In a preferred embodiment of the process of the invention, the deformation step comprises the steps of:
- gripping the piece at two opposite sides thereof;
 - rotating at least one side of the piece by a predetermined angle of rotation away from the other side
- 15 about a respective pin axis.

Advantageously, this way of deformation allows the piece to be given the same curvature as the deposition part on which the piece is intended to be deposited, with high flexibility and through conventional mechanical rotation

20 movements.

Preferably, the aforementioned opposite sides of the piece are parallel to the feeding direction of the continuous reinforcing band-like element.

- 25 Preferably, the gripping step is carried out in such a way that said pin axis is arranged at an end area of said at least one side.

Preferably, the end area of said at least one side is intended to be deposited at a radially inner end area of the deposition part.

- 30 The extent of the angle of rotation is preferably between about 1° and about 10°.

In a preferred embodiment of the process of the invention the rotation step comprises the step of:

- rotating both opposite sides of the piece by respective predetermined angles of rotation away from each other about
5 respective pin axes.

Also in this case, the gripping step is preferably carried out in such a way that the pin axes are arranged at respective end areas of said opposite sides.

- 10 Preferably, such end areas are intended to be deposited at respective radially inner end areas of the deposition part.

Preferably, the aforementioned respective angles of rotation are equal to each other.

The extent of such angles of rotation is preferably between about 1° and about 10°.

- 15 In a preferred embodiment of the process of the invention, the deposition path extends along an annular portion of the toroidal support, said portion being substantially circular with centre lying on a rotation axis of the toroidal support, and the piece is deformed according to a radius of
20 the aforementioned annular portion.

Preferably, the aforementioned annular portion has an inner radius of between about 200 mm and about 350 mm.

- 25 In a preferred embodiment of the process of the invention, the deposition step of the at least one reinforcing structure also comprises the step of:

- moving the piece between a first position at the feeding device and a second position at the toroidal support.

- 30 Preferably, in this case, the deformation step of the piece is carried out during the moving step. The execution of the deformation step during the moving step advantageously allows the overall time taken to carry out the deposition

process to be reduced.

Preferably, the cutting, deformation and deposition steps are repeated for a number of times at least sufficient to cover substantially the entire deposition path through a plurality of said pieces.

In a preferred embodiment, the process of the invention further comprises the step of:

- passing a pressing member on one or more of said deposited pieces.

Advantageously, this further step ensures that the pieces deposited stick perfectly and along their entire surface to the underlying structures of the tyre being processed.

Preferably, the at least one continuous reinforcing band-like element has a width of between about 10 mm and about 50 mm.

Preferably, the at least one continuous reinforcing band-like element comprises at least one thread-like reinforcing element incorporated in an elastomeric material.

Preferably, in the cutting step the piece is cut according to a cutting angle of between about 0° and about 70°.

More preferably the cutting angle is between about 20° and about 65°.

Preferably, in the deposition step the piece is deposited at the deposition part along a direction forming a predetermined deposition angle defined between a radial direction of the toroidal support passing, at the moment of deposition, through a radially inner point of the piece and belonging to a direction of longitudinal extension of the piece, and the same direction of longitudinal extension.

Preferably, the deposition angle is between about 0° and about 35°.

Preferably, in the deformation step the deformation of the piece is carried out according to said deposition angle.

Preferably, in the deformation step the deformation of the piece is carried out according to said cutting angle.

- 5 Preferably, each reinforcing element comprises at least one thread-like reinforcing element orientated at the end of said deposition step so as to form an angle, with the radial direction passing through the radially inner end thereof, having a width greater than or equal to 0° and
10 lower than 90° .

In a second aspect thereof, the present invention relates to an apparatus for the deposition on a toroidal support of at least one reinforcing element of a tyre for vehicle wheels, comprising:

- 15 - a feeding device of a continuous reinforcing band-like element;
- a cutting device for cutting to size a piece of the continuous reinforcing band-like element;
- a gripping device for gripping the piece and depositing
20 it on the toroidal support at a deposition part of a predetermined curvilinear deposition path;
wherein the gripping device comprises a device for deforming the piece according to the curvature of the deposition part.
- 25 Such an apparatus can advantageously be used to carry out the process of the present invention described above.

Preferably, the feeding device feeds the continuous band-like element along a predetermined feeding direction.

- 30 Preferably, the gripping device comprises at least two gripping elements, at least one of which is rotatable in a plane coinciding with or substantially parallel to a gripping plane about a respective pin axis substantially perpendicular to such a gripping plane.

In the present description and in the subsequent claims, the term "gripping plane" is used to indicate the plane on which the piece lies at the moment when it is gripped by the gripping device.

- 5 Through such rotatable gripping elements it is advantageously possible to obtain the deformation of the piece as outlined above with reference to the process of the invention in a simple way and with high flexibility.

- 10 Preferably, the at least two gripping elements are both rotatable about respective pin axes substantially perpendicular to the gripping plane.

Preferably, each of the at least two gripping elements comprises a plurality of needles adapted to penetrate into a respective portion of said piece.

- 15 Preferably, such needles are aligned along a longitudinal direction of the at least two gripping elements.

Advantageously, such needles allow a secure gripping to be achieved even on small surfaces, as the edges of the piece could be at the gripping sides.

- 20 Preferably, the needles of said plurality of needles are individually movable in respective housing seats defined in the at least two gripping elements.

- 25 Preferably, each of such housing seats comprises a pneumatic cylinder adapted to control the movement of the movable needle in the respective housing seat. More preferably, such pneumatic cylinders are in fluid communication with each other.

- 30 Advantageously, the independent stroke of each needle allows, in the deposition step, a perfect sticking of the gripping sides of the piece to the respective deposition part to be ensured, even when it has a surface that is not flat, like in the case of deposition on toroidal drums at

the region of the beads. More specifically, each pneumatic cylinder associated with the corresponding needle, thanks to its sliding on the needle itself, allows the detachment of the individual reinforcing element to be counteracted at the end of the deposition when the needles lift up after the positioning of the reinforcing element. Should the friction between needles and reinforcing element indeed be greater than the sticking action of the reinforcing element on the drum, without the aforementioned pneumatic cylinders, the reinforcing element would remain fixed to the needles.

