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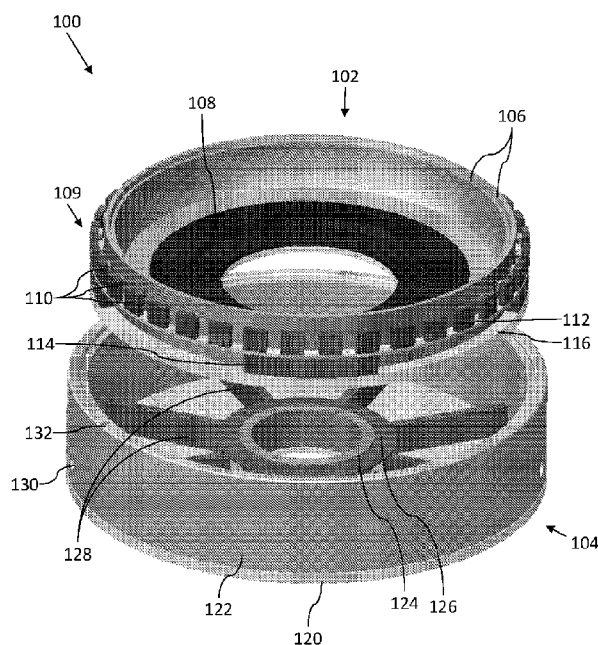


FIG. 1

(57) Abstract: An adjustable tire mold for use with molds of various diameters and widths is provided. In one embodiment, an adjustable tire molding system is provided, the adjustable tire molding system, comprising: an annular mold assembly including at least one mold segment; an adjuster ring assembly including at least one adjuster engaged with the at least one mold segment, wherein the adjuster ring assembly is oriented radially outwardly of the annular mold assembly; and an outer side plate, wherein the at least one mold segment and the adjuster ring assembly are operatively connected to the outer side plate.

ADJUSTABLE TIRE MOLD**BACKGROUND**

[0001] In the manufacture of a vehicle tire, an uncured, or “green” tire is typically assembled and placed inside of a tire mold. The tire mold may comprise various mold segments and/or components oriented adjacent to one another and configured to create the outside dimensions, patterns, markings, etc. of the cured tire.

[0002] Tire molds are typically oriented within an outer ring of a mold container during curing of the tire. Molds within an outer ring are traditionally configured to fit within the outer ring with a high degree of precision. As a result, molding differing sizes of tires (for example, tires of differing outside diameters) typically require not only different sets of molds, but also different outer rings.

[0003] Often, however, specific tires are only built on a limited basis (e.g., experimental tires) and the cost of manufacturing a separate outer ring for each tire size/model far exceeds the value. What is needed is an adjustable tire mold capable of utilizing a single outer ring for a variety of tire sizes and/or models.

SUMMARY

[0004] In one embodiment, an adjustable tire molding system is provided, the adjustable tire molding system, comprising: an annular mold assembly including at least one mold segment; an adjuster ring assembly including at least one adjuster engaged with the at least one mold segment, wherein the adjuster ring assembly is oriented radially outwardly of the annular mold assembly; and an outer side plate, wherein the at least one mold segment and the adjuster ring assembly are operatively connected to the outer side plate.

[0005] In another embodiment, an adjustable tire molding system is provided, the adjustable tire molding system comprising: an annular mold assembly including at least one mold segment; an adjuster ring assembly including an adjuster ring, at least one support element connected to the adjuster ring, and at least one adjuster supported by the support element and engaged with the at least one mold segment, wherein the adjuster ring assembly is oriented radially outwardly of the annular mold assembly; and an outer side plate, wherein the at least one mold segment and the adjuster ring assembly are operatively connected to the outer side plate.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] 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.

[0007] **FIG. 1** illustrates a perspective view of an example embodiment of a tire molding system **100** including a mold assembly **102** and an outer ring assembly **104**.

[0008] **FIG. 2** illustrates a perspective view of an example embodiment of an adjuster ring assembly **209**.

[0009] **FIG. 3** illustrates a perspective view of an example embodiment of an adjuster ring assembly **309**.

[0010] **FIG. 4A** illustrates a perspective view of an example embodiment of an adjustment support element **410**.

[0011] **FIG. 4B** illustrates a sectional view of an example embodiment of an adjustment support element **410**.

[0012] **FIG. 5** illustrates a partial, perspective, sectional view of an example embodiment of a mold assembly **502**.

[0013] **FIG. 6** illustrates a partial, side, sectional view of an example embodiment of a tire molding system **600**.

[0014] **FIG. 7** illustrates a partial, top, sectional view of an example embodiment of tire molding system **600**.

[0015] **FIG. 8** illustrates a perspective view of an example embodiment of a mold assembly **802**.

[0016] **FIG. 9** illustrates a partial, side, sectional view of an example embodiment of a mold assembly **802**.

[0017] **FIG. 10** illustrates a perspective view of an example embodiment of a mold assembly **1002**.

[0018] **FIG. 11** illustrates a perspective view of an example embodiment of a mold assembly **1102**.

[0019] **FIG. 12** illustrates a perspective view of an example embodiment of a tire molding system **1100** including mold assembly **1102** and an outer ring assembly **1104**.

[0020] **FIG. 13** illustrates a partial, side, sectional view of an example embodiment of tire molding system **1100**.

DETAILED DESCRIPTION

[0021] **FIG. 1** illustrates a perspective view of an example embodiment of an adjustable tire molding system **100** including a mold assembly **102** and an outer ring assembly **104**.

[0022] A tire in adjustable tire molding system **100** may be molded and/or cured under heat and pressure. Adjustable tire molding system **100** may be configured for the molding and/or curing of a tire. Adjustable tire molding system **100** may be configured for the molding and/or curing of a vehicle tire. Adjustable tire molding system **100** may be configured for the molding and/or curing of a pneumatic tire. Adjustable tire molding system **100** may be configured for the molding and/or curing of a nonpneumatic tire. Adjustable tire molding system **100** may be configured for the molding and/or curing of any of a variety of tires, including tires for any of a variety of applications, including: passenger car tires, light truck tires, truck and bus tires, agricultural tires, off the road tires, all-terrain vehicle tires, and the like.

[0023] Adjustable tire molding system **100** may be configured for the molding and/or curing of a variety of sizes of tires. Adjustable tire molding system **100** may be configured for the molding and/or curing of tires of varying diameters. Adjustable tire molding system **100** may be configured for the molding and/or curing of tires of varying section widths.

[0024] Adjustable tire molding system **100** may be configured to withstand heat and/or pressure necessary for molding and/or curing of a tire. Adjustable tire molding system **100** may be formed from any of a variety of materials, including for example one or more of: a metal such as steel, an alloy such as aluminum, a polymer, and the like. Further discussion of materials may be found in the following descriptions of other elements of adjustable tire molding system **100**.

[0025] Mold assembly **102** may be substantially circular. Mold assembly **102** may be circular. Mold assembly **102** illustrated in **FIG. 1** may represent one half of a total mold, being configured to mate with a corresponding mold half so as to permit molding of a tire. As illustrated, mold assembly **102** may be configured to mold a single bead portion, a single sidewall portion, a single shoulder portion, and one half of a tread portion, of a tire. The total mold, made up of two corresponding mold assemblies **102**, may be substantially annular. The total mold, made up of two corresponding mold assemblies **102**, may be annular.

[0026] Mold assembly **102** may include a plurality of mold segments **106**. Alternatively, mold assembly **102** may include a single mold element formed in a circular, or annular, shape (not shown). Mold assembly **102** may be substantially circular in shape, regardless of the number of mold segments **106**, or mold elements (not shown), used. Mold assembly **102** may be circular in shape, regardless of the number of mold segments **106**, or mold elements (not shown), used. Mold assembly **102** may be substantially annular. Mold assembly **102** may be annular.

