

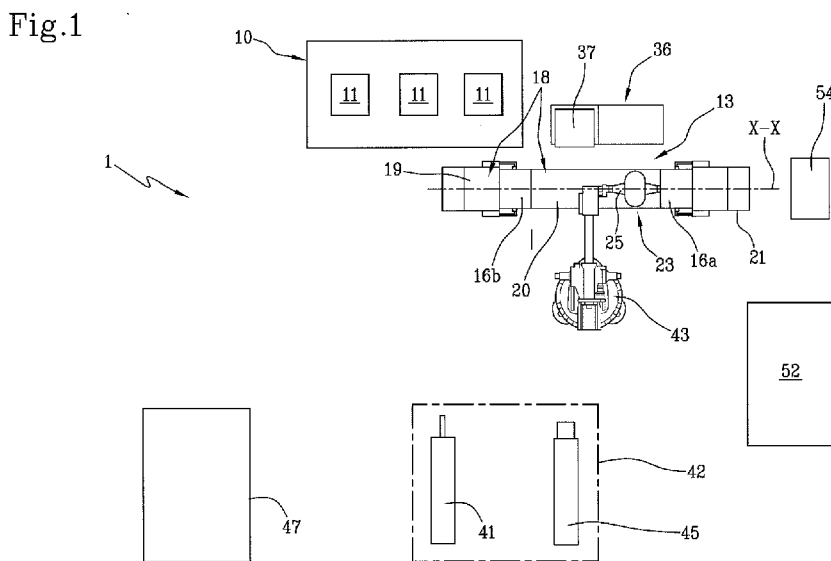


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(57) Abstract: A carcass sleeve (12) is situated in radially external position with respect to a toroidal forming drum (23) arranged in a first radially contracted operative condition. The carcass sleeve (12) is shaped according to a toroidal configuration while the forming drum (23) is positioned inside the carcass sleeve (12). During shaping of the carcass sleeve, the forming drum (23) is radially expanded up to a second radially expanded operative condition. Upon completed shaping, the carcass sleeve (12) is coupled to the forming drum (23) in the second operative condition. The forming drum (23), coupled to said shaped carcass sleeve (12), is arranged in proximity to at least one device (41) for building at least one belt layer (7a) at a radially external position relative to said shaped carcass sleeve (12).



## METHOD AND PLANT FOR BUILDING TYRES

The present invention relates to a method, a process and a plant for building tyres.

More particularly, the invention is directed to the method, process and equipment used for building the green tyre, to be subsequently subjected  
5 to a vulcanisation cycle for the obtainment of the final product.

A tyre for vehicle wheels generally comprises a carcass structure comprising at least one carcass ply having respectively opposite end flaps engaged with respective anchoring annular structures, integrated in the zones normally identified with the name "beads", having an internal  
10 diameter substantially corresponding to a so-called "fitting diameter" of the tyre on a respective mounting rim.

The carcass structure is associated with a belt structure which can comprise one or more belt layers, situated in radial superimposition with respect to each other and with respect to the carcass ply, having textile or  
15 metallic reinforcement cords with crossed orientation and/or substantially parallel to the circumferential extension direction of the tyre (at 0 degrees). At a radially external position relative to the belt structure, a tread band is applied, it too made of elastomeric material like other semifinished products constituting the tyre.

20 On the lateral surfaces of the carcass structure, each extended from one of the lateral edges of the tread band up to the respective anchoring annular structure to the beads, respective sidewalls made of elastomeric material are also applied in axially external position. In the tyres of "tubeless" type, an air impermeable cover layer, normally termed "liner",  
25 covers the internal surfaces of the tyre.

After the building of the green tyre actuated by assembly of respective components, a moulding and vulcanisation treatment is generally executed aimed to determine the structural stabilisation of the tyre through cross-linking of the elastomeric compositions as well as imparting on the same, if

required, a desired tread pattern and possible distinctive graphic marks at the sidewalls of the tyre.

The carcass structure and the belt structure are generally made separately from each other in respective work stations, in order to be mutually  
5 assembled at a later time.

More particularly, the obtainment of the carcass structure first provides that the carcass ply or plies are applied on a building drum, to form a substantially cylindrical so-called "carcass sleeve". The anchoring annular structures to the beads are fit or formed on the opposite end flaps of the  
10 carcass ply or plies, which are subsequently turned up around the annular structures themselves in a manner so as to enclose them in a kind of noose.

On a second drum or auxiliary drum, a so-called "crown structure" is obtained in the form of an external sleeve comprising one or more belt  
15 layers applied in mutual radial superimposition, and possibly the tread band applied at a radially external position relative to the belt layer(s). The crown structure is then drawn from the auxiliary drum in order to be coupled to the carcass sleeve. The crown structure is for such purpose arranged coaxially around the carcass sleeve, after which the carcass ply  
20 or plies are shaped according to a toroidal configuration by means of mutual axial approaching of the beads and simultaneous introduction of pressurised fluid inside the carcass sleeve, in a manner so as to cause a radial dilatation of the carcass plies until they are made to adhere against the internal surface of the crown structure.

25 The assembly of the carcass sleeve with the crown structure can be actuated on the same drum used for obtaining the carcass sleeve; in such case, this is termed "single-stage building process" or "unistage process". Also known are building processes of so-called "two-stage" type, in which a so-called "first-stage drum" is employed for obtaining the carcass sleeve,  
30 while the assembly between the carcass sleeve and the crown structure is actuated on a so-called "second-stage drum" or "shaping drum", on which

the carcass sleeve drawn from the first-stage drum and subsequently the crown structure drawn from the auxiliary drum are transferred.

With the term "elastomeric material", it is intended to indicate a composition comprising at least one elastomeric polymer and at least one reinforcement filler. Preferably, such composition further comprises additives such as, for example, a cross-linking agent and/or a plasticiser. Due to the presence of the cross-linking agent, through heating such material can be cross-linked, so as to form the final manufactured product. By tyre for two-wheel vehicles, in particular motorcycles, it is intended a tyre whose curvature ratio is approximately comprised between about 0.15 and about 0.45.

By curvature ratio relative to a tyre (or to a portion thereof), it is intended the ratio between the distance of the radially external point of the tread band (or of the external surface) from the line passing through the laterally opposite ends of the tread itself (or of the external surface itself), measured on a radial plane of the tyre (or of said portion thereof), i.e. on a plane containing the rotation axis thereof, and the distance measured along the cord of the tyre (or of a portion thereof) between said ends.

By curvature ratio relative to a forming drum, it is intended the ratio between the distance of the radially external point of the external surface of the drum from the line passing through the laterally opposite ends of the drum itself, measured on a radial plane of the drum, i.e. on a plane containing the rotation axis thereof, and the distance measured along the cord of the drum between said ends.

In the document WO 2004/041520, on behalf of the same Applicant, the shaping drum can be carried by a robotic arm which interacts with a transfer member carrying the belt structure drawn from an auxiliary drum, in order to determine the coupling between the carcass structure and the belt structure. The robotic arm therefore carries the shaping drum in proximity to devices for applying the tread band and/or sidewalls comprising supply members arranged to deposit a continuous elongated

element made of elastomeric material on the mutually coupled carcass structure and belt structure.

The document WO 2004/041522 illustrates a further example in which a shaping drum carried by a robotic arm is moved in order to interact with devices that complete the obtainment of the green tyre after having  
5 determined the application of a belt structure previously formed on an auxiliary drum.

US 2009/0020200 describes the obtainment of a tyre for two-wheel vehicles, in which a tread band is obtained by continuously winding a  
10 continuous elongated element made of elastomeric material in a spiral in the circumferential direction of the tyre being processed, supported by a rigid drum whose external surface profile copies the internal surface profile of the tyre being processed.

The Applicant has verified that in the execution of embodying methods of the type illustrated in WO 2004/041520 or WO 2004/041522, it may be  
15 difficult to ensure a correct mutual positioning between the crown structure comprising at least one belt layer and the carcass structure in the initial carcass sleeve form. The Applicant has perceived that this circumstance is particularly but not exclusively evident in the obtainment of tyres with a  
20 high curvature ratio, as can be typically found in the tyres for two-wheel vehicles.

The Applicant has also verified that the use of a substantially rigid toroidal forming drum, with fixed geometry of the type described in US  
25 2009/0020200, tends to introduce process difficulties and criticalities, also involving significant logistics complications with regard to equipment and spaces required for the installation of the production plants.

The Applicant has thus realised that by obtaining the components of the crown structure directly on the shaped carcass sleeve according to the desired configuration thereof in the built green tyre, it is possible to ensure  
30 greater geometric and structural precision of the single components, and

an optimal positioning of each of these with respect to other components of the tyre being processed.

The Applicant then verified that by forming the crown structure directly on the carcass sleeve, this eliminates the need to use and arrange layers  
5 made of elastomeric material or other auxiliary elements typically required for stabilizing the positioning of the components of the crown structure before its coupling with the carcass sleeve.