In a preferred embodiment of the apparatus of the invention, the at least two elements comprise respective skids capable of sliding longitudinally with respect to a fixed body of the gripping device. More preferably, such skids are capable of sliding independently from each other.

The provision of sliding skids advantageously allows the mutual longitudinal position of the gripping elements to be adjusted, so as to ensure optimal gripping even when the gripping sides of the piece are staggered apart in the feeding direction due to the fact that the piece is cut from the continuous reinforcing band-like element with a cutting angle different to 90° with respect to such a feeding direction.

Preferably, the gripping device is movable with respect to the feeding device and to the cutting device along two translation directions substantially perpendicular to each other.

Preferably, the gripping device is movable from a first position near to the cutting device to a second position near to the toroidal support.

In a preferred embodiment of the apparatus of the present invention, the gripping device comprises a permanent magnet positioned between the at least two gripping elements and

facing the gripping plane of the piece.

Advantageously, such a permanent magnet can contribute to the gripping of the piece in the case in which the latter comprises thread-like reinforcing elements made of steel.

- 5 Preferably, the apparatus of the invention further comprises a pressing member adapted to exert a pressure on the piece deposited on the toroidal support.

Further characteristics and advantages of the present invention shall become clearer from the following detailed
10 description of a preferred embodiment of an apparatus and of a process in accordance with the present invention, made with reference to the attached drawings. In such drawings:

- figure 1 is a view from above that schematically illustrates the cutting to size and deformation steps of
15 pieces of a continuous reinforcing band-like element in accordance with the process of the present invention;
- figure 2 is a side view that schematically illustrates the pieces of figure 1 deposited on corresponding deposition parts of a deposition path defined on a toroidal
20 support;
- figure 2a is a perspective view that schematically shows the pieces of figure 1 deposited through the process in accordance with the invention on a portion of the region of the bead of a tyre;
- 25 - figure 3 is a schematic side view of an apparatus for the deposition of reinforcing elements in accordance with the invention;
- figure 4 is a schematic perspective view of a gripping device of the apparatus of figure 3.

- 30 In figure 3, an example of an embodiment of an apparatus for the deposition of reinforcing elements of vehicle tyres in accordance with the present invention is wholly indicated with reference numeral 100.

The apparatus 100 is part of a work station of the type

described in document WO 01/36185 to the same Applicant.

In the described example of embodiment, the apparatus 100 is adapted to make a reinforcing structure, operatively associated with annular anchoring structures 2 of a carcass structure 3 in the region of the bead of a tyre (figure 2a). The reinforcing structure comprises at least one reinforcing layer 1 formed from one or more reinforcing elements 5' deposited as described hereafter. The specific axial position of each reinforcing layer 1 with respect to the annular anchoring structures 2 can vary according to the requirements of the product; in particular, the reinforcing structure can comprise a single reinforcing layer 1 made directly on the carcass structure 3, or else between two layers of annular anchoring structures 2, or else in an axially outer position with respect to the annular anchoring structures 2. It is also possible to provide a reinforcing structure comprising many reinforcing layers 1 operatively associated, in different axial positions, with the annular anchoring structures 2.

The manufacture of the reinforcing structure, of the annular anchoring structures 2, of the carcass structure 3, as well as of the other components of the tyre, is advantageously carried out on a toroidal support 60, having an outer surface configured substantially according to the inner configuration of the tyre to be made. The toroidal support 60, not described in detail here since it can be made in any convenient way by the man skilled in the art, is preferably supported by an anthropomorphous robotised arm 61 (only partially visible in figure 3), for example of the type described in the aforementioned document WO 01/36185 to the same Applicant.

Each reinforcing element 5' is formed from a piece 5 of predetermined length obtained through cutting operations carried out in sequence on at least one continuous reinforcing band-like element 4 and then suitably deposited along a predetermined deposition path 7 defined on the

toroidal support 60 (figures 2 and 2a), as shall be described in detail hereafter, with reference to a preferred embodiment of the process of the invention.

5 The continuous band-like element 4 and, consequently, the pieces 5 obtained from it, preferably each comprise a plurality of thread-like reinforcing elements 6 (shown only in figure 1 for the sake of clarity) made from metallic material or textile incorporated in a matrix of elastomeric material. Such thread-like reinforcing elements 6 extend
10 parallel to each other, along a direction of longitudinal extension G of the continuous band-like element 4 and of the pieces 5 (figure 1). Throughout the present description and in the subsequent claims "direction of longitudinal extension" of the continuous band-like element 4 - and,
15 consequently, of the pieces 5 - is defined as the line defining the longitudinal direction of the continuous band-like element 4 and passing through the middle point of an end side thereof.

20 The width of the continuous band-like element 4 is preferably between about 10 mm and about 50 mm, wherein about 25 mm is a particularly preferred operative value.

As schematically represented in figure 3, the apparatus 100 comprises a feeding device 20 of the continuous band-like element 4, for example a drawing and/or calandering device
25 or else a feed reel, a cutting device 30 adapted to carry out cutting to size operations on the continuous band-like element 4 to make the pieces 5, and a gripping device 40 to grip the pieces 5 and deposit them on the toroidal support 60.

30 In accordance with the invention, the gripping device 40, in addition to grip and deposit the pieces 5, is adapted to deform such pieces 5 to adapt them to respective deposition parts of the deposition path 7.

As can be seen in particular in figure 4, the gripping

device 40 preferably comprises two gripping elements 41 and 42 rotatably associated with a fixed body 43 which in turn is connected to a moving arm 44 (figure 3) of the gripping device 40.