[0027] Mold segments **106** may include a negative of features desired to be included on a finished tire, including for example: sidewall elements including writing, markings, symbols, numbers, design, and other indicia; tread patterns including grooves, lugs, ribs, siping, and the like; bead profiles; shoulder profiles; and the like.

[0028] Mold segments **106**, or single mold element (not shown), may be formed from any of a variety of materials, including for example: an alloy such as aluminum, a steel, a polymer, and the like. Mold segments **106**, or single mold element (not shown), may be formed from any material capable of withstanding the heat and pressure associated with molding and curing a tire.

[0029] Mold segments **106** may be substantially solid. Mold segments **106** may be solid. Mold segments **106** may be at least partially hollow. Mold segments **106** may include interior vents. Mold segments **106** may include internal heating elements. Mold segments **106** may include internal orifices, apertures, and/or passageways for the introduction of a heating medium.

[0030] Mold segments **106** may be removably connected to one another to form an annular mold assembly **102**.

[0031] Mold assembly **102** may additionally include an inner side plate **108**. Inner side plate **108** may include a substantially annular plate configured to mold and/or cure at least a portion of a sidewall and/or bead area of a tire. Inner side plate **108** may include an annular plate configured to mold and/or cure at least a portion of a sidewall and/or bead area of a tire. Inner side plate **108** may include a negative of the desired elements of a sidewall and/or bead portion of a tire. Inner side plate **108** may include a single element, or a series of elements combined to form inner side plate **108**. Inner side plate **108** may be removably connected to mold segments **106**. Inner side plate **108** may include a series of elements removably connected to mold segments **106**. Inner side plate **108** may include a series of elements integrally connected to mold segments **106**. Inner side plate **108** may be oriented radially inwardly of at least one mold segment **106**.

[0032] Adjustable tire molding system **100** may include an adjuster ring assembly **109**. Adjuster ring assembly **109** may include one or more support elements **110**. One or more support elements **110** may be connected to an adjuster ring **112**. Adjuster ring **112** may be operatively connected to an outer side plate **116**. Adjuster ring **112** may be removably connected to an outer side plate **116**. Adjuster ring **112** may be connected to outer side plate **116** through at least one adjuster ring spacer **114**. Outer side plate **116** may be a substantially planar plate. Outer side plate **116** may be an annular plate.

[0033] Adjuster ring assembly **109** may include one or more support elements **110** operatively connected to adjuster ring **112**. Adjuster ring assembly **109** may include a plurality of support elements **110** operatively connected to adjuster ring **112**. Adjuster ring assembly **109** may include one or more support elements **110** operatively connected to adjuster ring **112** for each mold segment **106** included in mold assembly **102**. Adjuster ring assembly **109** may include at least two support elements **110** operatively connected to adjuster ring **112** for each mold segment **106** included in mold assembly **102**. Adjuster ring assembly **109** may include any number of support elements **110** operatively connected to adjuster ring **112** for each mold segment **106** included in mold assembly **102**.

[0034] Support elements **110** may be removably connected to adjuster ring **112**. Support elements **110** may be integrally connected to adjuster ring **112**. Support elements **110** may be connected to adjuster ring **112** via any of a variety of mechanisms, including for example via one or more fastener for each support element **110**.

[0035] Adjuster ring **112** may have an inner diameter greater than the outer diameter of mold segments **106** when assembled in mold assembly **102**. Adjuster ring **112** may include a substantially annular shape, configured to encircle mold assembly **102**. Adjuster ring **112** may include an annular shape, configured to encircle mold assembly **102**. Adjuster ring **112** and support elements **110** may be configured to provide a radial force upon mold segments **106**.

[0036] Adjuster ring spacer **114** may be configured to provide a desired spacing between adjuster ring **112** and outer side plate **116**. The spacing of adjuster ring **112** relative to outer side plate **116** may be configured such that support elements **110** are aligned with a specific portion of mold segments **106**, including for example, a portion of mold segment **106** that is at or near the center of its height, as measured from the base of mold segment **106** to its uppermost portion (where it mates with a second mold assembly **102**). Adjuster ring spacer **114** may be selected

based upon the width of the tire to be molded, which may accordingly affect the height of mold segment **106**.

[0037] Adjuster ring spacer **114** may be removably connected to adjuster ring **112**. Adjuster ring spacer **114** may be integrally connected to adjuster ring **112**. Adjuster ring spacer **114** may be removably connected to outer side plate **116**. Adjuster ring spacer **114** may be integrally connected to outer side plate **116**. Adjuster ring spacer **114** may be connected to other components via any of a variety of attachment mechanisms, including for example a fastener.

[0038] At least one mold segment **106** may be operatively connected to outer side plate **116**. At least one mold segment **106** may be operatively connected at its base to outer side plate **116**. At least one mold segment **106** may be removably connected to outer side plate **116**. At least one mold segment **106** may be integrally connected to outer side plate **116**. At least one mold segment **106** may not be connected to outer side plate **116**.

[0039] Any of the various components of adjuster ring assembly **109** may include any of a variety of materials, including for example, a metal such as steel, an alloy such as aluminum, a polymer, and the like.

[0040] Outer ring assembly **104** may include a container side plate **120** and an outer ring **122**. Outer ring assembly **104** may include a mold centering ring **126**, a container spacer **128**, a handling aperture **130**, and a rotational alignment aperture **132**.

[0041] Container side plate **120** may be a substantially annular-shaped plate. Container side plate **120** may be an annular-shaped plate. Container side plate **120** may be a substantially planar plate. Container side plate **120** may be a planar plate. Container side plate **120** may be operatively connected to outer ring **122**. Outer ring **122** may be substantially tubular in shape. Outer ring **122** may be tubular in shape. Container side plate **120** may be removably connected to outer ring **122**. Container side plate **120** may be integrally connected to outer ring **122**.

[0042] Outer ring **122** may include an inner diameter that is greater than the outer diameter of outer side plate **116**. Outer ring **122** may include an inner diameter that is greater than the outer diameter of adjuster mold assembly **109**. Outer ring **122** may include an inner diameter that is about equal to the outer diameter of outer side plate **116**. Mold assembly **102** and adjuster ring assembly **109** may be configured to be placed within outer ring **122**, and above container side plate **120**. Mold assembly **102** and adjuster ring assembly **109** may be configured to be

placed within outer ring **122**, and above container side plate **120** during molding and/or curing of a tire.

[0043] Mold centering ring **126** may be operatively connected to container side plate **120**. Mold centering ring **126** may have an outer diameter that is less than the inner diameter of inner side plate **108**. Mold centering ring **126** may have an outer diameter that is about equal to the inner diameter of inner side plate **108**. Mold centering ring **126** may be oriented within a central hole in inner side plate **108** during assembly of adjustable tire molding system **100**.

[0044] At least one container spacer **128** may extend along container side plate **120** between an inner edge of outer ring **122** and mold centering ring **126**. Container spacer **128** may have a vertical height (measured from its base contacting container side plate to its upper edge). Container spacer may be configured to effect the desired spacing between outer side plate **116** and container side plate **120** after adjustable tire molding system **100** is assembled. In one embodiment, it may be desirable to align the upper edge of mold segments **106** with the upper edge of outer ring **122**. This alignment may be effected via the installation of container spacers **128** of the appropriate height.

[0045] After assembly of adjustable tire molding system **100**, system **100** may be mated to an inverted, and substantially similar, system **100**, so as to form a complete tire mold for molding and/or curing of a tire. A void may be left within the center of mold centering ring **126** to allow a curing bladder to extend into the interior of mold assembly **102**, and thus provide force and heat to an uncured tire, so as to mold and/or cure the tire.

[0046] Outer ring **122** may include a handling aperture **130**. Handling aperture **130** may permit a person, machine, or the like, to lift, orient, transport, or the like, adjustable tire molding system **100** after assembly. Likewise, handling aperture **130** may permit a person, machine, or the like, to lift, orient, transport, or the like, at least outer ring **122** or outer ring assembly **104**.