The Applicant has thus perceived that it is advantageous to arrange the shaped carcass sleeve on a substantially rigid toroidal forming drum with  
10 variable geometry (at least in radial direction) or expandable, shaped in part according to the internal geometric configuration of the built green tyre.

The Applicant has also realised that in order to prevent the carcass structure, initially formed as carcass sleeve according to a cylindrical  
15 shaping, from undergoing undesired structural distortions during shaping, it is opportune that the coupling of the forming drum be completed when the carcass sleeve is already shaped according to a toroidal configuration.

The Applicant has therefore found that by coupling a substantially rigid and expandable toroidal forming drum to a substantially cylindrical carcass  
20 sleeve already formed, by means of shaping the carcass sleeve, expanding the toroidal forming drum and finally associating the latter with the shaped carcass sleeve, in order to subsequently execute the deposition of the crown structure, it is possible to obtain tyres whose structural elements, including the single components of the crown  
25 structure therein (at least one from among one or more belt layers, underlayer of the tread band, tread band, at least one sidewall portion), are in accordance with precise design specifications without involving significant processing waste. Such tyres can also be obtained in relatively simple, economical production plants that can be installed in limited  
30 spaces.

The presence of a forming drum with variable geometry by means of radial expansion then allows the same to be advantageously inserted contracted inside the carcass sleeve formed according to a cylindrical configuration, and to be radially expanded inside the carcass sleeve subsequently or at  
5 the same time as the toroidal shaping thereof, in order to determine the coupling thereof upon completed shaping. The structural rigidity of such forming drum finally ensures the carcass sleeve, shaped and coupled thereto, an excellent geometric and structural stability, which facilitates a precise positioning of the single elements that constitute the crown  
10 structure.

In accordance with a first aspect, the present invention relates to a method for building tyres.

Preferably provision is made for building a carcass sleeve and a crown structure of each tyre in sequence relative to each other.

15 Preferably said carcass sleeve is toroidally shaped and subsequently coupled to an expandable toroidal forming drum.

Preferably the crown structure is built on the radially external surface of said toroidally shaped carcass sleeve and associated with said expanded toroidal forming drum.

20 In accordance with a second aspect, the invention relates to a process for building tyres.

Preferably provision is made for arranging a carcass sleeve comprising at least one carcass ply and a pair of anchoring annular structures.

25 Preferably provision is made for arranging a toroidal forming drum in a first radially contracted operative condition.

Preferably provision is made for positioning said carcass sleeve at a radially external position relative to said forming drum.

Preferably provision is made for toroidally shaping said carcass sleeve while said forming drum is positioned inside the carcass sleeve.

30 Preferably provision is made for expanding said forming drum up to a second radially expanded operative condition.

Preferably provision is made for coupling the carcass sleeve toroidally shaped to the forming drum in said second operative condition.

Preferably provision is made for arranging said forming drum, coupled to said carcass sleeve, in proximity to at least one device for building at least  
5 one belt layer at a radially external position relative to said carcass sleeve.

In accordance with a further aspect, the present invention relates to a plant for building tyres.

Preferably a shaping station is provided comprising devices for engaging a carcass sleeve.

10 Preferably shaping devices are provided, operating in the shaping station for shaping the carcass sleeve according to a toroidal configuration.

Preferably an expandable toroidal forming drum is provided, engageable in the shaping station in radially internal position with respect to the carcass sleeve.

15 Preferably actuator devices are provided, operating in the shaping station in order to radially expand the forming drum inside the carcass sleeve.

Preferably at least one belt structure application station is provided.

Preferably transfer devices are provided, configured for transferring the forming drum carrying said carcass sleeve toroidally shaped from the  
20 shaping station to said at least one belt structure application station.

The Applicant deems that the crown structure therefore can be obtained on the carcass structure shaped according to a precise predefined profile, set by the geometric configuration of the forming drum, advantageously selectable based on the design parameters of the tyre being processed.

25 Thus, greater structural precision of the single components of the crown structure is attained, along with their positioning with respect to the other constituent elements of the tyre.

The Applicant finally deems that with the elimination of the need to couple, to the carcass sleeve, the belt structure and/or other components obtained  
30 apart from the crown structure, the problems related to process precision and repeatability are also overcome, which are typically correlated to the

need to couple structural components obtained separately. A simplification of the production plants is also attained, since it is no longer necessary to execute additional operations, nor are relative machinery required for determining the transfer of the belt structure and/or other geometrically  
5 unstable components from the stations where they are constructed to the station where they must be coupled with the carcass structure itself.

Also eliminated is the execution of additional operations, and relative machinery and materials, required for the production and management of auxiliary components, such as sheets and the like, which can prove useful  
10 or necessary for temporarily stabilising the positioning of the different parts of the belt structure on a different auxiliary drum.

In at least one of the aforesaid aspects, the invention further comprises one or more of the following preferred characteristics that are described hereinbelow.

15 Preferably, the carcass sleeve is coupled in contact relation against an external surface of the forming drum.

Preferably, the carcass sleeve is obtained in at least one building station and subsequently transferred to a shaping station.

It is therefore possible to dedicate the shaping station to the execution of  
20 the shaping of the carcass sleeve in an accurate and precise manner, limiting the work cycle execution duration to the cycle-time required for obtaining the carcass sleeve on the building line.

Preferably, the carcass sleeve is fit coaxially around the forming drum arranged in the shaping station.

25 It is thus possible to engage the forming drum in the shaping station without having to wait until the loading of the carcass sleeve has completed.

The forming drum may be possibly subjected to additional processing in the shaping station, before the engagement of the carcass sleeve.

30 Preferably, the carcass sleeve is first moved with a radial translation movement relative to the forming drum until it is in a relation of substantial

axial alignment therewith, and subsequently fit around the latter with an axial translation movement.

Preferably, the carcass sleeve is axially centred with respect to the forming drum before being shaped according to a toroidal shaping.

- 5 In this manner, it is ensured that an axial middle line plane of the forming drum substantially coincides with an axial middle line plane of the shaped carcass sleeve.

Preferably, the carcass sleeve is subjected to a radial expansion during shaping according to a toroidal configuration.

- 10 Preferably, at least one part of the expansion of the forming drum is actuated simultaneously with at least one part of the shaping of the carcass sleeve.

It is thus possible to reduce the cycle-time required in the shaping station, since the expansion of the forming drum can start without having to wait

- 15 for the end of the shaping of the carcass sleeve.

Preferably, the external surface of the forming drum remains spaced from the carcass sleeve during an expansion of the forming drum, at least until the attainment of the second radially expanded operative condition.

The absence of contact between the carcass sleeve and the forming drum  
20 during shaping ensures a correct shaping of the carcass sleeve, not affected by hard to control mechanical interferences.

- Preferably, at the end of the shaping, an internal surface of the carcass sleeve reaches a maximum diameter greater than the maximum diameter reached by the external surface of the forming drum in the second or  
25 expanded operative condition.

Preferably, the external surface of the forming drum is coupled against an internal surface of the carcass sleeve following a contraction of the shaped carcass sleeve.

- Therefore, an optimal adhesion of the carcass sleeve on the forming drum  
30 can be verified, in a controlled and uniform manner.

Preferably, the contraction is obtained by means of evacuation of an operative inflation fluid from the shaped carcass sleeve.

Preferably, the shaping of the carcass sleeve occurs by means of introduction of an operative inflation fluid inside the carcass sleeve.

5 Preferably, at least one diameter size of the carcass sleeve is monitored during shaping.

Preferably, at least one diameter size of the forming drum is monitored during shaping.

10 Preferably, control actions are executed on the shaping of the carcass sleeve and/or on the radial expansion of the forming drum to prevent mutual contacts during shaping.

Preferably, the shaping of the carcass sleeve is interrupted upon reaching a predetermined maximum value of said diameter size of the carcass sleeve.

15 Preferably, a radial expansion of the forming drum up to the second operative condition is enabled upon reaching a predetermined value of said diameter size of the carcass sleeve.

20 In such a manner, it is ensured that there are no undesired premature contacts between the forming drum and the carcass sleeve, before the latter is correctly shaped.

Preferably, the built tyre is vulcanised after having been removed from the forming drum.

25 Preferably, said device for building at least one belt layer is installed in a belt structure application station that is remote relative to said shaping station.

Preferably, said at least one belt layer is obtained by winding at least one continuous elongated reinforcement element according to axially adjacent circumferential coils around a radially external surface of the carcass sleeve coupled to the forming drum.

30 Due to the high stickiness of the elastomeric material that constitutes the carcass ply/plies and/or the continuous elongated element, a stable and

precise positioning of the single coils is thus ensured, even when the shaped carcass has a profile with accentuated curvature.

Preferably, a tread band is formed at a radially external position around said at least one belt layer made on the carcass sleeve.

