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(54) **Title:** METHOD FOR DETERMINING CONCENTRIC MOUNTING OF A TIRE ON A WHEEL

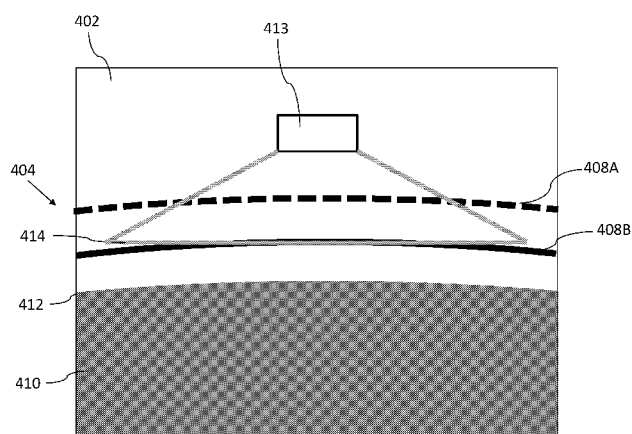


FIG. 4A

(57) **Abstract:** Method for determining concentric mounting of a tire on a wheel. In one embodiment, method for determining concentric mounting of a tire on a wheel comprises: providing a tire including at least one bead area, wherein at least one rim centering tolerance indicator is oriented in the at least one bead area, and wherein the at least one rim centering tolerance indicator extends circumferentially about the tire; mounting the tire on a wheel to form a tire-wheel assembly, the wheel includes a circular cross-section including a center point; rotatably mounting the tire-wheel assembly on a tire balancing machine; providing a light source adjacent to the tire-wheel assembly, the light source projects a projected reference point upon the at least one bead area; rotating the tire-wheel assembly; and observing the runout of the projected reference point relative to the at least one rim centering tolerance indicator.

**METHOD FOR DETERMINING CONCENTRIC
MOUNTING OF A TIRE ON A WHEEL**

BACKGROUND

[0001] When mounting a tire upon a rim, it is important to ensure that the tire and rim are at least substantially concentric. That is, an accepted industry tolerance exists for a tire's placement on a rim. An eccentric tire and rim relationship, outside of the accepted industry tolerance, may lead to irregular wear and reduced tread life.

[0002] Some tires include substantially circumferential lines extending about the sidewall of the tire. These lines are referred to as a first rim line and a second rim line. The first rim line, if available, is typically used by tire manufacturers and engineers as a reference point for analyzing tire sections. The first rim line is sometimes concealed from view by the rim's flange when the tire is mounted on the rim. However, the first rim line, which is ordinarily positioned at least somewhat radially-outwardly from the rim's flange, may also be utilized as a point against which to measure offset between a rim and a tire, and thus identify whether the tire and rim relationship is within the specified tolerances. Because the first rim line is often positioned radially-outwardly from the rim's flange in the tire's sidewall by some distance, an individual is required to take multiple measurements between the first rim line and the rim, about various points on the circumference of the rim. Due the curvature of the rim, it is difficult to obtain an accurate measurement between the first rim line and the rim.

[0003] What is needed is a method for ensuring that a tire and rim are concentric using a tire having rim centering tolerance indicators that create multiple visual points of reference.

SUMMARY

[0004] In one embodiment, a method for determining concentric mounting of a tire on a wheel is provided, the method comprising: providing a tire including at least one bead area, wherein at least one rim centering tolerance indicator is oriented in the at least one bead area, and wherein the at least one rim centering tolerance indicator extends circumferentially about the tire; mounting the tire on a wheel to form a tire-wheel assembly, wherein the wheel includes a circular cross-section including a center point; rotatably mounting the tire-wheel assembly on a tire balancing machine; providing a light source adjacent to the tire-wheel assembly, wherein the light source projects a projected reference point upon the at least one

bead area; rotating the tire-wheel assembly; and observing the runout of the projected reference point relative to the at least one rim centering tolerance indicator.

[0005] In another embodiment, a method for determining concentric mounting of a tire on a wheel is provided, comprising: providing a tire including at least one bead area, wherein three rim centering tolerance indicators are oriented in the at least one bead area, wherein the three rim centering tolerance indicators extend circumferentially about the tire, wherein each of the three rim centering tolerance indicators are concentric to one another, and wherein each of the three rim centering tolerance indicators are separated by a radial distance of about 1.5 mm; mounting the tire on a wheel to form a tire-wheel assembly, wherein the wheel includes a circular cross-section including a center point; rotatably mounting the tire-wheel assembly on a tire balancing machine; providing a light source adjacent to the tire-wheel assembly, wherein the light source projects a projected reference point upon the at least one bead area; rotating the tire-wheel assembly; and observing the runout of the projected reference point relative to the three rim centering tolerance indicator.

[0006] In another embodiment, a method for determining concentric mounting of a tire on a wheel is provided, comprising: providing a tire including at least one bead area, wherein three rim centering tolerance indicators are oriented in the at least one bead area, wherein the three rim centering tolerance indicators extend circumferentially about the tire, wherein each of the three rim centering tolerance indicators are concentric to one another, and wherein each of the three rim centering tolerance indicators are separated by a radial distance of 1.5 mm; mounting the tire on a wheel to form a tire-wheel assembly, wherein the wheel includes a circular cross-section including a center point; rotatably mounting the tire-wheel assembly on a tire balancing machine; providing a light source adjacent to the tire-wheel assembly, wherein the light source projects a projected reference point upon the at least one bead area; rotating the tire-wheel assembly; and observing the runout of the projected reference point relative to the three rim centering tolerance indicator.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] The accompanying figures, which are incorporated in and constitute a part of the specification, illustrate various example systems and apparatuses, and are used merely to illustrate various example embodiments. In the figures, like elements bear like reference numerals.

[0008] FIG. 1A illustrates an example embodiment of a tire **100** including at least one rim centering tolerance indicator **108**.

[0009] FIG. 1B illustrates a partial view of an example embodiment of tire **100** including at least one rim centering tolerance indicator **108A**, **108B**, **108C**.

[0010] FIG. 2A illustrates an example embodiment of a tire **200** including at least one rim centering tolerance indicator **208** mounted on a rim **210**.

[0011] FIG. 2B illustrates a partial view of an example embodiment of tire **200** including at least one rim centering tolerance indicator **208A**, **208B** mounted on rim **210**.

[0012] FIG. 3A illustrates an example embodiment of a tire **300** including at least one rim centering tolerance indicator **308** mounted on a rim **310**.

[0013] FIG. 3B illustrates a partial view of an example embodiment of tire **300** including at least one rim centering tolerance indicator **308A**, **308B** mounted on rim **310**.

[0014] FIG. 4A illustrates a partial view of an example embodiment of a tire sidewall **402** including at least one rim centering tolerance indicator **408A**, **408B** mounted on a rim **410**.

[0015] FIG. 4B illustrates a partial view of an example embodiment of tire sidewall **402** including at least one rim centering tolerance indicator **408A**, **408B** mounted on rim **410**.

[0016] FIG. 4C illustrates a partial view of an example embodiment of tire sidewall **402** including at least one rim centering tolerance indicator **408A**, **408B** mounted on rim **410**.

[0017] FIG. 5 illustrates a partial view of an example embodiment of a tire sidewall **502** including at least one rim centering tolerance indicator **508A**, **508B** mounted on a rim **510**.

[0018] FIG. 6 illustrates an example embodiment of a tire **600** mounted on a wheel, and mounted on a tire balancing machine **620**.

DETAILED DESCRIPTION

[0019] When a tire is mounted on a rim, the fitment between the tire and the rim may be such that the tire may actually mount on the rim without being within the industry accepted rim centering tolerance. That is, an industry standard tolerance for tire and rim alignment, herein referred to as a rim centering tolerance, exists to ensure that a tire is centered on a rim within an acceptable degree of error to avoid the negative effects of tire and rim eccentricity.

[0020] **FIG. 1A** illustrates a tire **100** including at least one rim centering tolerance indicator **108**. Tire **100** includes at least one sidewall **102** and at least one bead area **104**. Tire **100** may include a radially innermost portion **105**. Tire **100** may include a tread portion **106**. Tire **100** may include at least one rim centering tolerance indicator **108**.