[0047] Outer ring **122** may include a rotational alignment aperture **132**. In practice, a pin, fastener, or the like, may extend from rotational alignment aperture **132** on a first outer ring **122**, to an inverted, corresponding outer ring **122** (not shown), so as to ensure that a first adjustable tire molding system **100** and a second adjustable tire molding system **100** are aligned, and that mold segments **106** in each of the two systems **100** align to ensure proper molding patterns, tread, and the like, on the tire.

[0048] Any of the various elements of outer ring assembly **104** may include any of a variety of materials, including for example, a metal such as steel, an alloy such as aluminum, and a polymer.

[0049] **FIG. 2** illustrates a perspective view of an example embodiment of an adjuster ring assembly **209**. Adjuster ring assembly **209** may include a plurality of support elements **210** oriented upon an adjuster ring **212**. Each support element **210** may include an adjuster aperture **240**. Adjuster ring **212** may include at least one adjuster ring mounting aperture **242**.

[0050] Support element **210** may have a cuboid shape. Support element **210** may have any of a variety of shapes. Support element **210** may include at least one adjuster aperture **240**. Adjuster aperture **240** may include a through hole opening to both sides of support element **210**, or a blind hole opening to a radially inner side of support element **210** (when support element **210** is mounted upon adjuster ring **212**). Adjuster aperture **240** may permit the mounting of an adjuster (not shown) to support element **210**.

[0051] Adjuster ring mounting aperture **242** may include a through hole, or blind hole, configured to mount adjuster ring **212** to at least one of adjuster ring spacer **114** and outer side plate **116**.

[0052] **FIG. 3** illustrates a perspective view of an example embodiment of an adjuster ring assembly **309**. Adjuster ring assembly **309** may include a plurality of support elements **210** oriented upon an adjuster ring **212**. Each support element **210** may include an adjuster aperture **240**. Adjuster ring **212** may include at least one adjuster ring mounting aperture **242**.

[0053] At least one of support elements **210** may include an adjuster **344**. In one embodiment, each of support elements **210** may include at least one adjuster **344**. In another embodiment, each of support elements **210** may include one adjuster **344**. Each of support elements **210** may support at least one adjuster **344**.

[0054] Adjuster **344** may be a substantially linear element. Adjuster **344** may be a linear element. Adjuster **344** may be a substantially cylindrical element. Adjuster **344** may be a cylindrical element. Adjuster **344** may be a cylindrical element. Adjuster **344** may be a substantially tubular element. Adjuster **344** may be a tubular element. Adjuster **344** may be a bolt. Adjuster **344** may be a threaded rod. Adjuster **344** may be a pin. Adjuster **344** may be a hydraulic actuator.

[0055] Adjuster **344** may be any element capable of exerting force upon mold segment **106**. Adjuster **344** may be any element capable of being placed into compression, with force applied from support element **210** onto mold segment **106**. Adjuster **344** may be any element capable of advancing, or retracting, a desired amount in a controlled manner.

[0056] Adjuster **344** may include an adjuster arresting element **346**. Adjuster arresting element **346** may be any element configured to selectively mitigate or selectively prevent longitudinal movement of adjuster **344**. Adjuster **344** may be a threaded element, and adjuster arresting element **346** may be a jam nut. Adjuster **344** may be a pin with lateral apertures, and arresting element **346** may be cross-pin configured to extend through at least one lateral aperture.

[0057] Adjuster **344** may include a biasing element **348**. Biasing element **348** may be a spring. Biasing element **348** may be a diaphragm spring. Biasing element **348** may be a resilient material. Biasing element **348** may be one or more crush washer. Biasing element **348** may be any element configured to allow a desired amount of movement of mold segment **106**, at a desired force. Biasing element **348** may be any element configured to deflect at a desired force. In one embodiment, mold segment **106** and adjuster ring assembly **309** may include metals or alloys with differing thermal expansion coefficients. As such, as adjustable tire molding system **100** is heated for curing of the tire, a mold segment may expand at a greater rate than adjuster **344**, and biasing element **348** may be configured to prevent damage to, or over-compression of, at least one of mold segment **106**, mold assembly **102**, adjuster **344**, support element **210**, adjuster ring **212**, and adjuster ring assembly **309**.

[0058] Adjuster **344** may include a mold engagement surface **350** at its distal end. Mold engagement surface **350** may be any element configured to contact mold segment **106**. Mold engagement surface **350** may include a plate.

[0059] **FIG. 4A** illustrates a perspective view of an example embodiment of an adjustment support element **410**. **FIG. 4B** illustrates a sectional view of an example embodiment of an adjustment support element **410**. Support element may be operatively connected to an adjuster **444**, which may include an adjuster arresting element **446**, a biasing element **448**, and a mold engagement surface **450**.

[0060] In one embodiment, adjuster **444** is a threaded rod having male threads. Adjuster arresting element **446** may be a jam nut, having female threads that engage the male threads of

adjuster **444**. Optionally, support element **410** may include female threads that engage the male threads of adjuster **444**.

[0061] Adjuster **444** may include an adjuster torquing element **452**. Adjuster torquing element **452** may be any element configured to permit torquing of adjuster **444**. Adjuster torquing element **452** may include flat, parallel sections for engagement with an open-end wrench. Adjuster torquing element **452** may be configured to permit rotation of adjuster **444**, so as to place adjuster **444** in compression via its engagement with threads in support element **410**.

[0062] Adjuster **444** may include an adjuster advancing element **454**. Adjuster advancing element **454** may be any element configured to permit one to selectively advance, or retract, adjuster **444**. Adjuster advancing element **454** may include a slot for engagement with a flat head screwdriver, a cross for engagement with a Phillips head screwdriver, a torx element for engagement with a torx head screwdriver, an allen element for engagement with an allen head screwdriver, and the like.

[0063] In practice, one may advance or retract adjuster **444** using either adjuster torquing element **452** or adjuster advancing element **454**. One may torque adjuster **444** using either adjuster torquing element **452** or adjuster advancing element **454**.

[0064] In one embodiment, one or more mold segment **106** is oriented in a ring upon outer side plate **116**. Adjuster ring **112**, including a plurality of support elements **410**, is oriented radially outwardly of mold segment(s) **106**. Each support element **410** may include adjuster **444**, not in contact with mold segment **106**. Adjuster **444** may be a threaded element. Adjuster **444** may be advanced radially inward through rotational manipulation of adjuster advancing element **454**. Upon contact between mold segment **106** and mold engagement surface **450**, adjuster torquing element **452** may be rotationally manipulated to impart the desired torque upon adjuster **444**, resulting in imparting the desired force upon mold segment **106**. Adjuster arresting element **446** may be manipulated so as to substantially mitigate, or eliminate, movement of adjuster **444**, including for example longitudinal movement of adjuster **444**.

[0065] In this manner, the one or more mold segment **106** of mold assembly **102** may be restrained with appropriate force, and alignment, upon outer side plate **116**, and may subsequently be placed within outer ring **122**. The application of radial force upon mold assembly **102** may result in mold segments **106** (where a plurality of mold segments **106** are

utilized) being maintained in the shape of an annular ring with appropriate circumferential compression.

[0066] **FIG. 5** illustrates a partial, perspective, sectional view of an example embodiment of a mold assembly **502**. Mold assembly **502** may include one or more mold segment **506** and an inner side plate **508**. Mold segments **506** and inner side plate **508** may be oriented upon an outer side plate **516**.

[0067] An adjuster ring assembly **509** may be oriented radially outwardly of mold assembly **502**. Adjuster ring assembly **509** may include a plurality of support elements **510**. Support elements **510** may be operatively connected to an adjuster ring **512**. Adjuster ring **512** may be operatively connected to outer side plate **516**, optionally through an adjuster ring spacer **514**.