- 5 The tread band can thus be obtained directly according to the final geometric shape that it must have in the built green tyre. Thus, there is no longer the need for subsequent handling in order to adapt the shaping of the tread band to that of the underlying carcass sleeve, and hence no consequent undesired material upsettings and/or other uncontrolled  
10 deformations.

Preferably, the tread band is obtained by means of winding at least one continuous elongated element made of elastomeric material according to consecutively adjacent circumferential coils around a radially external surface of said at least one belt layer.

- 15 It is thus possible to increase the operative flexibility of the process and machinery, suitably modulating the number and position of the coils as a function of the geometric and size characteristics that one wishes to confer to the tread band.

- Preferably, the carcass sleeve coupled to said at least one belt layer has a  
20 curvature ratio comprised between about 0.15 and about 0.45.

In such a manner, optimal conditions are attained for building tyres adapted for two-wheel vehicles.

- Preferably, the following are provided: a carcass building line and carcass loading devices configured for transferring the carcass sleeve from the  
25 carcass building line to the shaping station.

Preferably, said carcass loading devices comprise a handling device operating on a radially external surface of the carcass sleeve.

- Preferably, the forming drum in a first radially contracted operative condition has a maximum external diameter smaller than a minimum  
30 internal diameter of the carcass sleeve.

Preferably, the forming drum comprises a central shaft and a plurality of sectors circumferentially distributed around the central shaft and movable from a first operative condition, in which said sectors are close to the central shaft, to a second operative condition in which said sectors are  
5 moved away from the central shaft.

Preferably, each sector has an external surface shaped according to an internal surface configuration to be given to the shaped carcass sleeve.

Preferably, the sectors are carried by respective telescopically extendable guide members, radially extending from the central shaft.

10 Preferably, the forming drum comprises transmission mechanisms operatively engageable by said actuator devices and configured for simultaneously translating the sectors from the first operative condition to the second operative condition.

Preferably, said transmission mechanisms comprise control levers each  
15 hinged to one of said sectors and to at least one control collar slidably fit along the central shaft.

Preferably, the control collar is operatively connected to a threaded bar rotatably engaged in the central shaft.

Preferably, the actuator devices comprise a rotary driving device  
20 operatively engageable with the threaded bar to a first end of the central shaft.

Preferably, said engagement devices comprise a pair of flange elements coaxially facing each other and operatively engageable with respective anchoring annular structures carried by respective axially opposite ends of  
25 the carcass sleeve.

Preferably, said engagement devices comprise members for axially moving the flange elements.

Preferably, said axial movement members comprise at least one carriage carrying one of said flange elements and movable towards the other  
30 flange element in order to switch the shaping station between a loading/unloading condition, in which the flange elements are mutually

spaced according to a measure greater than an axial size of the non-shaped carcass sleeve, coming from the carcass building line, and a work condition, in which the flange elements are mutually spaced according to a measure substantially corresponding to the axial size of the carcass sleeve.

Preferably, in the loading/unloading condition, the flange elements are mutually spaced according to a measure at least double the axial size of the non-shaped carcass sleeve.

Preferably, each of said flange elements comprises at least one circumferential sealing ring configured for operating against one of said anchoring annular structures.

Preferably, said flange elements further comprise expansion members configured for determining a radial expansion of the respective circumferential seal rings.

Preferably, the actuator devices are housed inside at least one of said flange elements.

Preferably, said shaping devices comprise a fluid-dynamic circuit for introducing an operative inflation fluid inside the carcass sleeve.

Preferably, said shaping devices comprise axial movement devices, operating on at least one of the flange elements in order to move them axially towards each other starting from the aforesaid work condition.

Preferably, devices are provided for monitoring the radial sizes respectively assumed by the carcass sleeve and by the forming drum in order to prevent mutual contacts thereof during shaping.

Preferably, said monitoring devices are configured for enabling control actions on the actuator devices and/or on the shaping devices when the difference between the external diameter of the carcass sleeve and the external diameter of the forming drum falls below a pre-established threshold value.

Preferably, said belt structure application station is integrated in a green tyre completion line.

Preferably, the belt structure application station comprises devices for building at least one belt layer configured for winding at least one continuous elongated reinforcement element according to axially adjacent circumferential coils around a radially external surface of the carcass sleeve coupled to the forming drum.

Preferably, said green tyre completion line comprises devices for obtaining tread bands.

Preferably, the tread band obtainment devices comprise at least one twisting unit configured for winding at least one continuous elongated elastomeric element according to circumferential coils, axially adjacent in mutual contact, around said belt structure.

Preferably, the forming drum has, in the second operative condition, a curvature ratio comprised between about 0.15 and about 0.45.

Further characteristics and advantages will be clearer from the detailed description of a preferred but not exclusive embodiment of a method, a process and a plant for obtaining tyres, in accordance with the present invention.

Such description will be set forth hereinbelow with reference to the enclosed drawings, provided only as a non-limiting example, in which:

- figure 1 schematically shows a top view of a plant for building tyres in accordance with the present invention;
- figure 2 schematically shows, in side view and in partial section, the loading of a carcass sleeve on a shaping station;
- figure 3 schematically shows, in side view and in partial section, the engagement of the carcass sleeve with shaping devices arranged in the shaping station;
- figure 3a shows an enlargement of the detail indicated with "A" in figure 3;
- figure 4 schematically shows, in side view and in partial section, the execution of the shaping of the carcass sleeve;

- figure 5 shows the application of a belt layer on the shaped carcass sleeve coupled to a forming drum;

- figure 6 schematically shows, in radial half-section, a tyre obtainable in accordance with the present invention.

5 With reference to the abovementioned figures, reference number 1 indicates overall a plant for building tyres for vehicle wheels, arranged to actuate a process according to the present invention.

The plant 1 is set to obtain tyres 2 (figure 6) essentially comprising at least one carcass ply 3 preferably internally covered by an impermeable  
10 elastomeric material layer or so-called liner 4. Two anchoring annular structures 5, each comprising a so-called bead core 5a carrying preferably an elastomeric filler 5b in radially external position, are engaged with respective terminal flaps 3a of the carcass ply/plies 3. The anchoring  
annular structures 5 are integrated in proximity to zones normally identified  
15 with the name of "beads" 6, at which the engagement between the tyre 2 and a respective mounting rim (not depicted) normally occurs.

A belt structure 7 is circumferentially applied around the carcass ply/plies 3, and a tread band 8 is circumferentially superimposed on the belt structure 7. Two sidewalls 9, each extended from the corresponding bead  
20 6 to a corresponding lateral edge of the tread band 8, are applied at laterally opposite positions on the carcass ply/plies 3.

The plant 1 comprises a carcass building line 10 having one or more building stations 11 where the obtainment of a carcass sleeve 12 having substantially cylindrical shape is executed, for example according to  
25 known modes. The carcass sleeve 12 comprises said at least one carcass ply 3, preferably internally covered by the liner 4, and having the respective end flaps 3a engaged, e.g. by turning up, with the respective anchoring annular structures 5. If necessary, the carcass sleeve 12 can also comprise the sidewalls 9 or first portions thereof, each extended  
30 starting from a respective bead 6.

The carcass building line 10 belongs to a shaping station 13 comprising devices 14 for engaging the carcass sleeve 12 and shaping devices 15, upon whose action the carcass sleeve 12 is shaped according to a toroidal configuration.

5 The engagement devices 14 for example comprise a first flange element 16a and a second flange element 16b, coaxially facing each other and having respective circumferential engagement seats 17a, 17b, by means of which they are each operatively engageable at one of the anchoring annular structures 5 respectively carried by the axially opposite ends of the  
10 carcass sleeve 12.

The engagement devices 14 can also comprise axial movement members 18 for the flange elements 16a, 16b. More in detail, it can be provided that at least one of the flange elements 16a, 16b, e.g. the first flange element 16a, is carried by a carriage 19 movable along one or more linear guides  
15 20, parallel to a geometric axis X-X of mutual alignment between the flange elements 16a, 16b and preferably integral with respect to a fixed base 21, carrying the second flange element 16b. The movement of the carriage 19 along the linear guides 20 determines the switching of the shaping station 13 between a loading/unloading condition and a work  
20 condition. In the loading/unloading condition (figure 2), the first flange element 16a is spaced from the second flange element 16b according to a greater measure, approximately at least double, with respect to an axial size of the non-shaped carcass sleeve 12, coming from the carcass building line 10. In the work condition, the flange elements 16a, 16b, and  
25 more precisely the respective circumferential engagement seats 17a, 17b thereof, are mutually spaced according to a measure substantially corresponding to the axial size of the carcass sleeve 12.

The shaping devices 15 can for example comprise a fluid-dynamic circuit (not shown) for introducing pressurised air or another operative inflation  
30 fluid between the flange elements 16a, 16b, inside the carcass sleeve 12.