- 5 The gripping elements 41, 42, identical to each other, can rotate in a plane coinciding with or substantially parallel to a gripping plane Π of the piece 5, about respective pin axes X_1 and X_2 (of which only X_1 can be seen in the perspective view of figure 4) substantially perpendicular
10 to the gripping plane Π . The pin axes X_1 and X_2 are defined by corresponding connection pins (only one of which, indicated with reference numeral 54, is shown in figure 3) between the fixed body 43 and the gripping elements 41, 42.

- The rotation of the gripping elements 41, 42 is carried out
15 through the rotation about respective rotation axes Y of suitably shaped rotatable arms 45, actuated through conventional actuators 46. Both the actuators 46 and the rotatable arms 45 are firmly connected with the fixed body 43 of the gripping device 40. Through their rotation, the
20 rotatable arms 45 thrust corresponding abutment elements 47 firmly connected with the gripping elements 41, 42, thus determining their rotation about the respective pin axes X_1 , X_2 with respect to the fixed body 43.

- Each of the gripping elements 41, 42, as well as the
25 abutment element 47, comprises a skid 48 carrying, at a face thereof facing towards the gripping plane Π , a plurality of needles 49 adapted to penetrate into portions of the piece 5 to obtain the gripping thereof. The needles 49 are arranged aligned along a longitudinal direction of
30 the skid 48. The needles 49 are operatively associated with respective small pneumatic cylinders 50 capable of independently controlling the vertical movement of each needle. In particular, each small pneumatic cylinder 50, in addition to move the respective needle 49, can slide with
35 respect to it, thus allowing the possible detachment of the reinforcing element 5' to be counteracted at the end of the

deposition, when the needles 49 lift up. The small pneumatic cylinders 50 in each skid 48 are preferably in fluid communication with each other, so as to be subjected to substantially the same pressure by an appropriate
5 pressurised fluid.

The skids 48 are associated with respective sliding guides 51 (only one of which can be seen in the perspective view of figure 4) that allow the longitudinal sliding thereof, independently from each other, with respect to the fixed
10 body 43. An adjustment unit 52 firmly connected with the fixed body 43 allows the longitudinal position of each skid 48 to be adjusted with respect to the fixed body 43. In particular, it allows a longitudinal staggering of the
15 skids 48 to be set according to the longitudinal staggering of the gripping sides of the piece 5 due to the fact that the piece 5 is obtained by cutting the continuous band-like element 4 with a cutting angle different from 90° with respect to a feeding direction of the continuous band-like element 4.

20 The gripping device 40 preferably also comprises a permanent magnet 53 firmly connected with the fixed body 43 and arranged facing towards the gripping plane Π between the two gripping elements 41, 42. Such a permanent magnet 53 contributes in particular to the gripping of the piece 5
25 when it comprises thread-like reinforcing elements 6 made of steel.

By means of the moving arm 44, the gripping device 40 as a whole can be moved between a first position near to the cutting device 30, in which the gripping of the pieces 5
30 takes place, and a second position near to the toroidal support 60, in which the deposition of the pieces 5 takes place. The gripping device 40 can be moved between these two positions according to two directions of translation substantially perpendicular to each other, indicated in
35 figure 3 through the double arrows A and B.

The deposition apparatus 100 preferably also comprises a pressing member (not shown in the figures) of the conventional type and known to the man skilled in the art, which can act upon the deposited pieces 5 so as to ensure
5 that they completely stick to the underlying structures of the tyre being processed. Such a pressing member can be firmly connected with the gripping device 40 and act upon each piece 5 individually, immediately after the deposition thereof, or else it can be independent from the gripping
10 device 40 and act upon the reinforcing layer 1 once the deposition thereof has ended.

With reference to figures 1, 2, 2a and 3 a preferred embodiment of the deposition process of the invention that can be carried out through the deposition apparatus 100
15 described above shall now be described.

Reference shall be made in particular to the deposition of reinforcing elements 5' on a deposition path 7 extending along an annular portion of the toroidal support 60, in the region of the bead of the tyre being processed. Such an
20 annular portion is substantially circular, with centre lying on a rotation axis of the toroidal support 60 and inner radius preferably between about 200 mm and about 350 mm.

In a first step of the process, a piece 5 is cut to size
25 from the continuous band-like element 4 fed by the feeding device 20. Feeding takes place along a feeding direction F substantially parallel to the direction of longitudinal extension G of the continuous band-like element 4. The piece 5 is cut according to a cutting angle α of between
30 about 0° and about 70° , more preferably between about 20° and about 65° , said cutting angle α being defined between the perpendicular to the direction of longitudinal extension G and a cutting direction C.

In a subsequent step, the piece 5 is gripped, through the
35 gripping elements 41, 42 of the gripping device 40, at two

opposite sides 5a, 5b thereof parallel to the feeding direction F, in the gripping plane Π (which in figure 1 coincides with the plane of representation, whereas in figure 3 it is perpendicular to the plane of representation).

The grip is ensured by the penetration of the needles 49 into the material of the piece 5 and preferably occurs in such a way that the row of needles 49 of each gripping element 41, 42 is positioned on the inside with respect to at least the first thread-like reinforcing element adjacent to each of the sides 5a, 5b. Preferably, the grip is achieved in such a way that the needles 49 are at a distance d of between about 1,5 mm and about 2,5 mm from the outer edges of the sides 5a, 5b. Preferably, moreover, the grip takes place in such a way that the pin axes X_1 , X_2 of the gripping elements are at corresponding end areas of the sides 5a, 5b. Such end areas are intended to be deposited at radially inner areas of the deposition path 7.

In a subsequent step of the process, the piece 5 is deformed through rotation of the gripping elements 41, 42 about the pin axes X_1 , X_2 by respective predetermined angles of rotation γ_1 , γ_2 away from each other. Deformation occurs substantially in the plane in which the piece 5 lies, coinciding with or substantially parallel to the gripping plane Π .