[0068] At least one support element **510** may include an adjuster aperture **540**. An adjuster **544** may be oriented within adjuster aperture **540**. Adjuster **544** may include an adjuster arresting element **546**. Adjuster **544** may include a biasing element **548**. Adjuster **544** may include a mold engagement surface **550**. Adjuster **544** may include an adjuster advancing element **554**.

[0069] Outer side plate **516** may include at least one adjuster ring spacer mounting aperture **560**. Adjuster ring spacer mounting aperture **560** may include a through hole, or a blind hole, configured to removably attach outer side plate **516** to adjuster ring spacer **514**. A fastener, such as a bolt, may be inserted into adjuster ring spacer mounting aperture **560** and engaged with adjuster ring spacer **514**.

[0070] At least one mold segment **506** may include at least one adjuster recess **562**. In one embodiment, each mold segment **506** includes an adjuster recess **562** for each adjuster **544** in adjuster ring assembly **509**. Mold engagement surface **550** may be oriented within adjuster recess **562**. Biasing element **548** may be oriented within adjuster recess **562**.

[0071] In practice, mold segments **506** and adjuster ring assembly **509** may include materials having different thermal expansion coefficients. For example, mold segments **506** may be aluminum, while adjuster ring assembly **509** may be steel. In another example, mold segments **506** may be steel, while adjuster ring assembly **509** may be aluminum. As a result, when the entire system is heated, mold segments **506** may expand at a greater, or lesser, rate than adjuster ring assembly **509**. If the difference in expansion is great enough, mold segments **506**, adjuster ring assembly **509**, or other elements of the system may be damaged, destroyed, warped, and the

like. Accordingly, biasing element **548** may permit mold segment **506** to expand as a result of its thermal expansion coefficient, without imparting enough force to adjuster ring assembly **509** to cause damage to any elements of the system. That is, biasing element **548** may deform and/or deflect, and thus absorb the expansion of mold segment **506**.

[0072] **FIG. 6** illustrates a partial, side, sectional view of an example embodiment of a tire molding system **600**, including a mold assembly **602**. Mold assembly **602** may include one or more mold segment **606** and an inner side plate **608**. Mold segments **606** and inner side plate **608** may be oriented upon an outer side plate **616**.

[0073] An adjuster ring assembly **609** may be oriented radially outwardly of mold assembly **602**. Adjuster ring assembly **609** may include a plurality of support elements **610**. Support elements **610** may be operatively connected to an adjuster ring **612**. Adjuster ring **612** may be operatively connected to outer side plate **616**, optionally through an adjuster ring spacer **614**. In one embodiment, adjuster ring **612** is directly connected to outer side plate **616**.

[0074] At least one support element **610** may include an adjuster aperture **640**. An adjuster **644** may be oriented within adjuster aperture **640**. Adjuster **644** may include an adjuster arresting element **646**. Adjuster **644** may include a biasing element **648**. Adjuster **644** may include a mold engagement surface **650**. Adjuster **644** may include an adjuster advancing element **654**.

[0075] Outer side plate **616** may include at least one adjuster ring spacer mounting aperture **660**. Adjuster ring spacer mounting aperture **660** may include a through hole, or a blind hole, configured to removably attach outer side plate **616** to adjuster ring spacer **614**. An adjuster ring spacer fastener **664** may be inserted into adjuster ring spacer mounting aperture **660** and engaged with adjuster ring spacer **614**.

[0076] At least one mold segment **606** may include at least one adjuster recess **662**. In one embodiment, each mold segment **606** includes an adjuster recess **662** for each adjuster **644** in adjuster ring assembly **609**. Mold engagement surface **650** may be oriented within adjuster recess **662**. Biasing element **648** may be oriented within adjuster recess **662**.

[0077] Mold assembly **602** and adjuster ring assembly **609** may be oriented within an outer ring **622**. Outer ring **622** may be operatively connected to container side plate **620**. As illustrated, adjuster ring assembly **609** may act to bridge the gap between outer ring **622** and mold assembly **602**. The “gap” between mold assembly **602** and outer ring **622** may result from

a mold assembly **602** that has a smaller diameter than is intended for the specific outer ring **622** illustrated. Alternatively, the gap may be a designed feature, resulting from an outer ring **622** specifically designed to be large enough to accommodate both mold assembly **602** and adjuster ring assembly **609**, such that outer ring **622** may be use with mold assemblies **602** of varying diameters. In this manner, outer ring **622** may be used with any of a variety of mold assemblies **602**, including mold assemblies of varying diameters and widths. Adjusters **644** may act to adapt the diameter of any mold assembly **602** to outer ring **622**. Spacers, such as adjuster ring spacer **614**, and container spacer **128**, may act to adapt the width of any mold assembly **602** to outer ring **622** and container side plate **620**.

[0078] Accordingly, adjuster ring assembly **609** may be configured to permit the use of mold assemblies **602** of varying diameters and widths within a single outer ring **622**.

[0079] It is understood that mold assembly **602** must be at least substantially concentric with outer ring **622**. Mold assembly **602** may be concentric with outer ring **622**. As such, a high degree of precision and adjustability must be present in adjuster ring assembly **609** so as to permit one to ensure that adjusters **644** result in equal spacing of the radially outer portion of each mold segment **606** from the radially inner portion of outer ring **622**.

[0080] FIG. 7 illustrates a partial, top, sectional view of an example embodiment of tire molding system **600** including mold assembly **602**. As illustrated, outer ring **622** may include a rotational alignment aperture **632**. Rotational alignment aperture **632** may be a through hole, a blind hole, or the like. Rotational alignment aperture **632** may accept a pin, bolt, rod, or any other element capable of engaging a first rotational alignment aperture **632** of a first outer ring **622**, and a second rotational alignment aperture **632** of a second outer ring **622**, wherein the second outer ring is mated to the first outer ring in an inverted orientation. Outer ring **622** may include a plurality of rotational alignment apertures **632**. Outer ring **622** may include at least two rotational alignment apertures **632**. Outer ring **622** may include at least three rotational alignment apertures **632**. Outer ring **622** may include at least four rotational alignment apertures **632**. Rotational alignment apertures **632** may act to ensure that at least one of: (a) a first outer ring **622** and outer ring assembly **104** are rotationally aligned with a second, inverted outer ring **622** and outer ring assembly **104**; (b) a first mold assembly **602** is rotationally aligned with a second, inverted mold assembly **602**; (c) a first outer ring **622** and outer ring assembly **104** are radially aligned with a second, inverted outer ring **622** and outer ring assembly **104**; (d) a first

mold assembly **602** is radially aligned with a second, inverted mold assembly **602**; (e) a first outer ring **622** and outer ring assembly **104** are coaxially aligned with a second, inverted outer ring **622** and outer ring assembly **104**; and (f) a first mold assembly **602** is coaxially aligned with a second, inverted mold assembly **602**.

[0081] Adjuster ring **612** may include an adjuster ring mounting aperture **642**. Adjuster ring mounting aperture **642** may include a through hole, or blind hole, configured to mount adjuster ring **612** to at least one of adjuster ring spacer **614** and outer side plate **616**.

[0082] It is contemplated that any of the embodiments above, including adjustable tire molding system **100**, mold assembly **502**, and mold assembly **602**, may be designed to be used without at least one of outer ring assembly **104**, container side plate **120**, outer ring **122**, container side plate **620**, and outer ring **622**.

[0083] In one embodiment, any of the adjuster ring assemblies illustrated and described above may be replaced with any system or apparatus capable of maintaining a radially inward force upon one or more mold segments, while maintaining a desired spacing between each mold segment and an outer ring. For example, an adjuster ring assembly may be replaced with an inflatable bladder, one or more wedges, or the like.