The shaping devices 15 can also comprise one or more linear actuators or other axial movement devices 22, operating on one or preferably both the flange elements 16a, 16b in order to move them axial towards each other starting from the aforesaid work condition. The mutual approaching of the flange elements 16a, 16b causes a mutual approaching of the anchoring annular structures 5 so as to allow the shaping of the carcass sleeve 12 according to a toroidal configuration, assisted by the simultaneous introduction of the pressurised operative fluid into the carcass sleeve 12.

In the shaping station 13, the shaped carcass sleeve 12 is coupled to a toroidal forming drum 23, rigid and expandable, arranged inside the carcass sleeve itself.

The forming drum 23 is expandable between a first operative condition, radially contracted (figures 2 and 3), and a second radially expanded operative condition (figures 4 and 5). For such purpose, it can for example be provided that the forming drum 23 comprise a plurality of sectors 24 circumferentially distributed around a central shaft 25. The sectors 24 are movable, preferably simultaneously with each other, from the aforesaid first operative condition in which they are close to the central shaft 25, to the second operative condition in which said sectors 24 are moved away from the central shaft 25. For such purpose, it can be provided that the sectors 24 are carried by respective telescopically extendable guide members 26, radially extending from the central shaft 25.

The movement of the sectors 24 can be attained by means of transmission mechanisms 27 comprising for example control levers 28 that are hinged, each at the respectively opposite ends thereof, to one of said sectors 24 and to at least one control collar 29 slidably fit along the central shaft 25. More particularly, a pair of control collars 29 are preferably provided, situated along the central shaft 25 in axially opposite positions with respect to the sectors 24, each engaging the respective control levers 28.

Each control collar 29 is operatively connected to a threaded bar 30, rotatably engaged coaxially inside the central shaft 25. The threaded bar

30 is extended along the central shaft 25, nearly for the entire length thereof or beyond, and carries two axially opposite threads 30a, 30b, respectively clockwise and anticlockwise. Operatively engaged on the threads 30a, 30b are respective nut screws 31, axially movable inside the  
5 central shaft 25 and each connected to one of the control collars 29, e.g. by means of at least one block 32 radially traversing the central shaft 25 at a longitudinal slit 33.

The rotation of the threaded bar 30 in the central shaft 25, actuable by means of a rotary driving device 34 or actuator devices of another type  
10 operating in the shaping station 13, causes an axial movement of the nut screws 31 and the control collars 29, to which a radial movement of the sectors 24 corresponds, towards the first or the second operative condition in accordance with the rotation sense of the threaded bar 30.

In the second operative condition, the set of sectors 24 of the forming  
15 drum 23 defines, along the circumferential extension thereof, a radially external toroidal surface "S", not necessarily continuous, shaped according to the internal configuration that a part of the carcass sleeve 12 must assume upon completed shaping. More in detail, it can advantageously be provided that the forming drum 23 in the second operative condition has a  
20 curvature ratio comprised between about 0.15 and about 0.45, typically adapted for obtaining tyres for motorcycles or other two-wheel vehicles. If necessary, however, curvature ratios can be employed of values lower than those indicated above, for example adapted for producing tyres for cars or trucks.

25 Preferably, the forming drum 23 is positioned in the shaping station 13 before the respective carcass sleeve 12, for example still being processed along the carcass building line 10, reaches the shaping station 13 itself.

More particularly, it is preferably provided that the forming drum 23 is projectingly supported in the shaping station 13. For example, a first end  
30 25a of the central shaft 25 of the forming drum 23 can for such purpose be retained by a mandrel 35 coaxially housed in the first flange element 16a

and provided with a rotary driving device 34 couplable with the threaded bar 30 in order to drive it in rotation.

The forming drum 23 can therefore be arranged in the first operative condition by means of said rotary driving device 34, if it is not already in such condition upon reaching the shaping station 13.

By means of carcass loading devices 36, the carcass sleeve 12 coming from the carcass building line 10 is then transferred into the shaping station 13 in order to be coaxially arranged at a radially external position around the forming drum 23 arranged in the first radially contracted operative condition.

The carcass loading devices 36 can for example comprise a carcass handling device 37 preferably operating on an external surface of the carcass sleeve 12. With a radial translation movement (with respect to the forming drum 23), the carcass sleeve 12 is first inserted, in axial alignment relation with the forming drum 23, between the flange elements 16a, 16b arranged in the loading/unloading condition (figure 2). The carcass sleeve 12 is subsequently arranged around the forming drum 23, preferably following an axial translation movement of the forming drum itself. More particularly, with a movement of the carriage 19 along the linear guides 20, the forming drum 23 is coaxially inserted in the carcass sleeve 12. Preferably, the translation of the carriage 19 and the forming drum 23 terminates with the engagement of a second end 25b of the central shaft 25 with a tailstock 38, situated inside the second flange element 16b (dashed line in figure 2).

For the axial movement of the forming drum 23 with respect to the carcass sleeve 12 to occur without mutual mechanical interferences, it is preferably provided that in the first operative condition, the forming drum 23 has a maximum external diameter smaller than a minimum internal diameter of the carcass sleeve 12, typically detectable at the beads 6.

At the end of the axial movement, each of the anchoring annular structures 5 integrated in the beads 6 is situated in axially internal position

with respect to the circumferential engagement seat 17a, 17b of the respective first and second flange element 16a, 16b.

Upon action of the axial movement devices 22, the flange elements 16a, 16b then carry the respective engagement seats 17a, 17b substantially in radial alignment relation inside the anchoring annular structures 5.

Each of said flange elements 16a, 16b comprises expansion members (not depicted) configured for determining a radial expansion of respective circumferential seal rings 39a, 39b integrating the circumferential engagement seats 17a, 17b. Following such radial expansion, each of the circumferential seal rings 39a, 39b is brought to act in thrust relation against one of the anchoring annular structures 5. The carcass sleeve 12 is thus stably constrained to the flange elements 16a, 16b. Upon completed engagement, the carcass handling device 37 can disengage the carcass sleeve 12 and be removed from the shaping station 13.

During shaping, when the carcass sleeve 12 starts to radially expand, the radial expansion of the shaping drum can be controlled by means of rotation of the threaded bar 30 upon action of the rotary driving device 34. The shaping of the carcass sleeve 12 is executed without contact between the latter and the forming drum 23, at least until the forming drum 23 itself has reached the maximum radial expansion, upon attaining its second operative condition.

For such purpose, it can be provided to use monitoring devices 40a, 40b that cyclically or continuously verify the diameter size respectively assumed by the carcass sleeve 12 and by the forming drum 23, to prevent mutual contacts thereof during the shaping step. In response to such monitoring actions, when the difference between the external diameter of the carcass sleeve 12 and the external diameter of the forming drum 23, for example at an axial middle line plane "E" perpendicular to the geometric axis X-X and equidistant from the flange elements 16a, 16b and/or from the anchoring annular structures 5, falls below a pre-established threshold value, the monitoring devices 40a, 40b enable

control actions on the rotary driving device 34 and/or on the shaping devices 15, such that the external surface of the toroidal forming drum 23 remains spaced from the carcass sleeve 12 during the expansion of the forming drum 23, at least until the second radially expanded operative  
5 condition of the forming drum 23 has been reached.

By way of example, the monitoring devices 40a, 40b can comprise at least one first optical sensor 40a positioned outside the carcass sleeve 12 in order to detect the external diameter thereof in proximity to the axial middle line plane "E", and at least one transducer 40b positioned inside  
10 one of the flange elements 16a, 16b and/or coupled to the rotary driving device 34 in order to detect the axial position assumed by at least one of the control collars 29 and/or the extent of the angular rotation completed by the threaded bar 30, so as to allow an electronic processing unit to calculate the value of the external diameter assumed by the forming drum  
15 23.

Upon reaching a predetermined maximum value of the diameter size of the carcass sleeve 12, the action of the shaping devices is interrupted and the completion of the radial expansion of the forming drum 23 is enabled, bringing it to reach the second operative condition.

20 Then, the coupling is enabled between the carcass sleeve 12 and forming drum 23. Such coupling is verified by carrying an internal surface of the carcass sleeve 12 in contact relation against the radially external toroidal surface "S" of the forming drum 23.

It is preferably provided that at the end of the shaping, the internal surface  
25 of the carcass sleeve 12 reaches a maximum diameter "D2" greater than the maximum diameter "D1" reached by the external surface of the forming drum 23 in the second operative condition. The coupling can therefore be actuated following a slight radial contraction of the carcass sleeve 12, for example obtained due to an elastic contraction of the same following the  
30 evacuation of the operative fluid previously introduced during shaping.

In order to facilitate an expansion of the carcass sleeve 12 beyond the maximum diameter reached by the forming drum 23 in the second operative condition, it can be provided that in the final steps of approaching the maximum radial expansion condition of the carcass sleeve 12, the flange elements 16a, 16b are axially inserted in radially internal position with respect to the sectors 24 of the forming drum 23, which is about to reach the second operative condition.