In this way a substantially "fan-shaped" deformation of the piece 5 is achieved, in which the portion of piece transversal to the two sides 5a, 5b that is nearest to the position of the pin axes X_1 , X_2 substantially is not subjected to deformations, whereas the transversal portions farther from the pin axes X_1 , X_2 are subjected to stretchings, wherein the magnitude of this stretchings increases as the distance of these transversal portions from the position of such axes increases (figure 1).

In figure 1 and 2 for comparison the shape that the

reinforcing elements 5' would assume by depositing non-deformed pieces 5, represented with dotted and dashed lines, along the deposition path 7, is also illustrated. It is clear that, without deformation, between one piece 5 and the adjacent ones empty spaces would remain such as to alter the uniformity of the reinforcing elements 5' forming a reinforcing layer 1.

The extent of the angles of rotation γ_1 , γ_2 , and therefore the extent of the deformation of the piece 5, is determined based upon the curvature of the deposition part on which each piece 5 is intended to be deposited, upon the cutting angle α of the piece 5 (figure 1) and upon a deposition angle β of the piece 5 (figure 2), the latter being defined as the angle between a radial direction R of the toroidal support 60 passing, at the moment of deposition, through a radially inner point of the piece 5 and belonging to the direction of longitudinal extension G of the piece (5), and the same direction of longitudinal extension G.

Typically, the cutting angle α and the deposition angle β are preset and remain constant during the entire deposition process of the reinforcing layer 1, whereas the curvature of the deposition path can, in general, vary, requiring corresponding variations of the angles of rotation γ_1 , γ_2 from one piece to the other. In the specific case illustrated here, however, since the deposition path 7 is a circular ring, the curvature is constant and therefore the angles of rotation γ_1 , γ_2 are the same for all of the pieces 5.

Preferably the angles of rotation γ_1 , γ_2 , are equal to each other, and have a width of between about 1° and about 10° .

In alternative embodiments, it is also possible to foresee that the pieces 5 undergo "asymmetrical" deformations, obtained by rotating just one of the gripping elements 41, 42 whereas the other is or is kept fixed.

The aforementioned deformation step is carried out at the same time as the piece 5 is moved between a first position at the feeding device 20 and a second position at said toroidal support 60.

- 5 In a subsequent step of the process, the piece 5 deformed as described above is deposited at the respective deposition part of the deposition path 7. As stated above, the deposition of each piece 5 is carried out according to the deposition angle β , of between about 0° and about 35° ,
10 and in such a way that the end areas of the piece 5 at which the pin axes X_1 , X_2 of the gripping elements 41, 42 pass are deposited at radially inner areas of the deposition path 7.

- The aforementioned cutting, deformation and deposition
15 steps of pieces 5 are repeated for a predetermined number of times, each time changing the deposition part so as to deposit a plurality of such pieces 5 in side-by-side relationship, so as to cover the entire deposition path 7, thus completing the formation of the reinforcing layer 1.
- 20 A step of passing a pressing member on the deposited pieces 5 is also preferably foreseen, so as to ensure that they completely stick to the underlying structures of the tyre being processed. Such a step can be carried out after the deposition of each piece 5 and onto each of them
25 individually, or else at the end of the deposition of all of the pieces 5, onto the entire reinforcing layer 1.

CLAIMS

1. Process for manufacturing tyres for vehicle wheels, comprising building, on a toroidal support (60), a carcass structure (3) comprising at least one carcass ply associated, at axially opposite end edges thereof, with annular anchoring structures (2);
5 wherein the step of building said carcass structure (3) comprises forming at least one reinforcing structure, operatively associated with said annular anchoring structures (2) through deposition on said toroidal support (60) of at least one reinforcing element (5') along a predetermined curvilinear deposition path (7);
10 wherein the deposition step of said at least one reinforcing element (5') comprises the steps of:
- 15 - cutting to size a piece (5) of at least one continuous reinforcing band-like element (4);
 - deforming said piece (5) according to the curvature of a deposition part of said deposition path (7) intended to receive said piece (5);
 - 20 - depositing said deformed piece (5) at said deposition part;
 - repeating said cutting, deformation and deposition steps for a predetermined number of times, each time changing the deposition part so as to deposit a plurality of pieces (5) in a side-by-side relationship along said deposition path (7).
 - 25
2. Process according to claim 1, wherein in said cutting to size step, said reinforcing continuous band-like element (4) is fed by a feeding device (20) along a predetermined feeding direction (F).
30
3. Process according to claim 1 or 2, in cui in said deformation step said piece (5) is deformed substantially in the plane on which it lies.
4. Process according to any one of the previous claims,
35 wherein said deformation step comprises the steps of:

- gripping said piece (5) at two opposite sides thereof (5a, 5b);
 - rotating at least one side (5a) of said piece (5) by a predetermined angle of rotation (γ_1) away from the other side (5b) about a respective pin axis (X_1).
- 5
5. Process according to claim 4, wherein said opposite sides (5a, 5b) are parallel to said feeding direction (F).
6. Process according to claim 4 or 5, wherein said gripping step is carried out in such a way that said pin axis (X_1) is arranged at an end area of said at least one side (5a).
- 10
7. Process according to claim 6, wherein said end area is intended to be deposited at a radially inner end area of said deposition part (7).
- 15
8. Process according to any one of claims 4 to 7, wherein said predetermined angle of rotation (γ_1) is between about 1° and about 10° .
9. Process according to any one of claims 4 to 7, wherein said rotation step comprises the step of:
- 20
- rotating both of said opposite sides (5a, 5b) of said piece (5) by respective predetermined angles of rotation (γ_1 , γ_2) away from each other about respective pin axes (X_1 , X_2).
10. Process according to claim 9, wherein said gripping step is carried out in such a way that said pin axes (X_1 , X_2) are arranged at respective end areas of said opposite sides (5a, 5b).
- 25
11. Process according to claim 10, wherein said end areas are intended to be deposited at respective radially inner end areas of said deposition part (7).
- 30
12. Process according to any one of claims 9 to 11, wherein said respective angles of rotation (γ_1 , γ_2) are equal to

each other.