[0084] **FIG. 8** illustrates a perspective view of an example embodiment of a mold assembly **802**. Mold assembly **802** may include one or more mold segment **806**. Mold assembly **802** may include an inner side plate **808**. Mold assembly **802** may be operatively connected to an adjuster ring assembly **809**.

[0085] Adjuster ring assembly **809** may be operatively connected to an outer side plate **816**. Adjuster ring assembly **809** may include at least one adjuster **870**. At least one adjuster **870** may be operatively connected to outer side plate **816** via an adjuster fastener **872**.

[0086] Adjuster **870** may be a substantially arcuate member. Adjuster **870** may be an arcuate member. Adjuster **870** may be an inclined member, whether arcuate or not. Adjuster **870** may be any shape spanning between outer side plate **816** and mold segment **806**. Mold segment **806** may include a planar radially outer surface to maximize engagement between mold segment **806** and adjuster **870**.

[0087] Adjuster fastener **872** may be configured to provide force between adjuster **870** and outer side plate **816**. Adjuster fastener **872** may be configured to provide force between adjuster **870** and mold segment **806**. Adjuster fastener **872** may be configured to provide force between

adjuster **870** and outer side plate **816**, which may result in a force between adjuster **870** and mold segment **806**. Force applied to mold segment **806** may include a force directed radially inwardly. Adjuster fastener **872** may provide a force at an angle that includes both axial components (e.g., toward outer side plate **816**) and radial components (e.g., radially inwardly toward mold segment **806**). Adjuster fastener **872** may include any of a variety of fasteners, including for example, a threaded bolt, a screw, a pin, a rivet, and the like. Adjuster fastener **872** may be selectively advanced and retracted to increase or decrease the force applied through adjuster fastener **872** to mold segment **806**.

[0088] As illustrated in **FIG. 8**, mold assembly **802** may be oriented to permit application of mold segments **806** to outer side plate **816**, where the mold segments **806** have any of various diameters and widths. A second mold assembly **802** may be inverted and mated to mold assembly **802**, thus forming an entire tire mold.

[0089] In one embodiment, the system illustrated in **FIG. 8**, may be used to mold and/or cure a tire without use of a container or outer ring assembly. In another embodiment, the system illustrated in **FIG. 8** may be used to mold and/or cure a tire utilizing at least one of a container, outer ring, and outer ring assembly, similar to those illustrated and described above.

[0090] **FIG. 9** illustrates a partial, side, sectional view of an example embodiment of a mold assembly **802**.

[0091] Outer side plate **816** may include an adjuster fastener aperture **874** configured to accept and at least partially engage adjuster fastener **872**. Adjuster fastener aperture **874** may be a through hole, a blind hole, or the like. Adjuster fastener aperture **874** may be a threaded hole.

[0092] Adjuster fastener **872** may include a biasing element **876**. Biasing element **876** may be a spring. Biasing element **876** may be a diaphragm spring. Biasing element **876** may be a resilient material. Biasing element **876** may be one or more crush washer. Biasing element **876** may be any element configured to allow a desired amount of movement of mold segment **806**, at a desired force. Biasing element **876** may be any element configured to deflect at a desired force. Biasing element **876** may be used to prevent, or mitigate, damage or deformations resulting from differences in thermal expansion coefficients of various materials in mold assembly **802** and adjuster ring assembly **809**.

[0093] **FIG. 10** illustrates a perspective view of an example embodiment of a mold assembly **1002**. Mold assembly **1002** may include a plurality of mold segments **1006**. Alternatively, mold

assembly **1002** may include a single mold element formed in a circular, or annular, shape (not shown). Mold assembly **1002** may be substantially circular in shape, regardless of the number of mold segments **1006**, or mold elements (not shown), used. Mold assembly **1002** may be circular in shape, regardless of the number of mold segments **1006**, or mold elements (not shown), used. Mold assembly **1002** may be substantially annular. Mold assembly **1002** may be annular.

[0094] Mold assembly **1002** may additionally include an inner side plate **1008**. Inner side plate **1008** may include a substantially annular plate configured to mold and/or cure at least a portion of a sidewall and/or bead area of a tire. Inner side plate **1008** may include an annular plate. Inner side plate **1008** may include at least one aperture **1080**. Aperture **1080** may be used as a mold handling aperture. Aperture **1080** may be used as a rotational alignment aperture. Aperture **1080** may be used as both a mold handling aperture and a rotational alignment aperture. Where aperture **1080** is used as a rotational alignment aperture, it may be used to ensure rotational alignment of inner side plate **1008** relative to mold segments **1006**.

[0095] Mold assembly **1002** may include an adjuster ring spacer **1014**. Adjuster ring spacer **1014** may be configured to provide a desired spacing between an adjuster ring (not shown) and an outer side plate **1016**. Adjuster ring spacer **1014** may be selected based upon the width of the tire to be molded, which may accordingly affect the height of mold segment **1006**. Adjuster ring spacer **1014** may include at least one mold handling aperture **1082**. Mold handling aperture **1082** may be configured to allow for the lifting, moving, or like manipulation of mold assembly **1002**.

[0096] At least one mold segment **1006** may be operatively connected to outer side plate **1016**. At least one mold segment **1006** may be operatively connected at its base to outer side plate **1016**. At least one mold segment **1006** may be removably connected to outer side plate **1016**. At least one mold segment **1006** may be integrally connected to outer side plate **1016**. At least one mold segment **1006** may not be connected to outer side plate **1016**.

[0097] FIGS. 11-13 illustrate various views of an example embodiment of an adjustable tire molding system **1100** and a mold assembly **1102**. Mold assembly **1102** may include one or more mold segment **1106** and an inner side plate **1108**.

[0098] The adjustable tire molding system may include an adjuster ring assembly **1109**. Adjuster ring assembly **1109** may include one or more support elements **1110**. One or more support elements **1110** may be connected to an adjuster ring **1112**. Adjuster ring **1112** may be operatively connected to an outer side plate **1116**. Adjuster ring **1112** may be removably

connected to outer side plate **1116**. Adjuster ring **1112** may be connected to outer side plate **1116** through at least one adjuster ring spacer **1114**. Outer side plate **1116** may be a substantially planar plate. Outer side plate **1116** may be a planar plate. Outer side plate **1116** may be an annular plate. In one embodiment, at least one adjuster ring spacer **1114** may be integrally connected to, and formed as a part of, outer side plate **1116**.

[0099] Support element **1110** may include at least one adjuster aperture **1140**. Adjuster aperture **1140** may include a through hole opening to both sides of support element **1110**, or a blind hole opening to a radially inner side of support element **1110** (when support element **1110** is mounted upon adjuster ring **1112**).

[00100] At least one of support elements **1110** may include an adjuster **1144**. In one embodiment, each of support elements **1110** may include at least one adjuster **1144**. In another embodiment, each of support elements **1110** may include one adjuster **1144**. Each of support elements **1110** may support at least one adjuster **1144**.

[00101] Adjuster **1144** may include an adjuster arresting element **1146**. Adjuster arresting element **1146** may be any element configured to selectively mitigate or selectively prevent longitudinal movement of adjuster **1144**.

[00102] Mold assembly **1102** may additionally include an inner side plate **1108**. Inner side plate **1108** may include a substantially annular plate configured to mold and/or cure at least a portion of a sidewall and/or bead area of a tire. Inner side plate **1108** may include an annular plate configured to mold and/or cure at least a portion of a sidewall and/or bead area of a tire. Inner side plate **1108** may include at least one aperture **1180**. Aperture **1180** may be used as a mold handling aperture. Aperture **1180** may be used as a rotational alignment aperture. Aperture **1180** may be used as both a mold handling aperture and a rotational alignment aperture. Where aperture **1180** is used as a rotational alignment aperture, it may be used to ensure rotational alignment of inner side plate **1108** relative to mold segments **1106**. Where aperture **1180** is used as a mold handling aperture, aperture **1180** may be configured to allow for the lifting, orienting, moving, or like manipulation of mold assembly **1102**.