The attainment of a coupling by means of radial contraction of the carcass sleeve 12 facilitates a uniform contact and in the absence of friction between the internal surface of the carcass sleeve 12 and the forming drum 23, preserving the structural integrity of the carcass sleeve 12 without inducing density variations in the distribution of the cords that constitute the carcass ply or plies, and/or other structural distortions.

Upon completed coupling, the flange elements 16a, 16b disengage the carcass sleeve 12, leaving it on the forming drum 23.

Carcass sleeve 12 and forming drum 23 in mutual coupling relation are adapted to be subjected to the action of at least one device 41 for building at least one belt layer at a radially external position relative to the shaped carcass sleeve 12. Such device 41 is preferably installed in a belt structure application station 42 that is remote relative to said shaping station 13.

In order to allow the transfer of the forming drum 23 to the belt structure application station 42, it is provided that the forming drum 23 carrying the carcass sleeve 12 be supported by the mandrel 35 operating at the first end 25a of the central shaft 25, while the tailstock 38 disengages from the second end 25b of the central shaft 25 itself. With a retreating of the first flange element 16a, the shaping station 13 is brought back into the loading/unloading condition, freeing the access to a first anthropomorphic robotic arm 43 or other suitable transfer devices, which in turn engages the forming drum 23 at the second end 25b of the central shaft 25.

The first robotic arm 43 transfers the forming drum 23 from the shaping station 13 to the belt structure application station 42. The first robotic arm

- 43 also suitably moves the forming drum 23 in front of the device 41 for building the belt layer, which can for example comprise a dispenser that feeds at least one rubber-covered cord or other continuous elongated reinforcement element made of textile or metallic material. A belt layer 7a is therefore obtained by winding said continuous elongated reinforcement element according to axially adjacent circumferential coils 44 around the radially external surface "S" of the carcass sleeve 12 coupled to the expanded toroidal forming drum 23, while the latter is driven in rotation and suitably moved by the first robotic arm 43.
- 10 The rigidity of the forming drum 23 ensures a stable positioning of the single circumferential coils 44 formed directly on the external surface of the shaped carcass sleeve 12, without undesired deformations of the carcass sleeve 12 occurring due to the stresses transmitted on its external surface during application. The stickiness of the green elastomeric material that constitutes the carcass ply or plies 3 prevents undesired spontaneous and/or non-controlled movements of the single circumferential coils 44, without having to arrange for this purpose additional intermediate layers between the belt layer 7a in manufacturing step and the underlying application surface. In other words, a precise positioning is facilitated of the single circumferential coils 44 of the belt layer 7a, directly formed according to the desired final profile of the carcass sleeve 12 upon completed shaping, even when such profile has an accentuated transverse curvature as is for example found in tyres intended for motorcycles or two-wheel vehicles.
- 25 The belt structure application station 42 can if necessary comprise building devices 45 of one or more auxiliary layers 7b, to be applied on the shaped carcass sleeve 12 before or after the application of said at least one belt layer 7a. In particular, such auxiliary layers 7b can comprise textile or metallic parallel cords, arranged according to an orientation that is tilted with respect to the circumferential extension direction of the carcass

sleeve 12, respectively crossed between auxiliary layers 7b adjacent to each other.

The transfer of the forming drum 23 between the auxiliary layer building devices 45 and the belt layer building device 41 can be assigned to the  
5 same first robotic arm 43, or to a second anthropomorphic robotic arm or handling device of another type.

The forming drum 23 is then transferred from the belt structure application station 42 to devices for obtaining tread bands 47, preferably constituting  
10 part of a green tyre completion line integrating the belt structure application station 42.

The tread band obtainment devices 47 can for example comprise at least one twisting unit configured for winding at least one continuous elongated elastomeric element according to circumferential coils, axially adjacent in mutual contact, at a radially external position around the belt structure 7,  
15 while the forming drum 23 is driven in rotation and suitably moved for distributing the circumferential coils according to a predefined scheme.

The plant 1 can finally comprise sidewall obtainment devices (not shown) against axially opposite lateral portions of the carcass sleeve 12.

The built green tyre 2 is adapted to be removed from the forming drum 23  
20 in order to be vulcanised in a vulcanisation unit 52.

**CLAIMS**

1. Process for building tyres comprising:
  - arranging a carcass sleeve (12) comprising at least one carcass ply and a pair of anchoring annular structures (5);
  - 5 arranging a toroidal forming drum (23) in a first radially contracted operative condition;
  - positioning said carcass sleeve (12) at a radially external position relative to said forming drum (23);
  - toroidally shaping said carcass sleeve (12) while said forming drum
  - 10 (23) is positioned inside the carcass sleeve (12);
  - expanding said forming drum (23) up to a second radially expanded operative condition;
  - coupling the toroidally shaped carcass sleeve (12) to the forming drum (23) in said second operative condition;
  - 15 arranging said forming drum (23), coupled to said carcass sleeve (12), in proximity to at least one device (41) for building at least one belt layer (7a) at a radially external position relative to said carcass sleeve (12).
2. Process as claimed in claim 1, wherein the carcass sleeve (12) is
- 20 obtained in at least one building station and subsequently transferred to a shaping station (13).
3. Process as claimed in claim 2, wherein the carcass sleeve (12) is fit coaxially around the forming drum (23) arranged in the shaping station (13).
- 25 4. Process as claimed in one or more of the preceding claims, wherein the carcass sleeve (12) is first moved with a radial translation movement relative to the forming drum (23) until it is in a relation of substantial axial alignment therewith, and subsequently fit around the latter with an axial translation movement.
- 30 5. Process as claimed in one or more of the preceding claims, wherein the external surface of the forming drum (23) remains spaced

from the carcass sleeve (12) during an expansion of the forming drum (23), at least until the second radially expanded operative condition is reached.

6. Process as claimed in one or more of the preceding claims, wherein the shaping of the carcass sleeve (12) occurs by means of introduction of an operative inflation fluid inside the carcass sleeve (12).

7. Process as claimed in one or more of the preceding claims, wherein at least one diameter size of the carcass sleeve (12) is monitored during shaping.

8. Process as claimed in one or more of the preceding claims, wherein at least one diameter size of the forming drum (23) is monitored during shaping.

9. Process as claimed in one or more of the preceding claims, wherein the shaping of the carcass sleeve (12) is interrupted upon reaching a predetermined maximum value of said diameter size of the carcass sleeve (12).

10. Process as claimed in one or more of the preceding claims, wherein a radial expansion of the forming drum (23) up to the second operative condition is enabled upon reaching a predetermined value of said diameter size of the carcass sleeve (12).

11. Process as claimed in one or more of the preceding claims, wherein said device (41) for building at least one belt layer (7a) is installed in a belt structure application station (42), remote relative to said shaping station (13).

12. Process as claimed in one or more of the preceding claims, wherein said at least one belt layer (7a) is obtained by winding at least one continuous elongated reinforcement element according to axially adjacent circumferential coils (44), around a radially external surface ("S") of the carcass sleeve (12) coupled to the forming drum (23).

13. Process as claimed in one or more of the preceding claims, wherein a tread band (8) is formed at a radially external position around said at least one belt layer (7a) made on the carcass sleeve (12).

14. Process as claimed in claim 13, wherein the tread band (8) is  
5 obtained by winding at least one continuous elongated element made of elastomeric material according to consecutively adjacent circumferential coils (44), around a radially external surface ("S") of said at least one belt layer (7a).

15. Process as claimed in one or more of the preceding claims,  
10 wherein the carcass sleeve (12) coupled to said at least one belt layer (7a) has a curvature ratio comprised between about 0.15 and about 0.45.

16. Method for building tyres comprising:  
building a carcass sleeve (12) and a crown structure of each tyre in  
sequence relative to each other;  
15 wherein said carcass sleeve (12) is toroidally shaped and subsequently coupled to an expandable toroidal forming drum (23);  
wherein the crown structure is built on the radially external surface (S) of said carcass sleeve (12) toroidally shaped and associated with said expanded toroidal forming drum (23).

20 17. Method as claimed in claim 16, wherein the carcass sleeve (12) is coupled in contact relation against an external surface of the forming drum (23).

18. Method as claimed in one or more of the claims 16 and 17,  
wherein the carcass sleeve (12) is axially centred with respect to the  
25 forming drum (23) before being toroidally shaped.

19. Method as claimed in one or more of the claims from 16 to 18,  
wherein at least one part of the expansion of the forming drum (23) is actuated simultaneously with at least one part of the shaping of the carcass sleeve (12).

30 20. Method as claimed in one or more of the claims from 16 to 19,  
wherein at the end of shaping, an internal surface of the carcass sleeve

(12) reaches a maximum diameter (D2) greater than the maximum diameter (D1) reached by the external surface of the expanded forming drum (23).