13. Process according to claim 12, wherein said respective angles of rotation (γ_1 , γ_2) are between about 1° and about 10°.

5 14. Process according to any one of the previous claims, wherein said deposition path (7) extends along an annular portion of said toroidal support (60) having a substantially circular shape and a centre lying on a rotation axis of said toroidal support (60), said piece (5)
10 being deformed according to a radius of said annular portion.

15. Process according to claim 14, wherein said annular portion has an inner radius of between about 200 mm and about 350 mm.

15 16. Process according to any one of the previous claims, wherein the deposition step of said at least one reinforcing element (5') further comprises the step of:
- moving said piece (5) between a first position at said feeding device (20) and a second position at said toroidal
20 support (60).

17. Process according to claim 16, wherein said deformation step is carried out during said moving step.

18. Process according to any one of the previous claims, wherein the cutting, deformation and deposition steps are
25 repeated for a number of times at least sufficient to cover substantially the entire deposition path (7) through a plurality of said pieces (5).

19. Process according to any one of the previous claims, further comprising the step of:
30 - passing a pressing member on one or more of said deposited pieces (5).

20. Process according to any one of the previous claims,

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wherein said at least one reinforcing continuous band-like element (4) has a width of between about 10 mm and about 50 mm.

21. Process according to any one of the previous claims,
5 wherein said at least one reinforcing continuous band-like element (4) comprises at least one thread-like reinforcing element (6) incorporated in an elastomeric material.

22. Process according to any one of the previous claims,
10 wherein in said cutting step said piece (5) is cut according to a cutting angle (α) of between about 0° and about 70°.

23. Process according to claim 22, wherein said cutting angle (α) is between about 20° and about 65°.

24. Process according to any one of the previous claims,
15 wherein in said deposition step said piece (5) is deposited at said deposition part along a direction forming a predetermined deposition angle (β) defined between a radial direction (R) of the toroidal support (60) passing, at the moment of deposition, through a radially inner point of the
20 piece (5) and belonging to a direction of longitudinal extension (G) of the piece (5), and the same direction of longitudinal extension (G).

25. Process according to claim 24, wherein said deposition angle (β) is between about 0° and about 35°.

25 26. Process according to claim 24 or 25, wherein in said deformation step the deformation of said piece (5) is carried out according to said deposition angle (β).

27. Process according to any one of claims 22 to 26,
30 wherein in said deformation step the deformation of said piece (5) is carried out according to said cutting angle (α).

28. Process according to any one of the previous claims,

wherein each reinforcing element (5') comprises at least one thread-like reinforcing element (6) orientated at the end of said deposition step so as to form an angle, with the radial direction passing through the radially inner end thereof, having a width greater than or equal to 0° and lower than 90° .

29. Apparatus (100) for the deposition on a toroidal support (60) of at least one reinforcing element (5') of a tyre for vehicle wheels, comprising:

- 10 - a feeding device (20) of a reinforcing continuous band-like element (4);
 - a cutting device (30) for cutting to size a piece (5) of said reinforcing continuous band-like element (4);
 - a gripping device (40) for gripping said piece (5) and
 - 15 depositing it on said toroidal support (60) at a deposition part of a predetermined curvilinear deposition path (7);
- wherein said gripping device (40) comprises a device (41, 42) for deforming said piece according to the curvature of said deposition part.

20 30. Apparatus according to claim 29, wherein said feeding device (20) feeds the continuous band-like element (4) along a predetermined feeding direction (F).

31. Apparatus (100) according to claim 29 or 30, wherein said gripping device (40) comprises at least two gripping

25 elements (41, 42), at least one (41) of which is rotatable in a plane coinciding with or substantially parallel to a gripping plane (Π) about a respective pin axis (X_1) substantially perpendicular to said gripping plane (Π).

32. Apparatus (100) according to claim 31, wherein said at

30 least two gripping elements (41, 42) are both rotatable about respective pin axes (X_1 , X_2) substantially perpendicular to said gripping plane (Π).

33. Apparatus (100) according to claim 31 or 32, wherein each of said at least two gripping elements (41, 42)

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comprises a plurality of needles (49) adapted to penetrate into a respective portion of said piece (5).

34. Apparatus (100) according to claim 33, wherein the needles (49) of said plurality of needles are aligned along
5 a longitudinal direction of said at least two gripping elements (41, 42).

35. Apparatus (100) according to claim 33 or 34, wherein the needles (49) of said plurality of needles are individually movable in respective housing seats defined in
10 said at least two gripping elements.

36. Apparatus (100) according to claim 35, wherein each housing seat comprises a pneumatic cylinder (50) adapted to control the movement of the movable needle in said housing seat.

15 37. Apparatus (100) according to claim 36, wherein said pneumatic cylinders (50) are in fluid communication with each other.

38. Apparatus (100) according to any one of claims 31 to 37, wherein said at least two gripping elements (41, 42)
20 comprise respective skids (48) capable of sliding longitudinally with respect to a fixed body (43) of said gripping device (40).

39. Apparatus (100) according to claim 38, wherein said skids (48) are capable of sliding independently from each
25 other.

40. Apparatus (100) according to any one of claims 29 to 39, wherein said gripping device (40) is movable with respect to said feeding device (20) and to said cutting device (30) along two translation directions (A, B)
30 substantially perpendicular to each other.

41. Apparatus (100) according to any one of claims 29 to 40, wherein said gripping device (40) is movable from a

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first position near to said cutting device (30) to a second position near to said toroidal support (60).

42. Apparatus (100) according to any one of claims 31 to 41, wherein said gripping device (40) comprises a permanent
5 magnet (53) positioned between said at least two gripping
elements (41, 42) and facing said gripping plane (Π).

43. Apparatus (100) according to any one of claims 29 to 42, further comprising a pressing member adapted to exert a
pressure on said piece (5) deposited on said toroidal
10 support (60).