[00103] Adjuster ring spacer **1114** may be configured to provide a desired spacing between adjuster ring **1112** and outer side plate **1116**. Adjuster ring spacer **1114** may be selected based upon the width of the tire to be molded, which may accordingly affect the height of mold segment **1106**. Adjuster ring spacer **1114** may include at least one mold handling aperture **1182**.

Mold handling aperture **1182** may be configured to allow for the lifting, orienting, moving, or like manipulation of mold assembly **1102**.

[00104] Adjuster ring **1112** may be selectively connected to adjuster ring spacer **1114** via at least one adjuster ring fastener **1184**. At least one adjuster ring fastener **1184** may selectively connect adjuster ring **1112** to at least one of adjuster ring spacer **1114** and outer side plate **1116**. Adjuster ring fastener **1184** may include any of a variety of fasteners, including for example, a bolt, a screw, a rivet, a nail, a pin, a clamp, an adhesive, a ligature, a chain, and the like.

[00105] At least one of adjuster ring **1112**, adjuster ring spacer **1114**, and outer side plate **1116** (which may be integrally formed with adjuster ring spacer **1114**) may include a keyway slot **1186**. In one embodiment, each of adjuster ring **1112**, adjuster ring spacer **1114**, and outer side plate **1116** include keyway slot **1186**. Keyway slot **1186** may be a substantially rectangular slot, or depression, configured to accept a corresponding key, or rib, of an outer ring **1122**. Keyway slot **1186** may be a rectangular slot, or depression, configured to accept a corresponding key, or rib, of an outer ring **1122**. Alternatively, at least one of adjuster ring **1112**, adjuster ring spacer **1114**, and outer side plate **1116** may include a key, or rib, while outer ring **1122** may include a corresponding slot, or depression. Alternatively, at least one of adjuster ring **1112**, adjuster ring spacer **1114**, and outer side plate **1116** may include a keyway slot, or depression, while outer ring **1122** also includes a corresponding keyway slot, or depression, with a separate key to be oriented within each keyway slot. Keyway slot **1186** may be configured to ensure alignment between mold assembly **1102** and outer ring assembly **1104**. Keyway slot **1186** may be configured to ensure rotational alignment between mold assembly **1102** and outer ring assembly **1104**.

[00106] With respect to **FIG. 12**, outer ring **1122** may include at least one handling aperture **1130**. Handling aperture **1130** may permit a person, machine, or the like, to lift, orient, transport, or the like, adjustable tire molding system **1100** after assembly. Likewise, handling aperture **1130** may permit a person, machine, or the like, to lift, orient, transport, or the like, at least outer ring **1122** or outer ring assembly **1104**. Handling aperture **1130** may be aligned with at least one mold handling aperture **1182**, so as to form a continuous aperture. Handling aperture **1130** may not be aligned with at least one mold handling aperture **1182**.

[00107] Outer ring **1122** may include a rotational alignment aperture **1132**. In practice, a pin, fastener, or the like, may extend from rotational alignment aperture **1132** on a first outer ring

1122, to an inverted, corresponding outer ring **1122** (not shown), so as to ensure that a first adjustable tire molding system **1100** and a second adjustable tire molding system **1100** are aligned, and that mold segments **1106** in each of the two systems **1100** align to ensure proper molding patterns, tread, and the like, on the tire.

[00108] With respect to **FIG. 13**, adjustable tire molding system **1100** may include an adjuster ring spacer mounting aperture **1160** may extend at least partially through a container spacer **1128** and outer side plate **1116**, and may accept an adjuster ring spacer fastener **1164**. Adjuster ring spacer fastener **1164** may selectively connect container spacer **1128** to outer side plate **1116**.

[00109] Outer ring **1122** may be operatively connected to a container side plate **1120**. Outer ring **1122** may be integrally connected to container side plate **1120**. Outer ring **1122** may be removably connected to container side plate **1120**.

[00110] Keyway slot **1186** may be machined into at least one of adjuster ring **1112**, adjuster ring spacer **1114**, and outer side plate **1116**. The radially inner side of outer ring **1122** may include a key **1188** configured to selectively engage keyway slot **1186**. Key **1188** may be selectively connected to outer ring **1122** via at least one key fastener **1190**.

[00111] Adjuster ring **1112** may be removably connected to adjuster ring spacer **1114** via an adjuster ring fastener **1192**.

[00112] It is contemplated that any of the molds, mold segments, and mold assemblies discussed herein may be used to mold and/or cure any of a variety of articles, including without limitation, tires, tire components, innertubes, air springs, rollers, and the like.

[00113] 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.

[00114] 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. An adjustable tire molding system, comprising:
an annular mold assembly including at least one mold segment;
an adjuster ring assembly including at least one adjuster engaged with the at least one mold segment, wherein the adjuster ring assembly is oriented radially outwardly of the annular mold assembly; and
an outer side plate, wherein the at least one mold segment and the adjuster ring assembly are operatively connected to the outer side plate.
2. The adjustable tire molding system of claim 1, wherein the adjuster ring assembly includes at least one support element connected to an adjuster ring, wherein each of the at least one support element supports the at least one adjuster.
3. The adjustable tire molding system of claim 1, wherein the adjuster ring assembly includes an adjuster ring, wherein the adjuster ring is operatively connected to the outer side plate, and wherein an adjuster ring spacer is oriented between the adjuster ring and the outer side plate.
4. The adjustable tire molding system of claim 1, wherein the mold assembly further comprises an inner side plate oriented radially inward of the at least one mold segment.
5. The adjustable tire molding system of claim 1, wherein:
the at least one adjuster is oriented within an adjuster aperture in a support element,
the at least one adjuster includes an adjuster arresting element, and
the at least one adjuster includes a biasing element.
6. The adjustable tire molding system of claim 5, wherein:
the at least one adjuster includes a mold engagement surface, and
the at least one adjuster includes at least one of an adjuster torquing element and an adjuster advancing element.
7. The adjustable tire molding system of claim 1, further comprising an outer ring assembly including an outer ring, wherein the outer ring has an inner diameter that is greater than an outer diameter of the adjuster ring assembly.
8. The adjustable tire molding system of claim 7, wherein the outer ring includes at least one handling aperture.

9 The adjustable tire molding system of claim 7, wherein the outer ring includes at least one rotational alignment aperture.

10. The adjustable tire molding system of claim 1, further comprising an outer ring assembly, including an outer ring and a container side plate, wherein the outer ring has an inner diameter that is greater than an outer diameter of the adjuster ring assembly.

11. The adjustable tire molding system of claim 10, wherein the mold assembly and the adjuster ring assembly are oriented within the outer ring assembly.

12. An adjustable tire molding system, comprising:

an annular mold assembly including at least one mold segment;

an adjuster ring assembly including an adjuster ring, at least one support element connected to the adjuster ring, and at least one adjuster supported by the support element and engaged with the at least one mold segment, wherein the adjuster ring assembly is oriented radially outwardly of the annular mold assembly; and

an outer side plate, wherein the at least one mold segment and the adjuster ring assembly are operatively connected to the outer side plate.

13. The adjustable tire molding system of claim 12, wherein:

the at least one adjuster is oriented within an adjuster aperture in a support element,

the at least one adjuster includes an adjuster arresting element, and

the at least one adjuster includes a biasing element.

14. The adjustable tire molding system of claim 12, further comprising an outer ring assembly including an outer ring, wherein the outer ring has an inner diameter that is greater than an outer diameter of the adjuster ring assembly.

15. The adjustable tire molding system of claim 12, further comprising an outer ring assembly, including an outer ring and a container side plate, wherein the outer ring has an inner diameter that is greater than an outer diameter of the adjuster ring assembly, and wherein the mold assembly and the adjuster ring assembly are oriented within the outer ring assembly.