21. Method as claimed in one or more of the claims from 16 to 20,  
5 wherein the external surface of the forming drum (23) is coupled against an internal surface of the carcass sleeve (12) following a contraction of the shaped carcass sleeve (12).

22. Method as claimed in one or more of the claims from 16 to 21,  
wherein control actions are carried out on the shaping of the carcass  
10 sleeve (12) and/or on the expansion of the forming drum (23) to prevent mutual contacts during shaping.

23. Plant for building tyres, comprising:

a shaping station (13) comprising devices (14) for engaging a  
carcass sleeve (12);

15 shaping devices (15) operating in the shaping station (13) for shaping the carcass sleeve (12) according to a toroidal configuration;

an expandable toroidal forming drum (23) engageable in the  
shaping station (13) at a radially internal position relative to the carcass  
sleeve (12);

20 actuator devices (34) operating in the shaping station (13) for radially expanding the forming drum (23) inside the carcass sleeve (12);

at least one belt structure application station (42);

transfer devices (43) configured for transferring the forming drum  
(23) carrying said toroidally shaped carcass sleeve (12) from the shaping  
25 station (13) to said at least one belt structure application station (42).

24. Plant as claimed in claim 23, further comprising:

a carcass building line (10);

carcass loading devices (36) configured for transferring the carcass  
sleeve (12) from the carcass building line (10) to the shaping station (13).

25. Plant as claimed in claim 24, wherein said carcass loading devices (36) comprise a carcass handling device (37) operating on a radially external surface ("S") of the carcass sleeve (12).

26. Plant as claimed in one or more of the claims from 23 to 25,  
5 wherein the forming drum (23) in a first radially contracted operative condition has a maximum external diameter smaller than a minimum internal diameter of the carcass sleeve (12).

27. Plant as claimed in one or more of the claims from 23 to 26,  
10 wherein the forming drum (23) comprises a central shaft (25) and a plurality of sectors (24) circumferentially distributed around the central shaft (25) and movable from a first operative condition, wherein said sectors (24) are close to the central shaft (25), to a second operative condition wherein said sectors (24) are moved away from the central shaft (25).

15 28. Plant as claimed in claim 27, wherein each sector (24) has an external surface shaped according to an internal surface configuration to be given to the shaped carcass sleeve (12).

29. Plant as claimed in claim 27 or 28, wherein the sectors (24) are carried by respective telescopically extendable guide members (26),  
20 radially extending from the central shaft (25).

30. Plant as claimed in one or more of the claims from 27 to 29,  
wherein the forming drum (23) comprises transmission mechanisms (27) operatively engageable by said actuator devices (34) and configured for simultaneously translating the sectors (24) from the first operative  
25 condition to the second operative condition.

31. Plant as claimed in claim 30, wherein said transmission mechanisms (27) comprise control levers (28), each hinged to one of said sectors (24) and to at least one control collar (29) slidably fit along the central shaft (25).

32. Plant as claimed in claim 31, wherein the control collar (29) is operatively connected to a threaded bar (30) rotatably engaged in the central shaft (25).

33. Plant as claimed in claim 32, wherein the actuator devices (34) 5 comprise a rotary driving device (34) operatively engageable with the threaded bar (30) at a first end (25a) of the central shaft (25).

34. Plant as claimed in one or more of the claims from 23 to 33, wherein said engagement devices (14) comprise a pair of flange elements (16a, 16b) coaxially facing each other and operatively engageable with 10 respective anchoring annular structures (5) carried by respective axially opposite ends of the carcass sleeve (12).

35. Plant as claimed in claim 34, wherein said engagement devices (14) comprise axial movement members for the flange elements (16a, 16b).

36. Plant as claimed in claim 35, wherein said axial movement 15 members comprise at least one carriage (19) carrying one of said flange elements (16a, 16b) and movable towards the other flange element in order to switch the shaping station (13) between a loading/unloading condition, in which the flange elements (16a, 16b) are mutually spaced 20 according to a measure greater than an axial size of the non-shaped carcass sleeve (12), coming from the carcass building line (10), and a work condition, in which the flange elements (16a, 16b) are mutually spaced according to a measure substantially corresponding to the axial size of the carcass sleeve (12).

37. Plant as claimed in claim 36, wherein in the loading/unloading 25 condition, the flange elements (16a, 16b) are mutually spaced according to a measure at least double the axial size of the non-shaped carcass sleeve (12).

38. Plant as claimed in one or more of the claims from 34 to 37, 30 wherein each of said flange elements (16a, 16b) comprises at least one

circumferential sealing ring (39a, 39b) configured for operating against one of said anchoring annular structures (5).

39. Plant as claimed in claim 38, wherein said flange elements (16a, 16b) further comprise expansion members configured for  
5 determining a radial expansion of the respective circumferential sealing rings (39a, 39b).

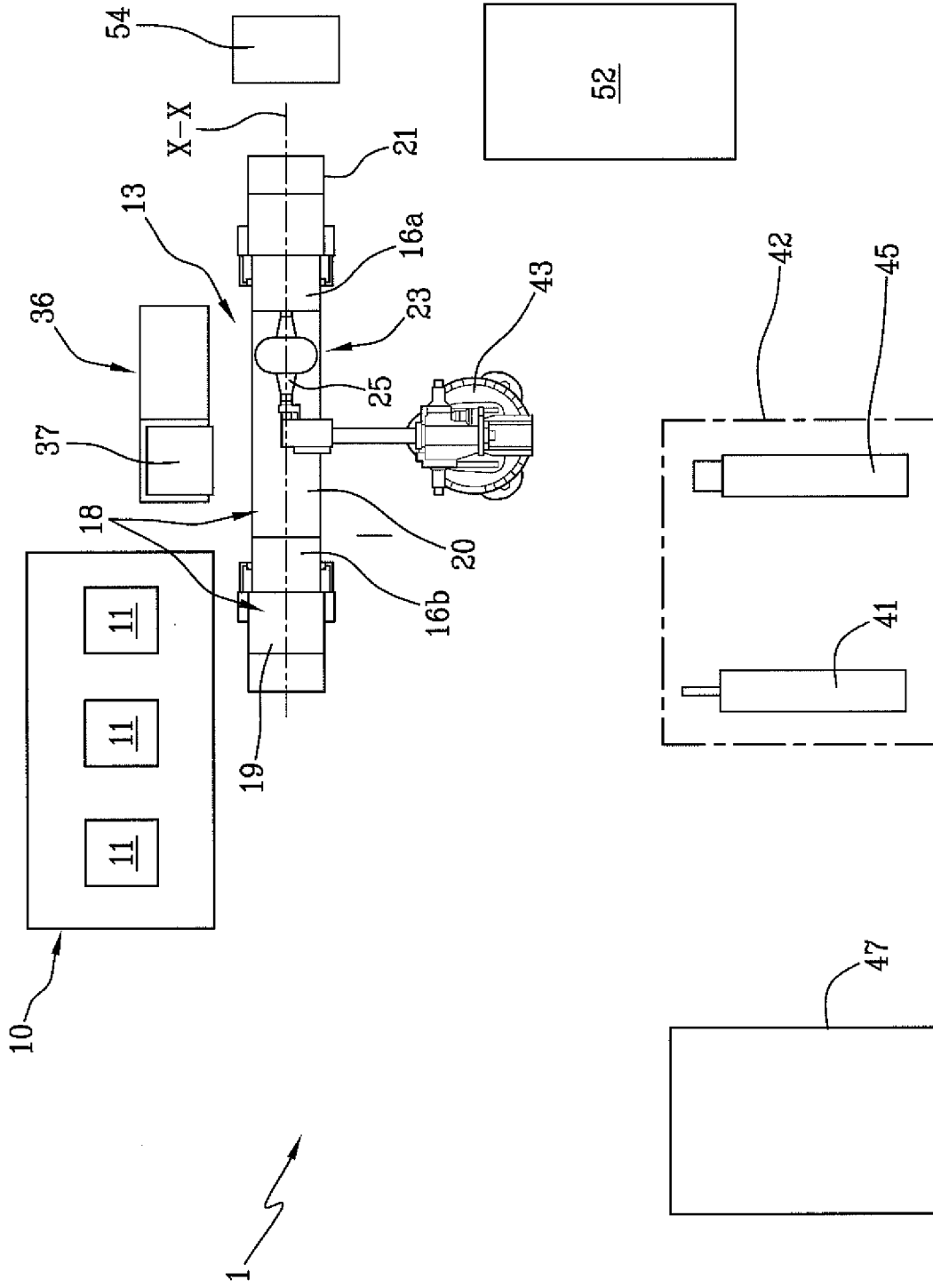
40. Plant as claimed in one or more of the claims from 34 to 39, wherein the actuator devices (34) are housed inside at least one of said flange elements (16a, 16b).

10 41. Plant as claimed in one or more of the claims from 23 to 40, further comprising devices (40a, 40b) for monitoring the radial sizes respectively assumed by the carcass sleeve (12) and by the forming drum (23), to prevent mutual contacts thereof during shaping.