[0021] Tire **100** may comprise any of a variety of tires, including a pneumatic tire, a non-pneumatic tire, a passenger tire, a truck tire, a bus tire, an off-the-road tire, and an agricultural tire.

[0022] At least one sidewall **102** may comprise a portion of tire **100** extending between tread portion **106** and at least one bead area **104**. In one embodiment, sidewall portion **102** does not include any portion of at least one bead area **104**. In one embodiment, sidewall **102** may include all of at least one bead area **104**.

[0023] At least one bead area **104** may comprise a portion of tire **100** configured to contact a flange of a wheel rim when tire **100** is mounted on a rim (not shown). Radially innermost portion **105** may contact a flange of a wheel rim when tire **100** is mounted on a rim (not shown). At least one bead area **104** may comprise a radially-inwardly portion of tire **100**. In one embodiment, at least one bead area **104** comprises an upper bead area, which may be defined as a portion of bead area **104** that is oriented at and near the radially-outwardly extending edge of bead area **104**. In one embodiment, the upper bead area extends to, but does not overlap, sidewall **102**.

[0024] In one embodiment, tire **100** comprises at least one rim centering tolerance indicator **108**. At least one rim centering tolerance indicator **108** may be oriented in at least one bead area **104**. In one embodiment, no rim centering tolerance indicator **108** is oriented on sidewall **102**. At least one rim centering tolerance indicator **108** may be oriented on a lower, radially inward, portion of sidewall **102**. At least one rim centering tolerance indicator **108** may include a plurality of rim centering tolerance indicators **108**. At least one rim centering tolerance indicator **108** may include at least two rim centering tolerance indicators **108**. At least one rim centering tolerance indicator **108** may include at least three rim centering tolerance indicators **108**.

[0025] At least one rim centering tolerance indicator **108** may comprise at least one of a substantially circumferential ring, and a reference mark. In one embodiment, as illustrated in **FIG. 1**, at least one rim centering tolerance indicator **108** comprises at least one ring extending about the circumference of at least one bead area **104**. In another embodiment, at

least one rim centering tolerance indicator **108** comprises at least one reference mark. In another embodiment, at least one rim centering tolerance indicator **108** comprises a combination of any number of substantially circumferential rings and reference marks. In another embodiment, at least one rim centering tolerance indicator **108** comprises a substantially solid circumferential ring. In another embodiment, at least one rim centering tolerance indicator **108** comprises a discontinuous circumferential ring. In another embodiment, as illustrated in **FIG. 1**, at least one rim centering tolerance indicator **108** comprises a combination of at least one substantially solid circumferential ring and at least one discontinuous circumferential ring. In one embodiment, at least one rim centering tolerance indicator **108** comprises a first rim line. In another embodiment, at least one rim centering tolerance indicator **108** comprises a first rim groove.

[0026] At least one rim centering tolerance indicator **108** may comprise any element configured to be visually detectable by an individual mounting tire **100** on a rim (not shown). In one embodiment, rim centering tolerance indicator **108** comprises a raised indicia extending from the surface of bead area **104**. In another embodiment, rim centering tolerance indicator **108** comprises a recessed indicia extending into the surface of bead area **104**. In another embodiment, rim centering tolerance indicator **108** comprises a combination of raised and recessed indicia. In one embodiment, rim centering tolerance indicator **108** comprises a colored indicia placed upon, formed into, or both, bead area **104**. In one embodiment, tire **100** comprises a plurality of rim centering tolerance indicators **108**, each of which may comprise differing or alternating colors, textures, raised portions, recessed portions, and the like. Rim centering indicator **108** may extend substantially circumferentially about tire **100**. Rim centering indicator **108** may extend substantially radially on tire **100**.

[0027] When tire **100** is mounted on a rim (not shown), at least one of rim centering tolerance indicators **108** may be aligned with or visible around a flange of the rim. In one embodiment, the flange of the rim (not shown) extends across bead area **104** from a radially-inwardly direction (the flange comprising an outer radius) and terminates at or near at least one of rim centering tolerance indicators **108**. In one embodiment, aligning an outer radius of a rim flange (not shown) with at least one of rim centering tolerance indicators **108** may indicate to an individual mounting tire **100** onto a rim that tire **100** is substantially concentric with, or within rim centering tolerance with, the rim. In another embodiment, confirming visually that the radially-innermost rim centering indicator **108** that is exposed around the rim's flange, is visible completely about the circumference of a rim flange, (not shown) may

indicate to an individual mounting tire **100** onto a rim that tire **100** is substantially concentric with, or within rim centering tolerances with, the rim. In another embodiment, confirming visually that any rim centering indicator **108** that is exposed around the rim's flange, is visible completely about the circumference of a rim flange, (not shown) may indicate to an individual mounting tire **100** onto a rim that tire **100** is substantially concentric with, or within rim centering tolerances with, the rim.

[0028] In one embodiment, any of various rims upon which tire **100** may be mounted comprise any of various geometries and sizes of rim flanges (not shown). A rim flange on one rim may extend a radially greater or lesser distance than a comparable rim flange. As such, tire **100** may comprise a plurality of rim centering tolerance indicators **108** to take into account various rim flange geometries and sizes. In one embodiment, tire **100** comprises a plurality of rim centering tolerance indicators **108**, at least one of which may be aligned with or visible around the outer radius of any of a variety of rim flanges (not shown) during mounting of tire **100** on a rim. Alignment of at least one rim centering tolerance indicator **108** with an outer radius of a rim flange may indicate to an individual mounting tire **100** onto a rim that tire **100** is substantially concentric with the rim. In one embodiment, a rim flange may comprise an outer radius greater than a radius of at least one rim centering tolerance indicator **108**, and as such may conceal that particular rim centering tolerance indicator **108** from view. However, a rim flange may comprise an outer radius less than a radius of another rim centering tolerance indicator **108**, which can be used to visually confirm concentricity of tire **100** and the rim. In one embodiment, the radius of a first rim centering tolerance indicator **108** and the radius of a second rim centering tolerance indicator **108** differ by about 1.5 mm. In one embodiment, the radius of a first rim centering tolerance indicator **108** and the radius of a second rim centering tolerance indicator **108** differ by 1.5 mm. The radius of a first rim centering tolerance indicator **108** and the radius of a second rim centering tolerance indicator **108** may differ by about 1.6 mm. The radius of a first rim centering tolerance indicator **108** and the radius of a second rim centering tolerance indicator **108** may differ by 1.6 mm.

[0029] **FIG. 1B** illustrates a partial view of tire **100**. Tire **100** may include at least one rim centering tolerance indicator **108A**, **108B**, **108C**. At least one rim centering tolerance indicator **108A** and **108B** may be radially offset from one another by a distance **D1**. At least one rim centering tolerance indicator **108B** and **108C** may be radially offset from one another by a distance **D2**. At least one of distance **D1** and distance **D2** may be about 1.5 mm. At

least one of distance **D1** and distance **D2** may be 1.5 mm. At least one of distance **D1** and distance **D2** may be about 1.6 mm. At least one of distance **D1** and distance **D2** may be 1.6 mm. At least one of distance **D1** and distance **D2** may be less than about 1.5 mm. At least one of distance **D1** and distance **D2** may be less than 1.5 mm. At least one of distance **D1** and distance **D2** may be greater than about 1.5 mm. At least one of distance **D1** and distance **D2** may be greater than 1.5 mm.

[0030] Rim centering tolerance indicator **108A** may be a radially outwardly-most rim centering tolerance indicator. Rim centering tolerance indicator **108C** may be a radially inwardly-most rim centering tolerance indicator. Rim centering tolerance indicator **108B** may be a radially-central rim centering tolerance indicator.

[0031] **FIG. 2A** illustrates a tire **200** including at least one rim centering tolerance indicator **208**. Tire **200** includes at least one sidewall **202** and at least one bead area **204**. Tire **200** may include a tread portion **206**. Tire **200** may include at least one rim centering tolerance indicator **208**.