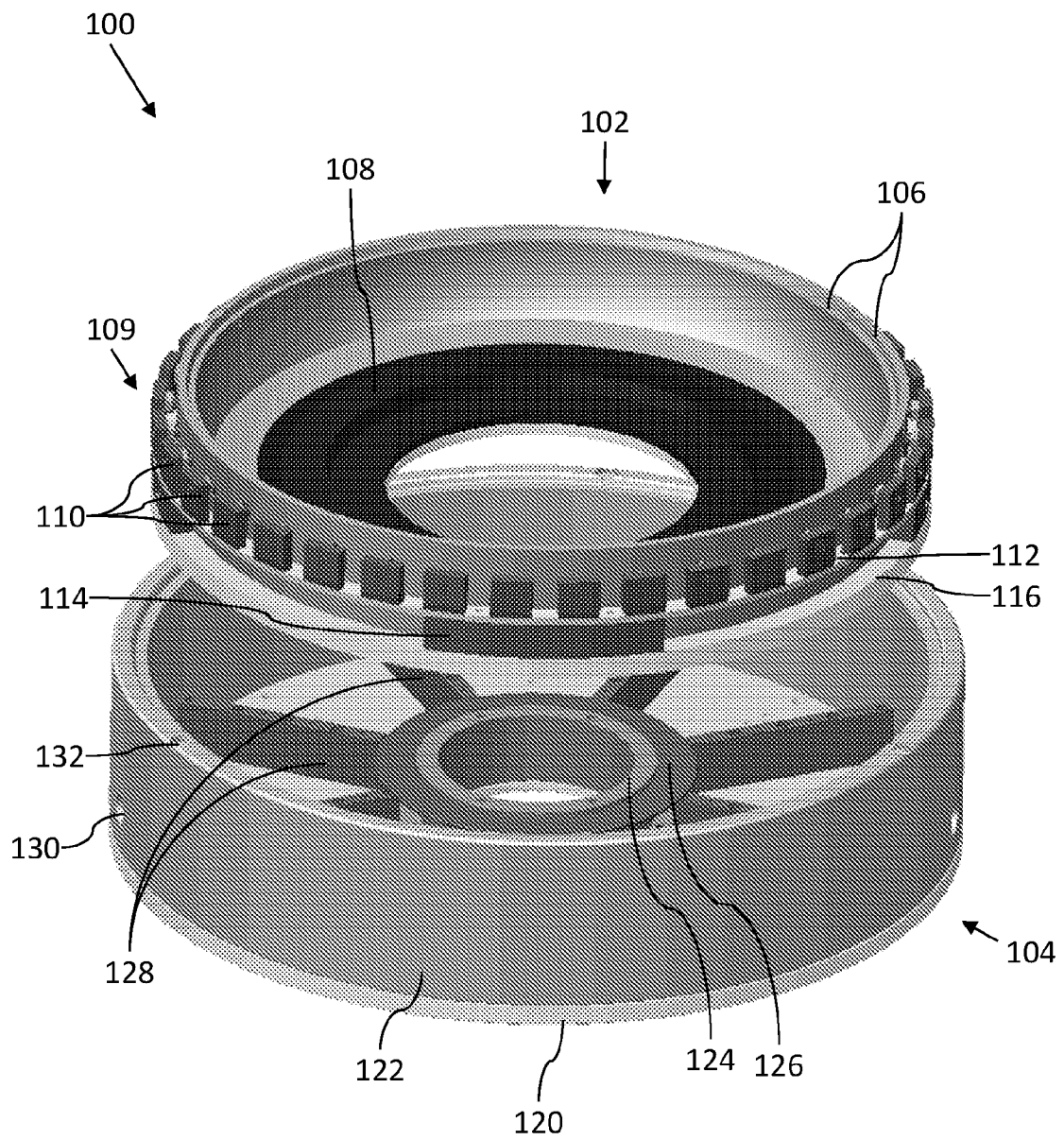
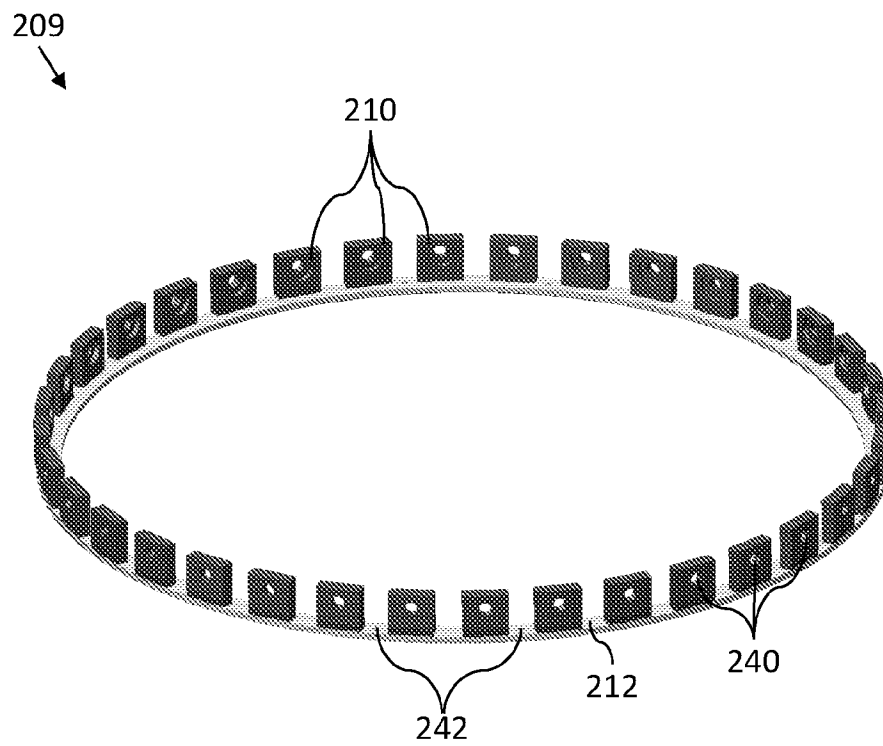
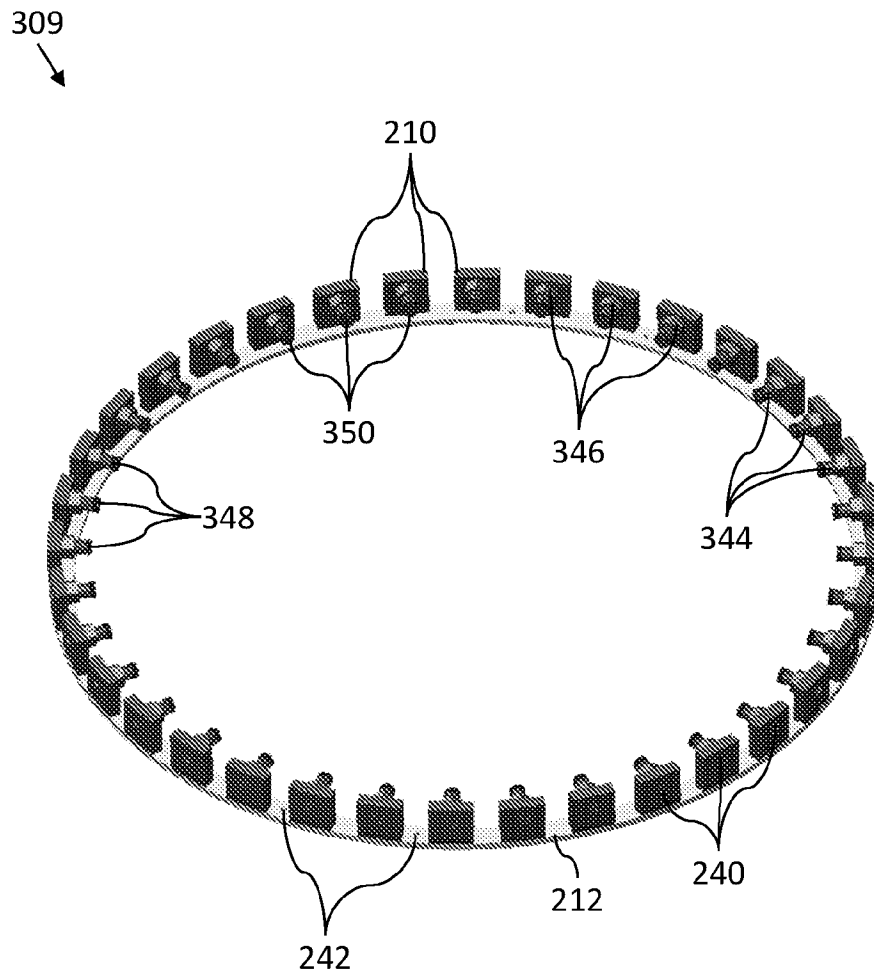