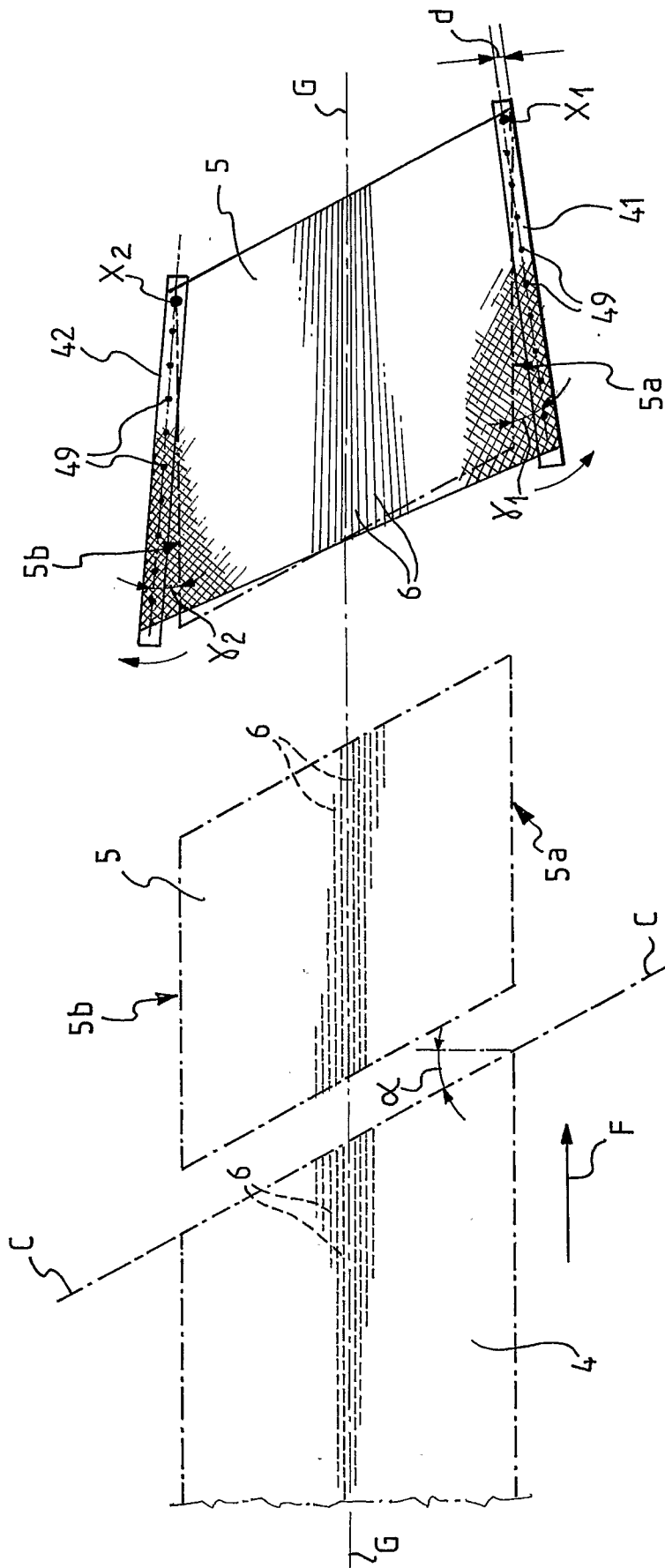
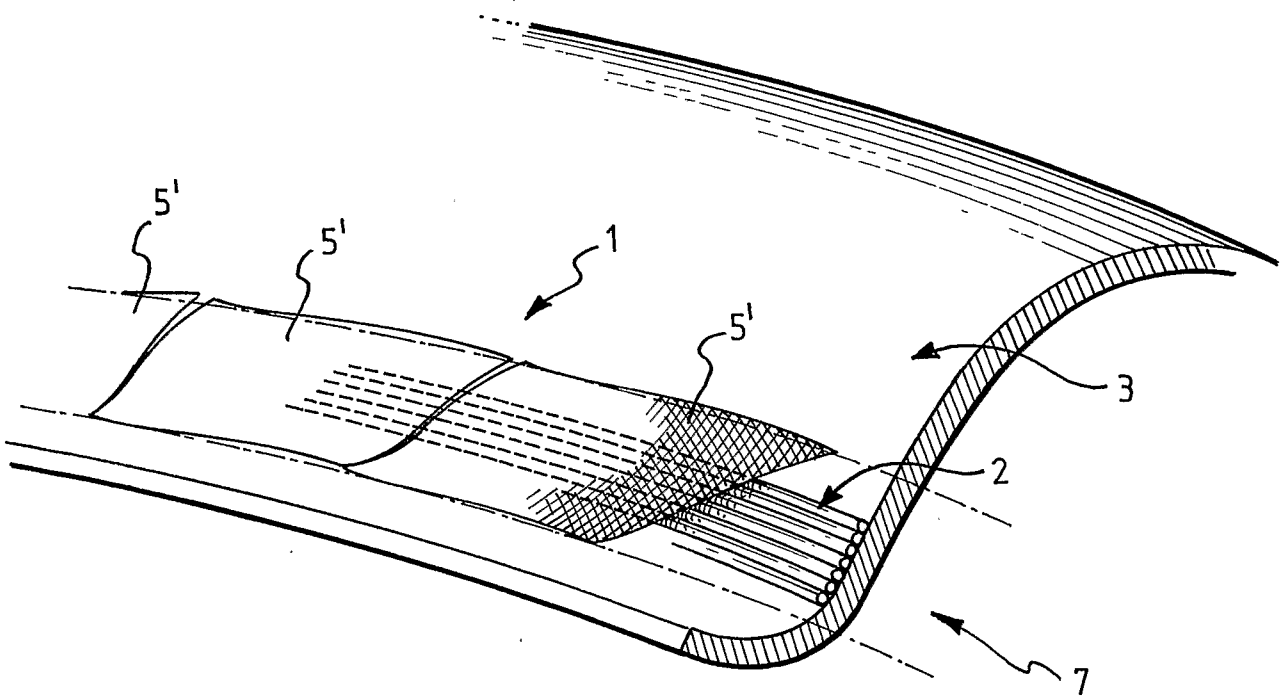