15 42. Plant as claimed in claim 41, wherein said monitoring devices (40a, 40b) are configured for enabling control actions on the actuator devices (34) and/or on the shaping devices (15) when the difference between the external diameter of the carcass sleeve (12) and the external diameter of the forming drum (23) falls below a pre-established threshold value.

20 43. Plant as claimed in one or more of the claims from 27 to 42, when dependent on claim 27, wherein the forming drum (23) has, in the second operative condition, a curvature ratio comprised between about 0.15 and about 0.45.

Fig.1



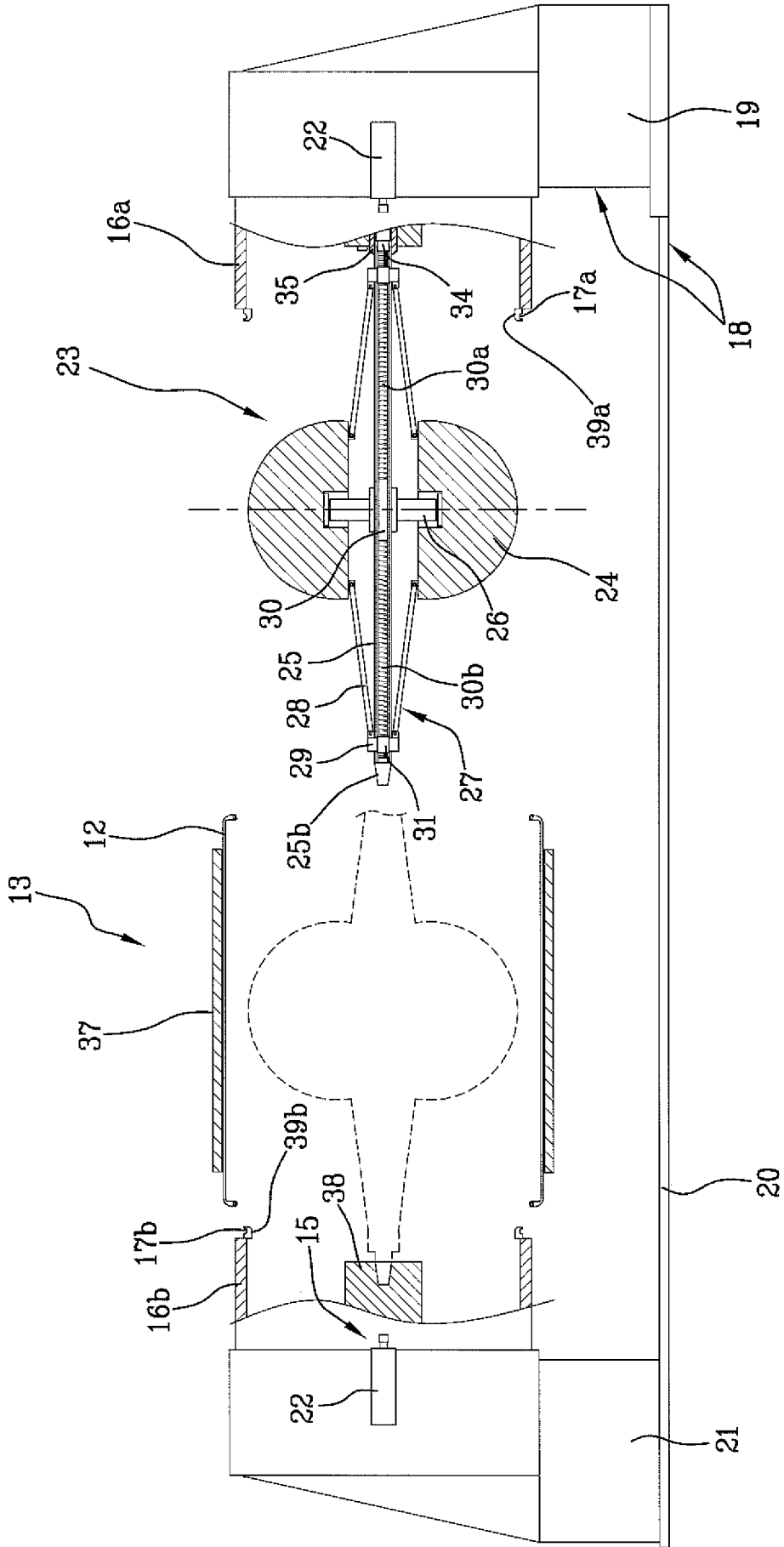


Fig. 2



Fig. 4

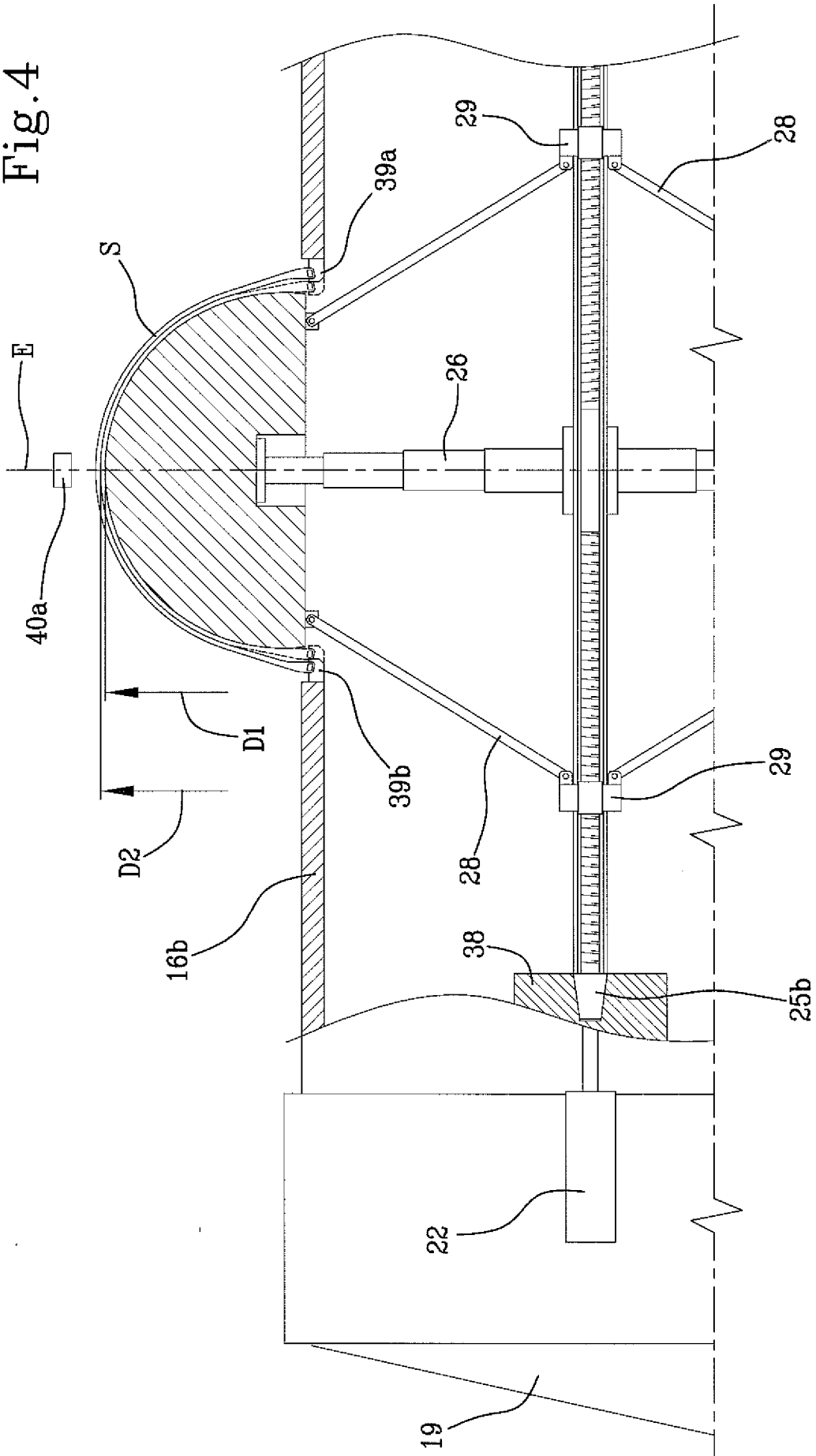
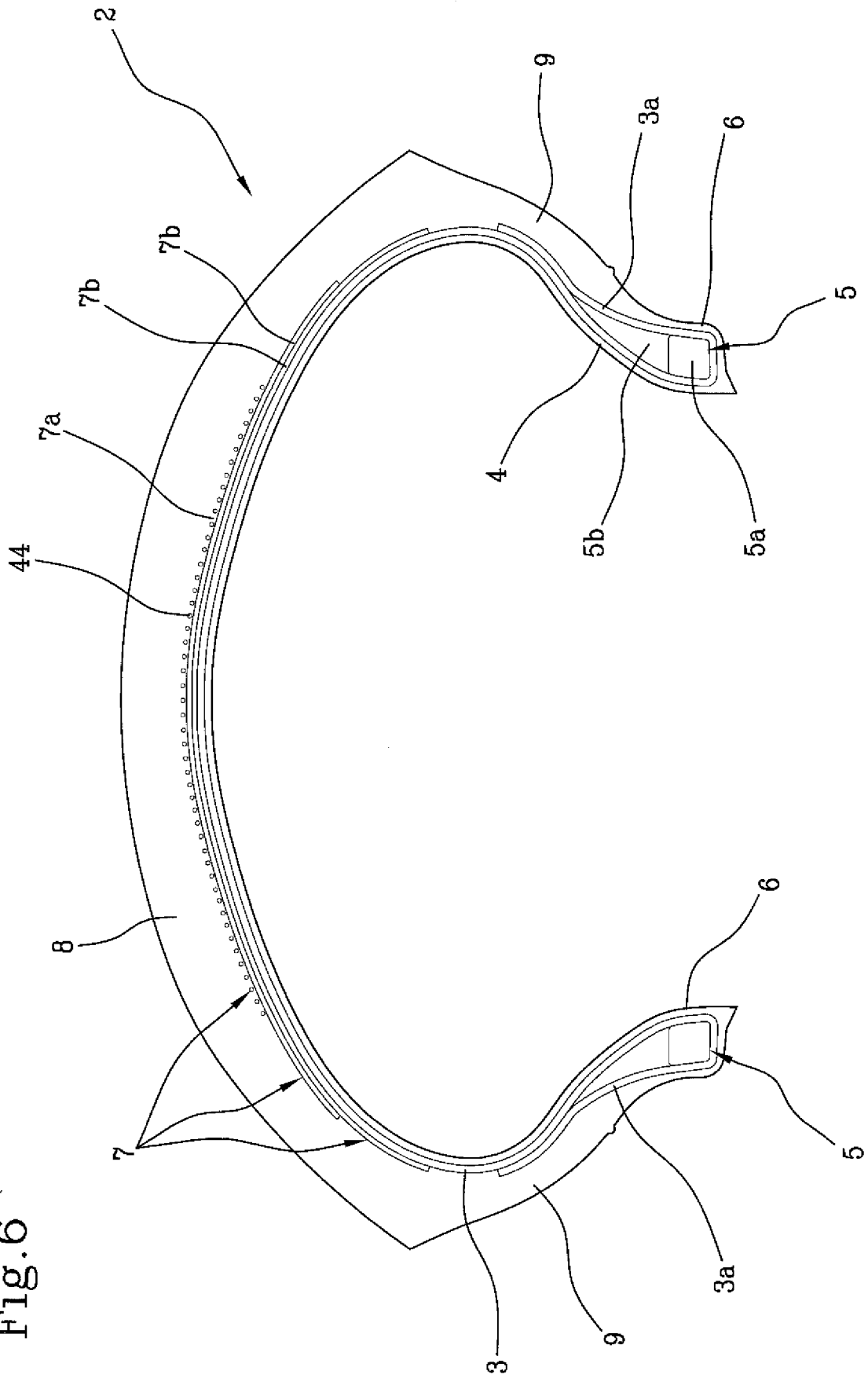