[0032] Tire **200** may be mounted on a wheel **210**, forming a tire-wheel assembly. Wheel **210** may be a vehicle wheel. Wheel **210** and the tire-wheel assembly may be a wheel for application to an of a variety of vehicles, including: a passenger vehicle, a motorcycle, an all-terrain vehicle, an agricultural vehicle, an off-the-road vehicle, a tractor-trailer, an airplane, a trailer, a wagon, and the like.

[0033] Wheel **210** may include a center point **211**. Wheel **210** may have a substantially circular cross-section, and center point **211** may be defined as the center of the circular cross-section. Wheel **210** may rotate about an axis that passes through center point **211**. Center point **211** may be the axis of rotation of wheel **210** as it rotates.

[0034] Wheel **210** may include a rim flange **212**. Rim flange **212** may be substantially circular in cross-section, having a center point at center point **211**.

[0035] As illustrated in **FIGS. 2A** and **2B**, tire **200** may be mounted on wheel **210** in a non-concentric orientation, such that center point **211** is not the same as the center point of tire **200** (not shown).

[0036] **FIG. 2B** illustrates a partial view of tire **200** mounted on wheel **210**. Tire **200** may include at least one rim centering tolerance indicator **208A**, **208B**. At least one rim centering tolerance indicator **208A** and **208B** may be separated by a radial distance **D1**. In one embodiment, rim flange **212** at a first point of tire **200** may extend to rim centering

tolerance indicator **208B**, while rim flange **212** at a second point of tire **200** may extend to a different rim centering tolerance indicator (not shown). Such differences between the extent of rim flange **212** relative to rim centering tolerance indicators **208A**, **208B** at various points on tire **200** may be indicative of a lack of concentricity between tire **200** and wheel **210**.

[0037] **FIG. 3A** illustrates a tire **300** including at least one rim centering tolerance indicator **308**. Tire **300** includes at least one sidewall **302** and at least one bead area **304**. Tire **300** may include a tread portion **306**. Tire **300** may include at least one rim centering tolerance indicator **308**.

[0038] Tire **300** may be mounted on a wheel **310**, forming a tire-wheel assembly. Wheel **310** may include a center point **311**. Wheel **310** may include a rim flange **312**.

[0039] As illustrated in **FIGS. 3A** and **3B**, tire **300** may be mounted on wheel **310** in a concentric orientation, such that center point **311** is the same as the center point of tire **300** (not shown).

[0040] **FIG. 3B** illustrates a partial view of tire **300** mounted on wheel **310**. Tire **300** may include at least one rim centering tolerance indicator **308A**, **308B**, **308C**. At least one rim centering tolerance indicator **308A** and **308B** may be separated by a radial distance **D1**. At least one rim centering tolerance indicator **308B** and **308C** may be separated by a radial distance **D2**. In one embodiment, rim flange **312** at a first point and a second point (e.g., the first and second points being on substantially opposite sides of the tire-wheel assembly, and separated by about 180 degrees) of tire **300** may extend to rim centering tolerance indicator **308C**. The first and second points being on substantially opposite sides of the tire-wheel assembly, and separated by 180 degrees. Such consistency between the extent of rim flange **312** relative to rim centering tolerance indicator **308C** may be indicative of concentricity between tire **300** and wheel **310**.

[0041] **FIG. 4A** illustrates a tire sidewall **402** including at least one rim centering tolerance indicator **408A**, **408B**. Tire sidewall **402** may include, or be adjacent to, at least one bead area **404**.

[0042] Tire **400** may be mounted on a wheel **410**, forming a tire-wheel assembly. Wheel **410** may include a center point (not shown). Wheel **410** may include a rim flange **412**.

[0043] A light source **413** may be provided relative to the tire-wheel assembly to project a projected reference point **414**. Projected reference point **414** may be projected upon a

surface of the tire-wheel assembly. Projected reference point **414** may be projected upon a surface of tire sidewall **402** or bead area **404**.

[0044] Light source **413** may be any of a variety of light sources capable of projecting a light upon a surface, including for example: a laser, an incandescent light, a fluorescent light, a high-intensity discharge light, a light emitting diode light, and the like. Light source **413** may include any of a variety of lenses, masks, filters, and the like configured for focusing the light to create a readily discernable projected reference point **414** upon a surface. Projected reference point **414** may include a laser beam.

[0045] Projected reference point **414** may comprise any of a variety of shapes, including for example: a line, an arc, a dotted line, hash marks, a pattern of dots, a pattern of shapes, a dot, a shape, a ring, a crosshair, a bullseye, and the like. Where projected reference point **414** is a line, the line may be substantially tangent to a circumference of tire sidewall **402**. Where projected reference point **414** is an arc, the arc may be substantially parallel to at least one rim centering tolerance indicator **408A**, **408B**. Stated differently, where projected reference point **414** is an arc, the arc may extend with a similar radius of curvature to at least one rim centering tolerance indicator **408A**, **408B**.

[0046] In practice, a user may mount tire having tire sidewall **402** and bead area **404** on wheel **414**, creating a tire-wheel assembly. The tire-wheel assembly may be operatively connected to light source **413**. Light source **413** may be oriented adjacent the tire-wheel assembly. Light source **413** may project projected reference point **414** onto at least one of tire sidewall **402** and bead area **404**. A user may visually observe projected reference point **414**'s position on at least one of tire sidewall **402** and bead area **404** relative to at least one rim centering tolerance indicator **408A**, **408B**. The user may rotate light source **413** and tire-wheel assembly relative to one another about an axis extending through the center point of wheel **410** (e.g., via rotating light source **413** relative to tire-wheel assembly, or via rotating tire-wheel assembly relative to light source **413**). As a result, projected reference point **414** may be projected, continuously, or intermittently, about a plurality of points about at least a portion of the circumference of at least one of sidewall **402** and bead area **404**.

[0047] Monitoring the radial displacement of a point on a tire while it is rotating is referred to as measuring its runout. In one embodiment, one may visually monitor the runout of projected reference point **414** during rotation of the tire-wheel assembly.

[0048] In one embodiment, a tire may be mounted on wheel **410**, forming a tire-wheel assembly. After mounting, but before balancing of the tire-wheel assembly, the tire-wheel assembly may be mounted on a tire machine (not shown). Light source **413** may be oriented upon the tire machine in a stationary position and configured to project projected reference point **414** onto a surface of at least one of sidewall **402** and bead area **404**. The tire-wheel assembly may be rotated and the runout of projected reference point **414** may be observed. If the runout of projected reference point **414** is within acceptable tolerances of concentricity, the tire-wheel assembly may be balanced. If the runout of projected reference point **414** is not within acceptable tolerances of concentricity, the tire-wheel assembly may be dismounted, and the tire may be removed from wheel **410** to be remounted to achieve acceptable tolerances of concentricity.

[0049] In one embodiment, the tire-wheel assembly is rotated at least about 90 degrees. In another embodiment, the tire-wheel assembly is rotated at least about 180 degrees. In another embodiment, the tire-wheel assembly is rotated at least about 270 degrees. In another embodiment, the tire-wheel assembly is rotated about 360 degrees. In another embodiment, the tire-wheel assembly is rotated about 360 degrees or less.

[0050] In one embodiment, the tire-wheel assembly is rotated at least 90 degrees. In another embodiment, the tire-wheel assembly is rotated at least 180 degrees. In another embodiment, the tire-wheel assembly is rotated at least 270 degrees. In another embodiment, the tire-wheel assembly is rotated 360 degrees. In another embodiment, the tire-wheel assembly is rotated 360 degrees or less.

[0051] In one embodiment, projected reference point **414** may be oriented initially upon rim centering tolerance indicator **408B**. The tire-wheel assembly may be rotated and the runout of projected reference point **414** may be observed.

[0052] As illustrated in **FIG. 4B**, in one embodiment, where projected reference point **414** does not extend radially outwardly of rim centering tolerance indicator **408A**, or radially inwardly of rim centering tolerance indicator **408C**, during rotation of the tire-wheel assembly, then the tire-wheel assembly is within acceptable tolerances of concentricity. Projected reference point **414** may have a maximum runout of runout **R1**.