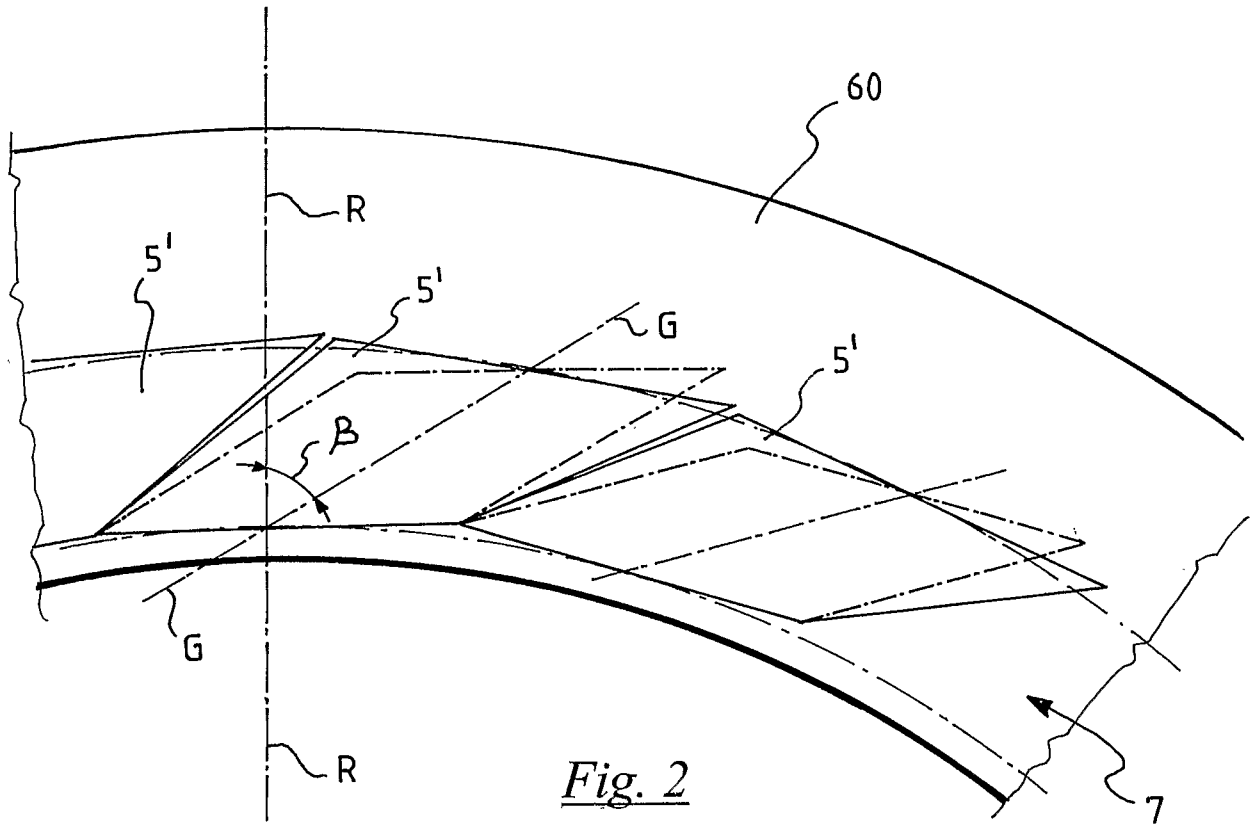