Fig. 6



**INTERNATIONAL SEARCH REPORT**

International application No  
PCT/IB2014/065582

A. CLASSIFICATION OF SUBJECT MATTER  
INV. B29D30/36  
ADD.  
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

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 practicable, search terms used)  
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 1 547 757 A1 (BRIDGESTONE CORP [JP]) 29 June 2005 (2005-06-29)  paragraph [0090] - paragraph [0125]; figures 1a, 1b, 8a-11c	1,3-6, 9-23, 26-28, 30-43
A	JP S57 212046 A (YOKOHAMA RUBBER CO LTD) 27 December 1982 (1982-12-27) abstract; figures 1-4c	1-43
A	US 6 234 227 B1 (BOSSEAUX BERNARD [FR]) 22 May 2001 (2001-05-22) column 2, line 66 - column 4, line 50; figures 1-5	1,6,16, 23,34-40
	----- -/--	

Further documents are listed in the continuation of Box C.

See patent family annex.

\* Special categories of cited documents :

<p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier application or patent but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p>	<p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone</p> <p>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art</p> <p>"&amp;" document member of the same patent family</p>
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Date of the actual completion of the international search  11 February 2015	Date of mailing of the international search report  19/02/2015
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Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Authorized officer  Fregosi, Alberto
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## INTERNATIONAL SEARCH REPORT

International application No  
PCT/IB2014/065582

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 6 012 500 A (CONNOR THOMAS M [US]) 11 January 2000 (2000-01-11) column 1, line 16 - column 6, line 10; figures 1-11	1,6,16, 23,34-40
A	----- US 2004/123930 A1 (NAKAMURA TSUTOMU [JP]) 1 July 2004 (2004-07-01) paragraph [0029] - paragraph [0053]; figures 1-7	1,11-13, 15,16,23
A	----- GB 1 487 426 A (BEKAERT SA NV) 28 September 1977 (1977-09-28) page 1, line 92 - page 2, line 106; figures 1-5	1,11-13, 15,16,23
A	----- US 3 674 604 A (GAZUIT GEORGES) 4 July 1972 (1972-07-04) column 2, line 46 - column 4, line 42; figures 1-5	1-43
A	----- US 3 867 230 A (VAN HORN RUSSELL F ET AL) 18 February 1975 (1975-02-18) column 2, line 43 - column 7, line 28; figures 1-11	1-43
A	----- US 3 776 802 A (MALLORY E ET AL) 4 December 1973 (1973-12-04) column 3, line 3 - column 8, line 67; figures 1-11	1-43
A	----- EP 2 014 451 A1 (CONTINENTAL AG [DE]) 14 January 2009 (2009-01-14) paragraph [0005] - paragraph [0022]; figures 1-5	1-43
	-----	

## INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/IB2014/065582

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 1547757	A1	29-06-2005	AT 443610 T 15-10-2009
			AU 2003254816 A1 23-02-2004
			CN 1681642 A 12-10-2005
			EP 1547757 A1 29-06-2005
			ES 2332093 T3 26-01-2010
			JP 4420820 B2 24-02-2010
			MX PA05001410 A 08-09-2005
			US 2006102272 A1 18-05-2006
			WO 2004012928 A1 12-02-2004
JP S57212046	A	27-12-1982	NONE
US 6234227	B1	22-05-2001	BR 9709562 A 10-08-1999
			CN 1225053 A 04-08-1999
			DE 69710888 D1 11-04-2002
			DE 69710888 T2 19-09-2002
			EP 0906186 A1 07-04-1999
			ES 2170395 T3 01-08-2002
			FR 2749536 A1 12-12-1997
			JP 4017191 B2 05-12-2007
			JP 2000511842 A 12-09-2000
			US 6234227 B1 22-05-2001
			WO 9747463 A1 18-12-1997
US 6012500	A	11-01-2000	NONE
US 2004123930	A1	01-07-2004	DE 60114111 D1 24-11-2005
			DE 60114111 T2 20-07-2006
			EP 1184204 A1 06-03-2002
			ES 2250317 T3 16-04-2006
			JP 2002059707 A 26-02-2002
			US 2002050314 A1 02-05-2002
			US 2004123930 A1 01-07-2004
GB 1487426	A	28-09-1977	BE 832973 A2 02-03-1976
			DE 2538154 A1 25-03-1976
			FR 2285255 A1 16-04-1976
			GB 1487426 A 28-09-1977
			IT 1047529 B 20-10-1980
			JP S5155505 A 15-05-1976
			LU 73408 A1 13-04-1976
US 3674604	A	04-07-1972	BE 730126 A 01-09-1969
			CS 164827 B2 28-11-1975
			DE 1916773 A1 27-08-1970
			FR 95397 E 11-09-1970
			GB 1262125 A 02-02-1972
			IT 989560 B 10-06-1975
			LU 58231 A1 11-07-1969
			NL 6906617 A 29-05-1970
			US 3674604 A 04-07-1972
US 3867230	A	18-02-1975	NONE
US 3776802	A	04-12-1973	CA 956560 A1 22-10-1974
			DE 2162311 A1 01-03-1973
			FR 2150275 A1 06-04-1973
			GB 1361679 A 30-07-1974

# INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
		IT 955100 B	29-09-1973
		JP S551182 B2	12-01-1980
		JP S4831273 A	24-04-1973
		SE 7412758 A	10-10-1974
		US 3776802 A	04-12-1973
-----			
EP 2014451	A1	14-01-2009	DE 102007031758 A1
			EP 2014451 A1
			08-01-2009
			14-01-2009
-----			