[0053] As illustrated in **FIG. 4C**, in one embodiment, where projected reference point **414** extends radially outwardly of rim centering tolerance indicator **408A**, or radially inwardly of rim centering tolerance indicator **408C**, during rotation of the tire-wheel

assembly, then the tire-wheel assembly is not within acceptable tolerances of concentricity. Projected reference point **414** may have a maximum runout of runout **R2**.

[0054] **FIG. 5** illustrates a tire sidewall **502** including at least one rim centering tolerance indicator **508A**, **508B**. Tire sidewall **502** includes, or is adjacent to, at least one bead area **504**.

[0055] Tire **500** may be mounted on a wheel **510**, forming a tire-wheel assembly. Wheel **510** may include a center point (not shown). Wheel **510** may include a rim flange **512**.

[0056] A light source (not shown) may be provided relative to the tire-wheel assembly to project a projected reference point **514**. Projected reference point **514** may be projected upon a surface of the tire-wheel assembly. Projected reference point **514** may be projected upon a surface of at least one of tire sidewall **502** and bead area **504**.

[0057] In one embodiment, projected reference point **514** may be caused to fall upon rim centering tolerance indicator **508B**. The tire-wheel assembly may be rotated and projected reference point **514** may remain in contact with rim centering tolerance indicator **508B**, which may indicate concentricity of the tire relative to wheel **510**.

[0058] **FIG. 6** illustrates a tire **600** mounted on a wheel to form a tire-wheel assembly **601**, which is mounted on a tire balancing machine **620**. Tire **600** may include at least one sidewall **602**.

[0059] A light source **613** may be oriented upon tire balancing machine **620**. Light source **613** may project a projected reference point **614** onto at least one of sidewall **602** and a bead area (not shown). Projected reference point **614** may be adjusted radially on at least one of sidewall **602** and a bead area (not shown) to be projected upon a specific rim centering tolerance indicator, including for example rim centering tolerance indicator **508B** illustrated in **FIG. 5**.

[0060] Tire-wheel assembly **601** may be operatively connected to tire balancing machine **620** via a shaft **622**. Shaft **622** may rotate relative to tire balancing machine **620**, thus causing tire-wheel assembly **601** to rotate relative to tire balancing machine **620**. The axis of rotation of shaft **622** may be collinear with a center point of the wheel of tire-wheel assembly.

[0061] To the extent that the term “includes” or “including” is used in the specification or the claims, it is intended to be inclusive in a manner similar to the term “comprising” as that term is interpreted when employed as a transitional word in a claim. Furthermore, to the

extent that the term “or” is employed (e.g., A or B) it is intended to mean “A or B or both.” When the applicants intend to indicate “only A or B but not both” then the term “only A or B but not both” will be employed. Thus, use of the term “or” herein is the inclusive, and not the exclusive use. See Bryan A. Garner, *A Dictionary of Modern Legal Usage* 624 (2d. Ed. 1995). Also, to the extent that the terms “in” or “into” are used in the specification or the claims, it is intended to additionally mean “on” or “onto.” To the extent that the term “substantially” is used in the specification or the claims, it is intended to take into consideration the degree of precision available or prudent in manufacturing. To the extent that the term “selectively” is used in the specification or the claims, it is intended to refer to a condition of a component wherein a user of the apparatus may activate or deactivate the feature or function of the component as is necessary or desired in use of the apparatus. To the extent that the term “operatively connected” is used in the specification or the claims, it is intended to mean that the identified components are connected in a way to perform a designated function. As used in the specification and the claims, the singular forms “a,” “an,” and “the” include the plural. Finally, where the term “about” is used in conjunction with a number, it is intended to include $\pm 10\%$ of the number. In other words, “about 10” may mean from 9 to 11.

[0062] As stated above, while the present application has been illustrated by the description of embodiments thereof, and while the embodiments have been described in considerable detail, it is not the intention of the applicants to restrict or in any way limit the scope of the appended claims to such detail. Additional advantages and modifications will readily appear to those skilled in the art, having the benefit of the present application. Therefore, the application, in its broader aspects, is not limited to the specific details, illustrative examples shown, or any apparatus referred to. Departures may be made from such details, examples, and apparatuses without departing from the spirit or scope of the general inventive concept.

CLAIMS

1. A method for determining concentric mounting of a tire on a wheel, comprising:
 - providing a tire including at least one bead area, wherein at least one rim centering tolerance indicator is oriented in the at least one bead area, and wherein the at least one rim centering tolerance indicator extends circumferentially about the tire;
 - mounting the tire on a wheel to form a tire-wheel assembly, wherein the wheel includes a circular cross-section including a center point;
 - rotatably mounting the tire-wheel assembly on a tire balancing machine;
 - providing a light source adjacent to the tire-wheel assembly, wherein the light source projects a projected reference point upon the at least one bead area;
 - rotating the tire-wheel assembly; and
 - observing the runout of the projected reference point relative to the at least one rim centering tolerance indicator.
2. The method of claim 1, wherein the light source is a laser.
3. The method of claim 1, wherein the projected reference point is a laser beam.
4. The method of claim 1, wherein the projected reference point is a line that is tangent to the at least one rim centering tolerance indicator.
5. The method of claim 1, wherein the at least one rim centering tolerance indicator includes three rim centering tolerance indicators, each concentric to the others, and each separated by a radial distance of 1.5 mm.
6. The method of claim 5, further comprising observing the runout of the projected reference point relative to the three rim centering tolerance indicators and observing whether the projected reference point extended radially outwardly of a radially outwardly-most rim centering tolerance indicator, and observing whether the projected reference point extended radially inwardly of a radially inwardly-most rim centering tolerance indicator.
7. The method of claim 5, wherein the projected reference point is projected upon a radially-central rim centering tolerance indicator before the tire-wheel assembly is rotated.
8. The method of claim 1, wherein the tire-wheel assembly is rotated at least 180 degrees.
9. The method of claim 1, wherein the tire-wheel assembly is rotated 360 degrees.

10. The method of claim 1, wherein the tire-wheel assembly is rotated about an axis that is collinear with the center point of the wheel.
11. A method for determining concentric mounting of a tire on a wheel, comprising:
 - providing a tire including at least one bead area, wherein three rim centering tolerance indicators are oriented in the at least one bead area, wherein the three rim centering tolerance indicators extend circumferentially about the tire, wherein each of the three rim centering tolerance indicators are concentric to one another, and wherein each of the three rim centering tolerance indicators are separated by a radial distance of 1.5 mm;
 - mounting the tire on a wheel to form a tire-wheel assembly, wherein the wheel includes a circular cross-section including a center point;
 - rotatably mounting the tire-wheel assembly on a tire balancing machine;
 - providing a light source adjacent to the tire-wheel assembly, wherein the light source projects a projected reference point upon the at least one bead area;
 - rotating the tire-wheel assembly; and
 - observing the runout of the projected reference point relative to the three rim centering tolerance indicators.
12. The method of claim 11, wherein the light source is a laser.
13. The method of claim 11, wherein the projected reference point is a laser beam.
14. The method of claim 11, wherein the projected reference point is a line that is tangent to the three rim centering tolerance indicators.
15. The method of claim 11, further comprising observing whether the projected reference point extended radially outwardly of a radially outwardly-most rim centering tolerance indicator, and observing whether the projected reference point extended radially inwardly of a radially inwardly-most rim centering tolerance indicator.
16. The method of claim 11, wherein the projected reference point is projected upon a radially-central rim centering tolerance indicator before the tire-wheel assembly is rotated.
17. The method of claim 11, wherein the tire-wheel assembly is rotated at least 180 degrees.
18. The method of claim 11, wherein the tire-wheel assembly is rotated 360 degrees.

19. The method of claim 11, wherein the tire-wheel assembly is rotated about an axis that is collinear with the center point of the wheel.