Fig. 1



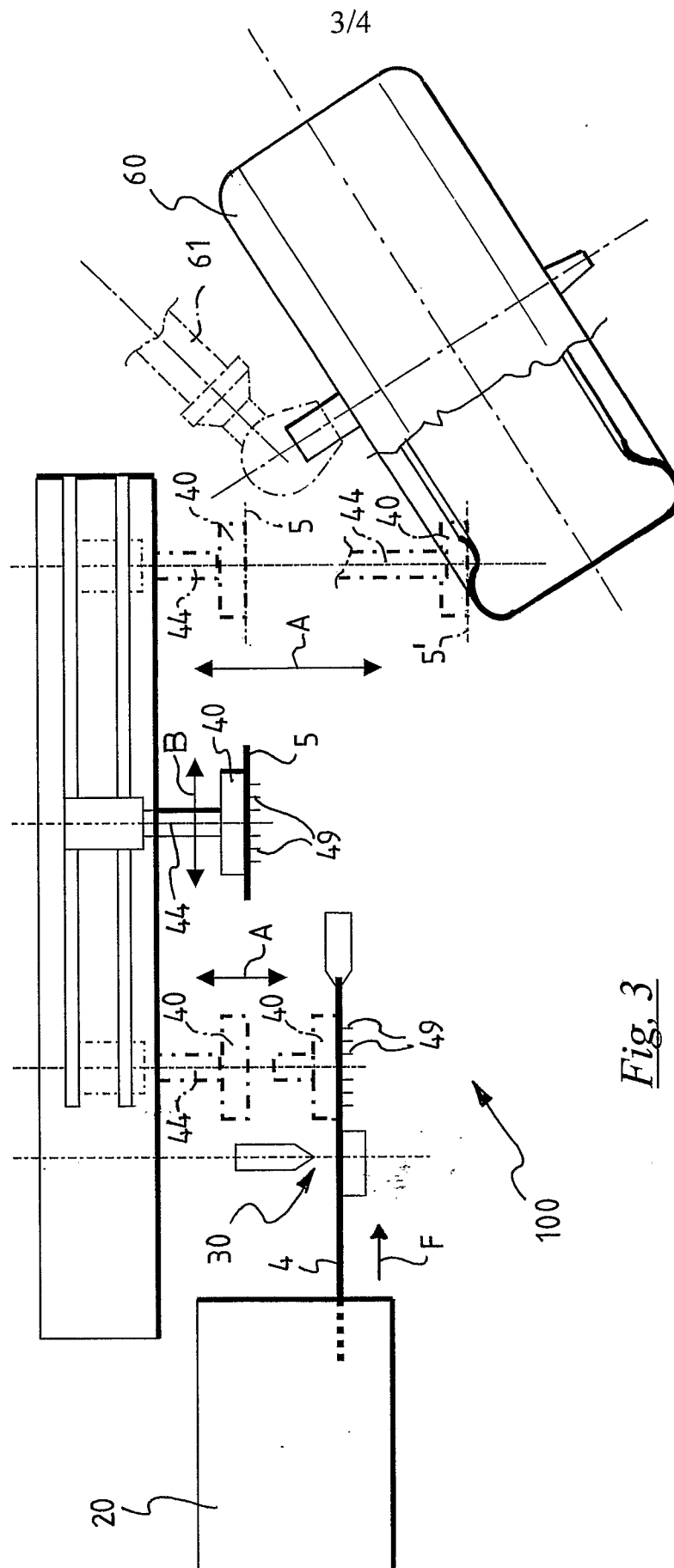


Fig. 3

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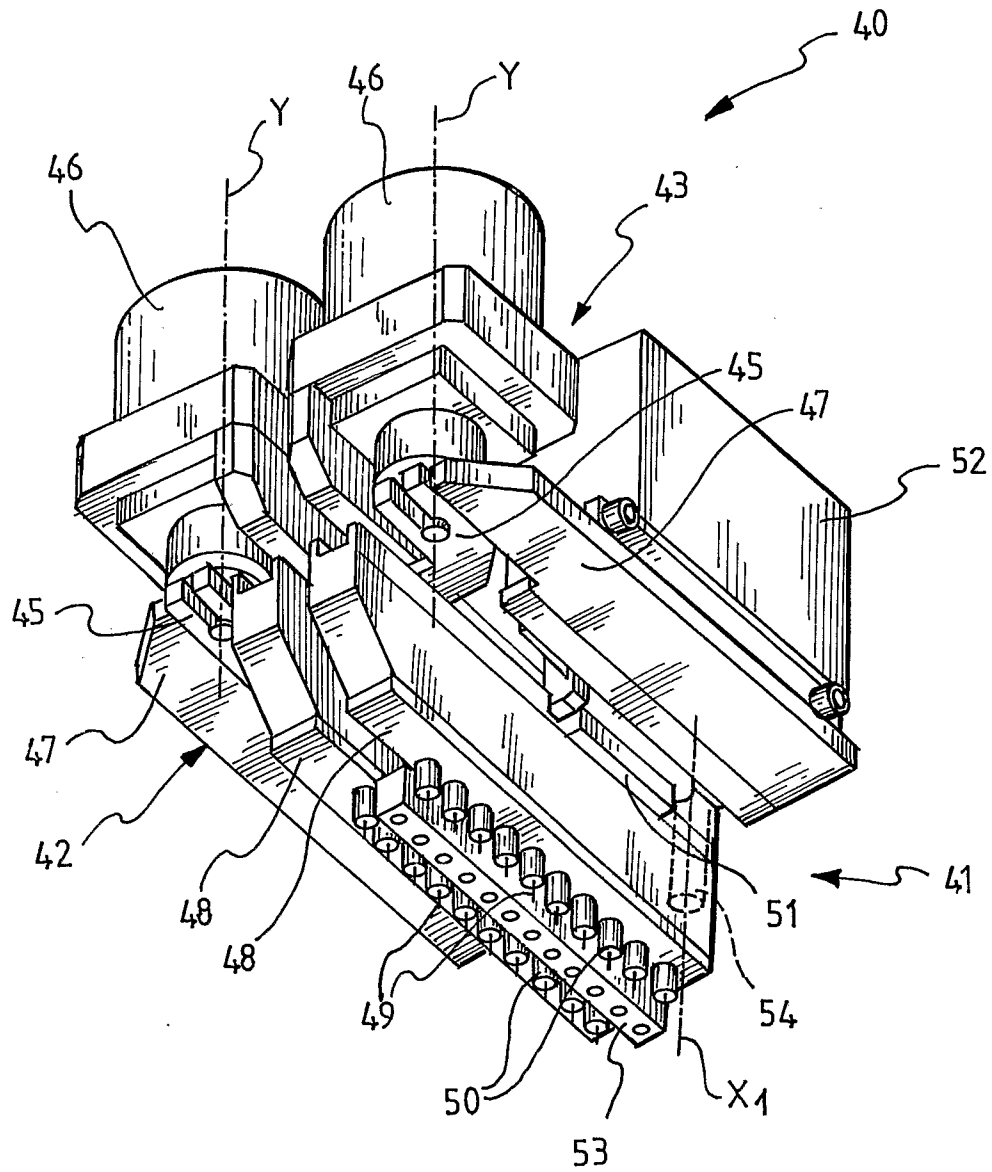


Fig. 4

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2006/001413

A. CLASSIFICATION OF SUBJECT MATTER

INV. B29D30/16 B29D30/44 B29D30/70

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)

B29D B29C

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)

EP0-Internal

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X	GB 2 327 397 A (HOLROYD ASSOCIATES LTD [GB]) 27 January 1999 (1999-01-27)	1-3, 14, 16-18, 21, 29
Y	page 1, paragraph 1 - page 5, paragraph 2; claims; figure 1	4-13, 19, 22-28, 30-43
Y	EP 0 956 940 A1 (BRIDGESTONE CORP [JP]) 17 November 1999 (1999-11-17) paragraphs [0032] - [0036]; figures	4-13, 22-43
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Y	US 2002/023705 A1 (MARCHINI MAURIZIO [IT] ET AL) 28 February 2002 (2002-02-28) figures 1-4	4-43
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☒ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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Date of the actual completion of the international search

25 January 2007

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INTERNATIONAL SEARCH REPORT

International application No

PCT/IB2006/001413

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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International application No

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