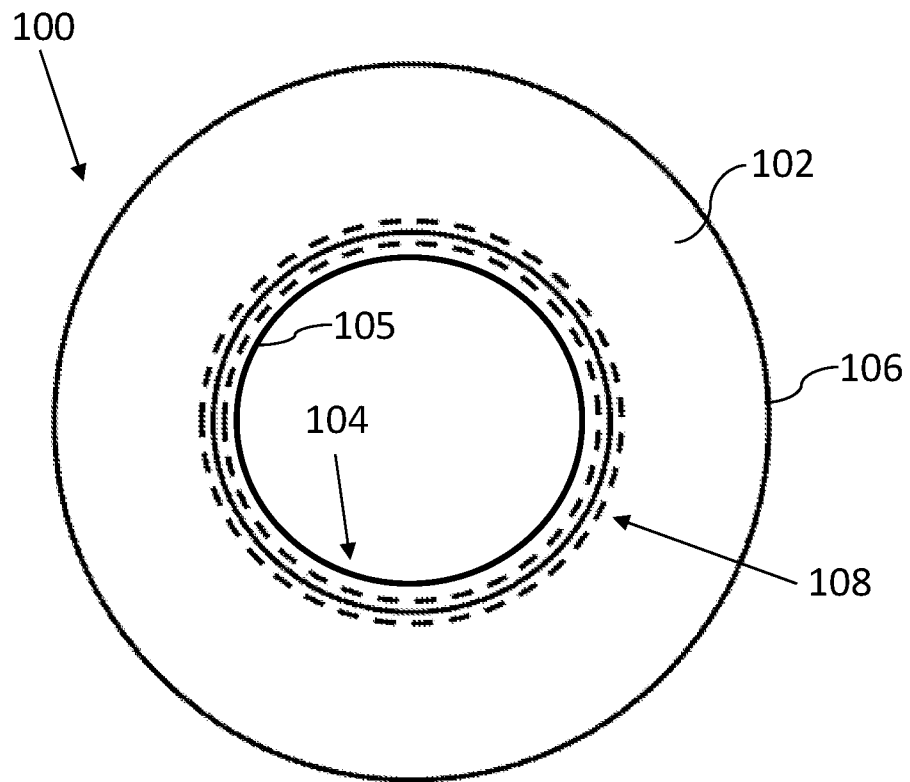


FIG. 1A

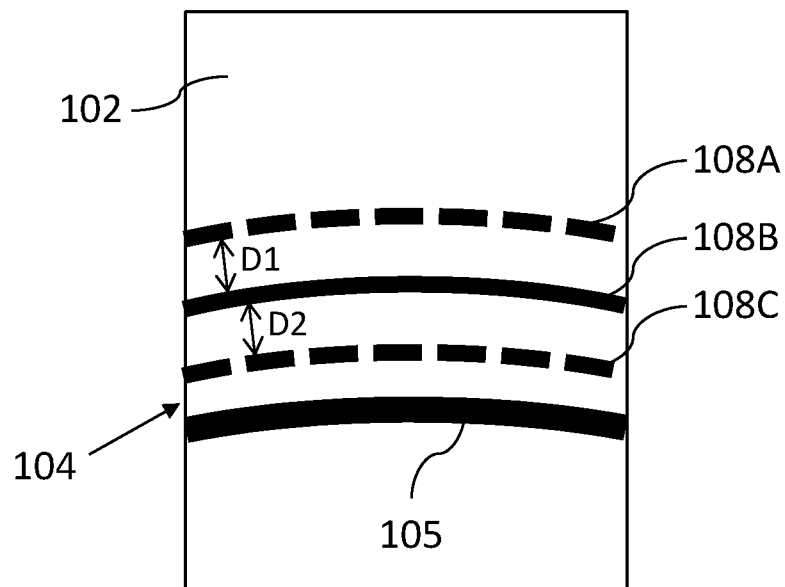


FIG. 1B

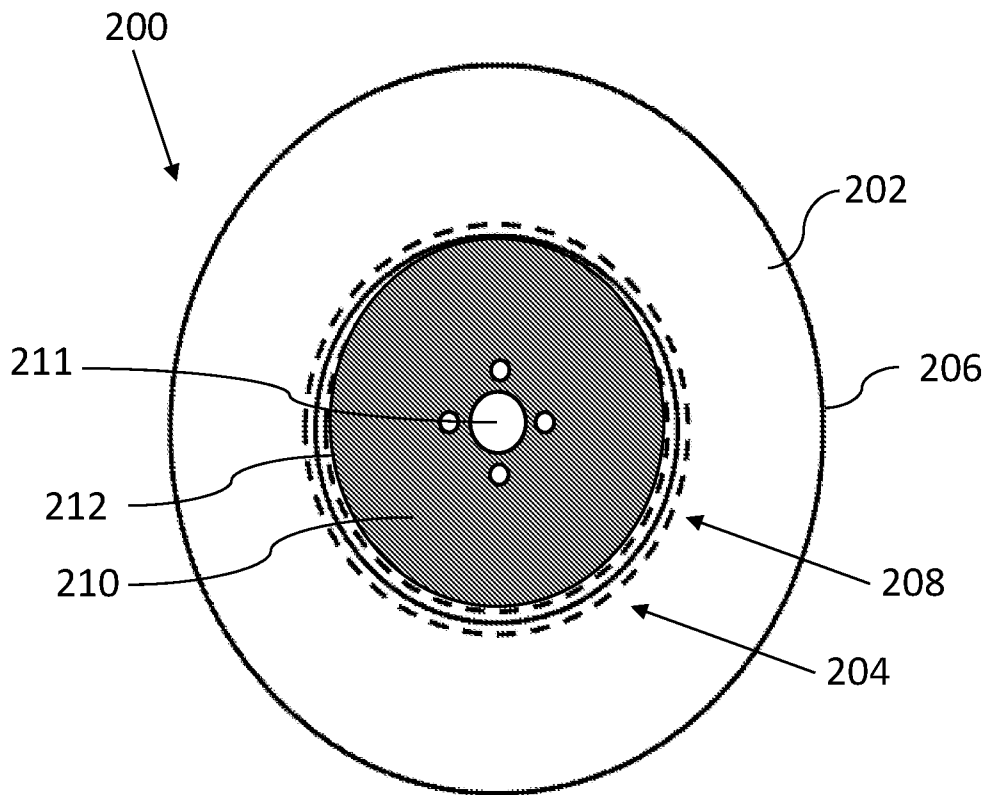


FIG. 2A

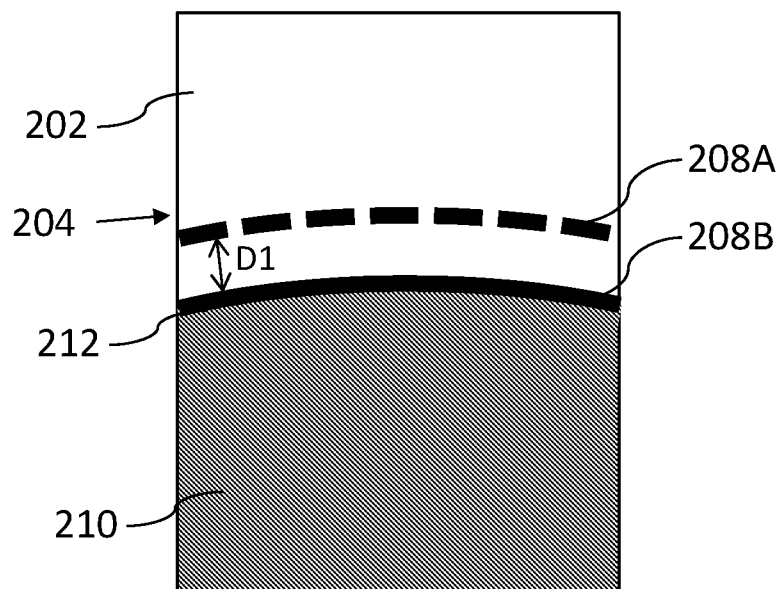


FIG. 2B

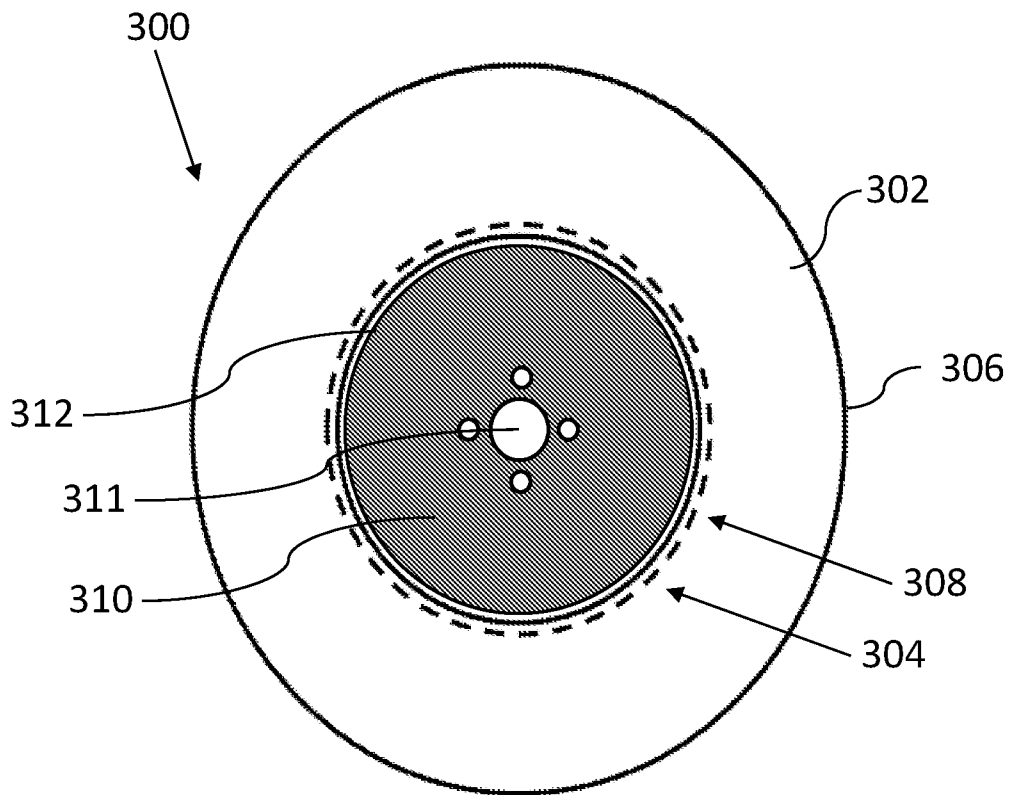


FIG. 3A

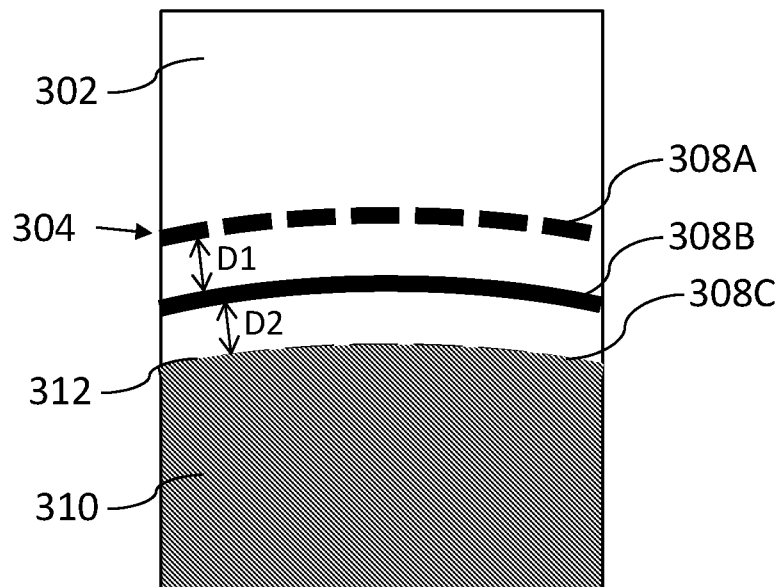


FIG. 3B

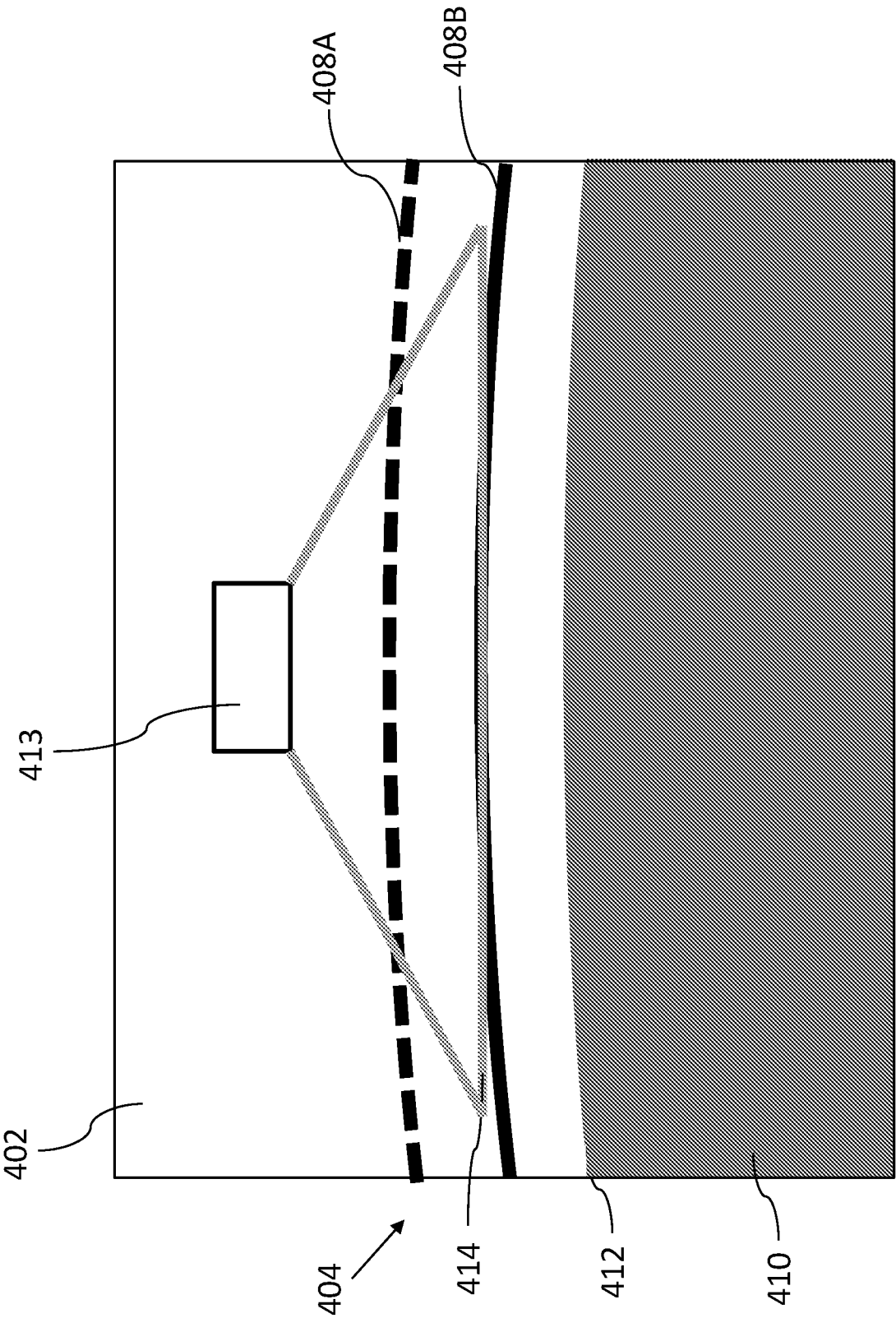


FIG. 4A

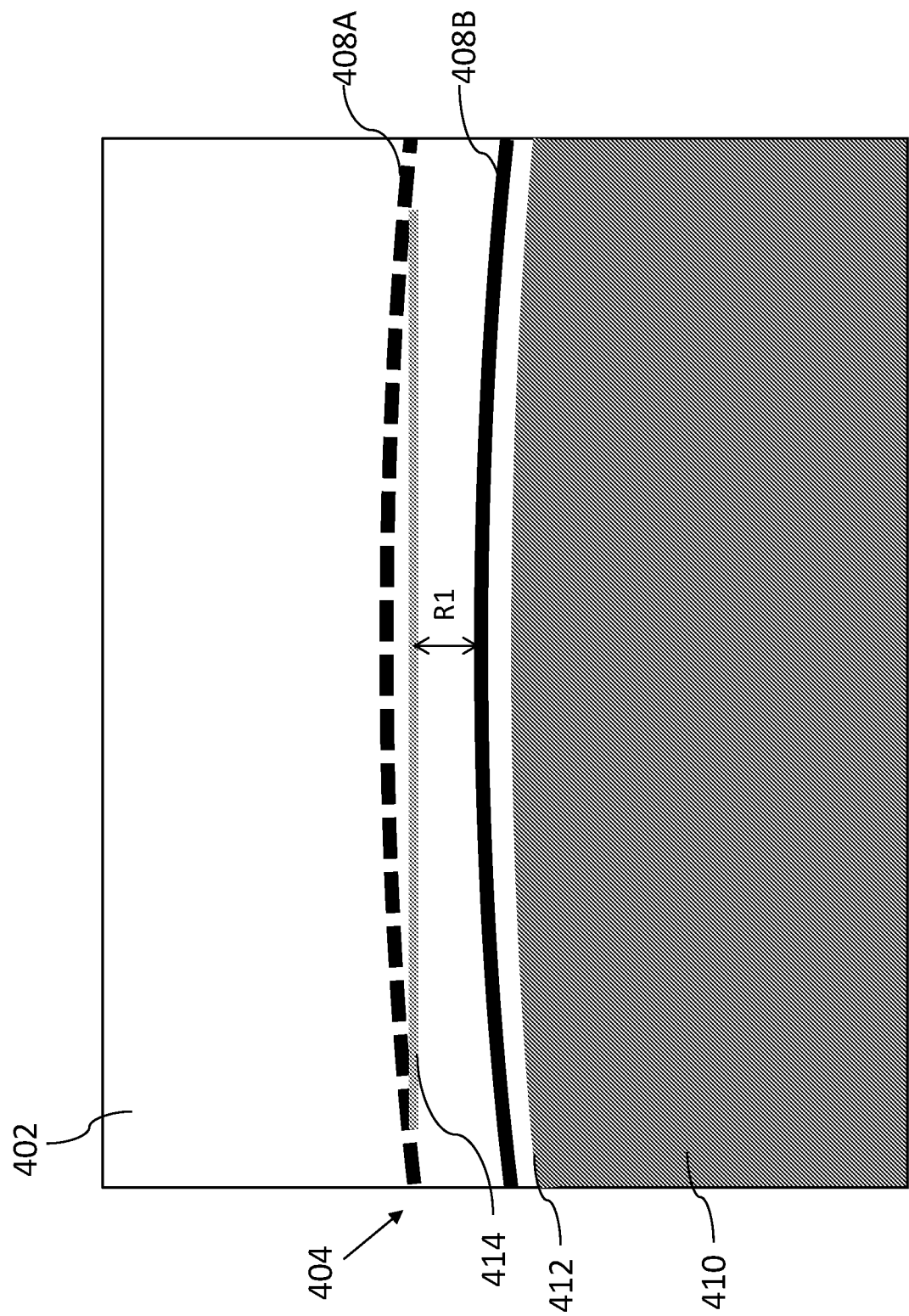


FIG. 4B

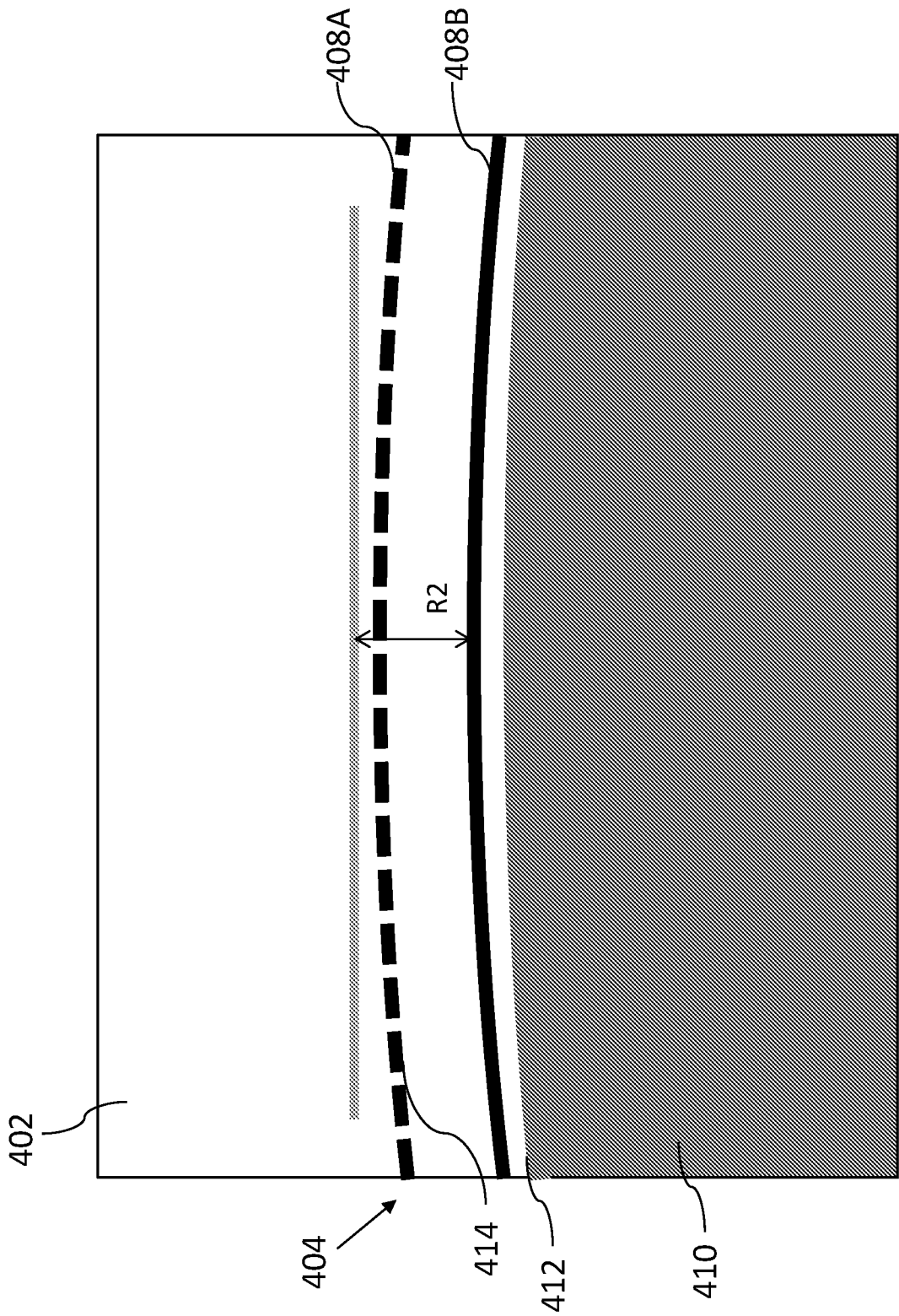


FIG. 4C

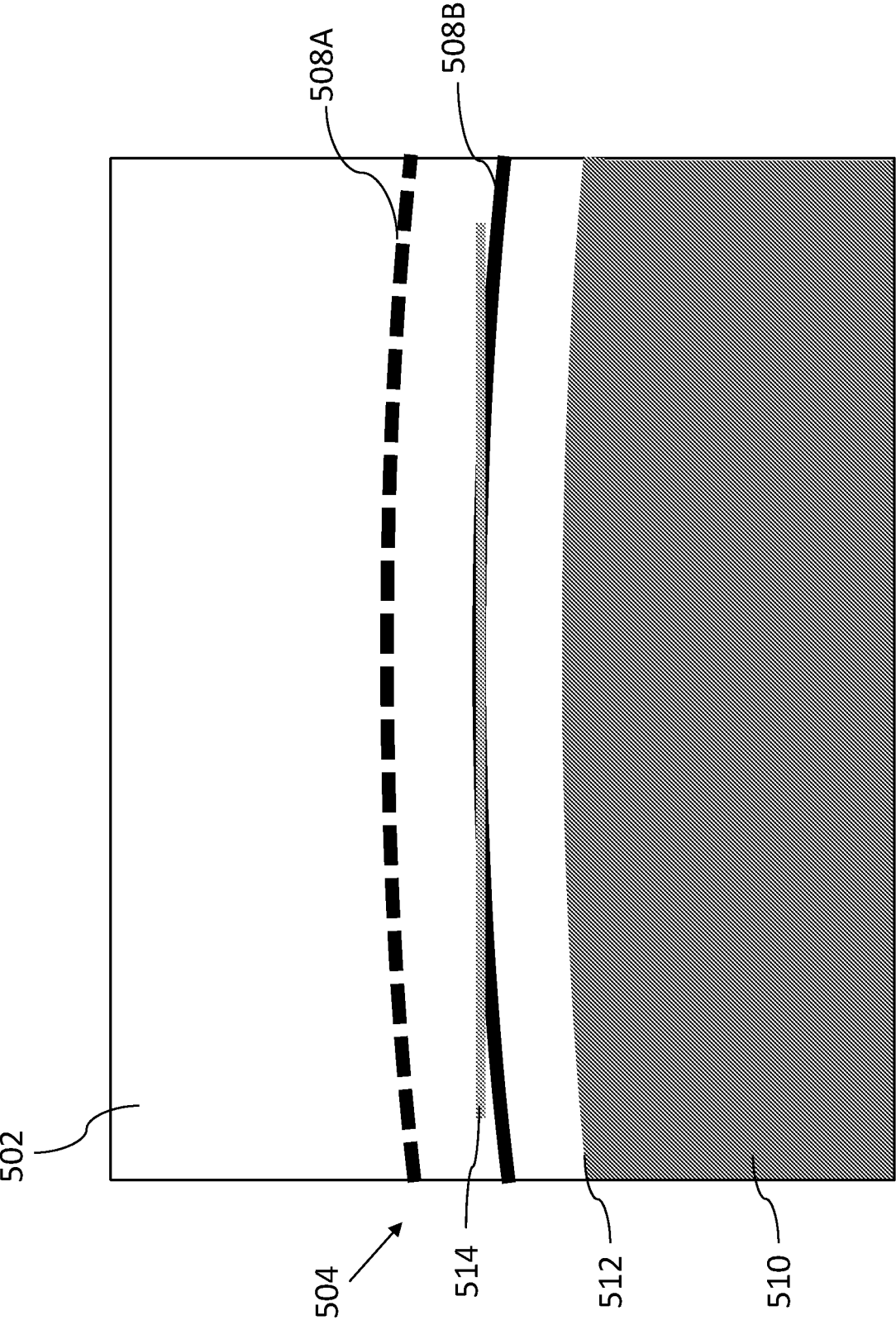


FIG. 5

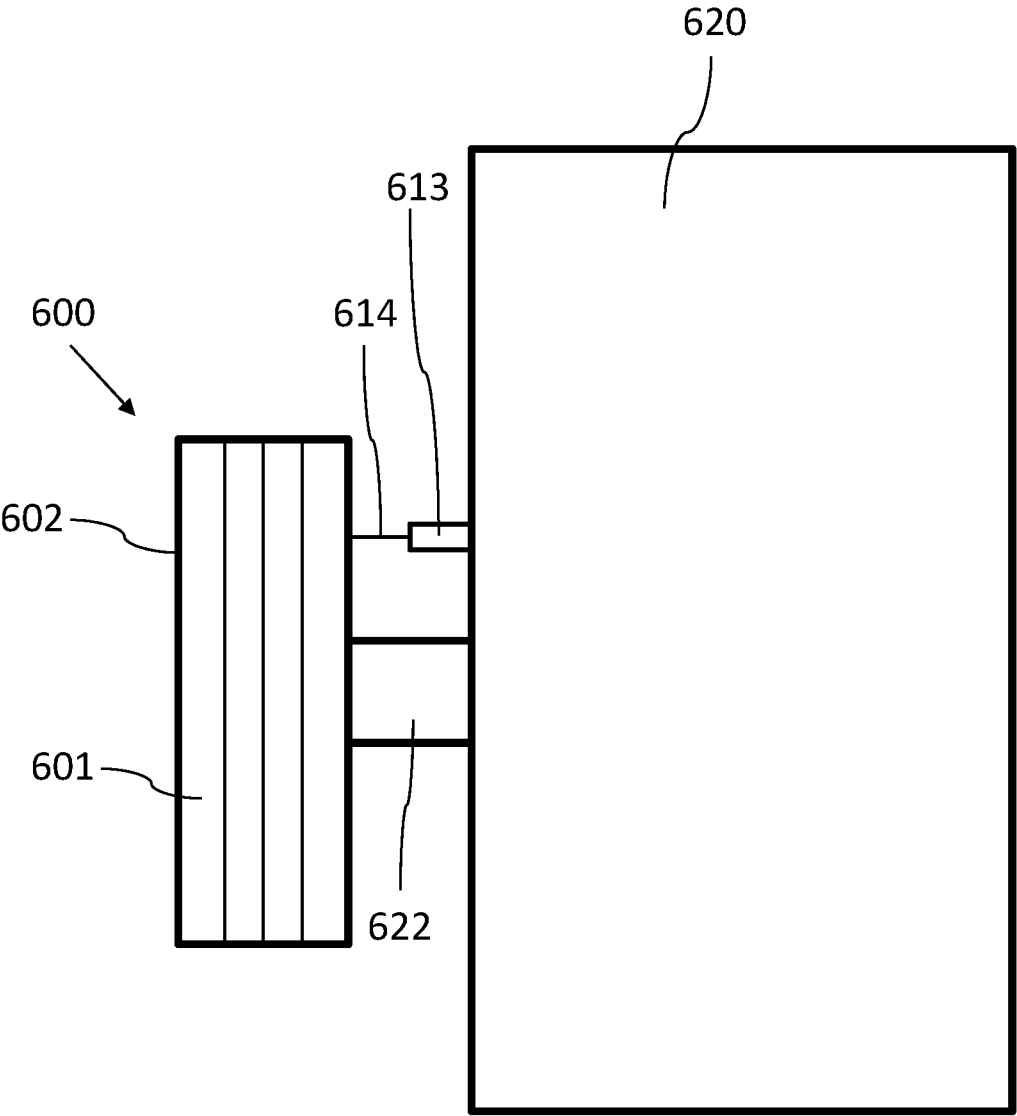


FIG. 6

A. CLASSIFICATION OF SUBJECT MATTER**B60C 25/05(2006.01)i, B60C 25/132(2006.01)i, B60C 25/138(2006.01)i**

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)

B60C 25/05; B60C 13/02; B60C 25/138; B60C 15/024; B60C 5/00; B60C 15/02; B60C 13/00; B60C 19/00; G01M 1/38; B60C 25/132

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

Korean utility models and applications for utility models

Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKOMPASS(KIPO internal) & Keywords: mounting tire, concentric, rim centering tolerance, indicator, light source and balancing

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2013-0133801 A1 (HODGES et al.) 30 May 2013 See paragraphs [0009], [0016], [0020]–[0025] and figures 1-2, 7.	1-19
Y	US 2008-0150348 A1 (DOUGLAS et al.) 26 June 2008 See paragraphs [0018]–[0019], [0022]–[0026], [0041] and figures 1-2, 5.	1-19
A	KR 10-2011-0072657 A (HANKOOK TIRE CO., LTD.) 29 June 2011 See paragraphs [0006]–[0007] and figures 1-2.	1-19
A	KR 10-2013-0075197 A (KUMHO TIRE CO., INC.) 05 July 2013 See paragraphs [0014]–[0016] and figure 2.	1-19
A	US 2014-0283590 A1 (SNAP-ON EQUIPMENT S.R.L. A UNICO SOCIO) 25 September 2014 See paragraph [0063]–[0068] and figure 4.	1-19



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"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

"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

"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

"&" document member of the same patent family

Date of the actual completion of the international search

26 June 2016 (26.06.2016)

Date of mailing of the international search report

27 June 2016 (27.06.2016)

Name and mailing address of the ISA/KR

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2016/024989

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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KR 10-2013-0075197 A	05/07/2013	None	
US 2014-0283590 A1	25/09/2014	None	