FIG. 1

**FIG. 2**

**FIG. 3**

4/13

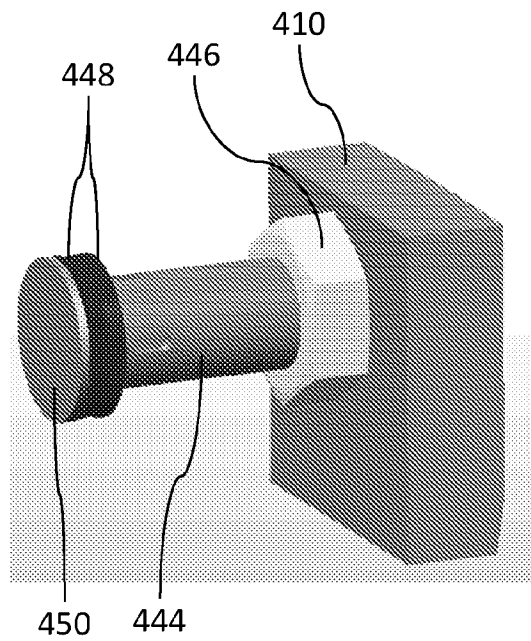


FIG. 4A

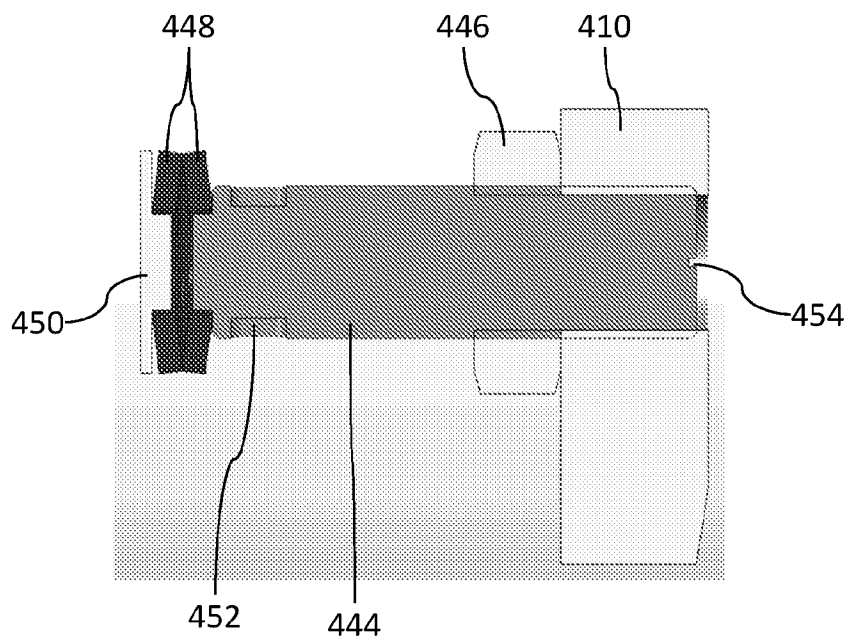
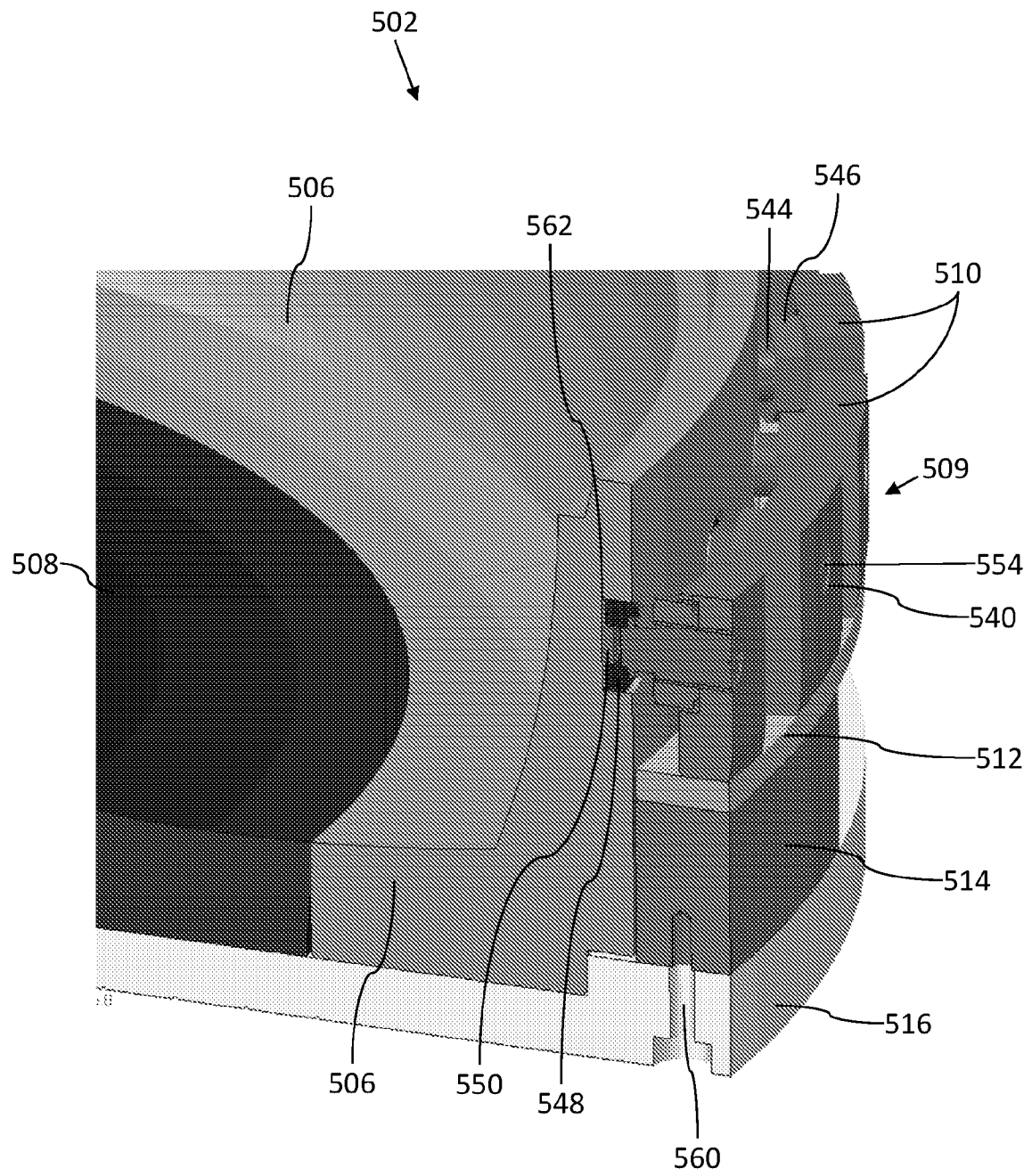


FIG. 4B

**FIG. 5**

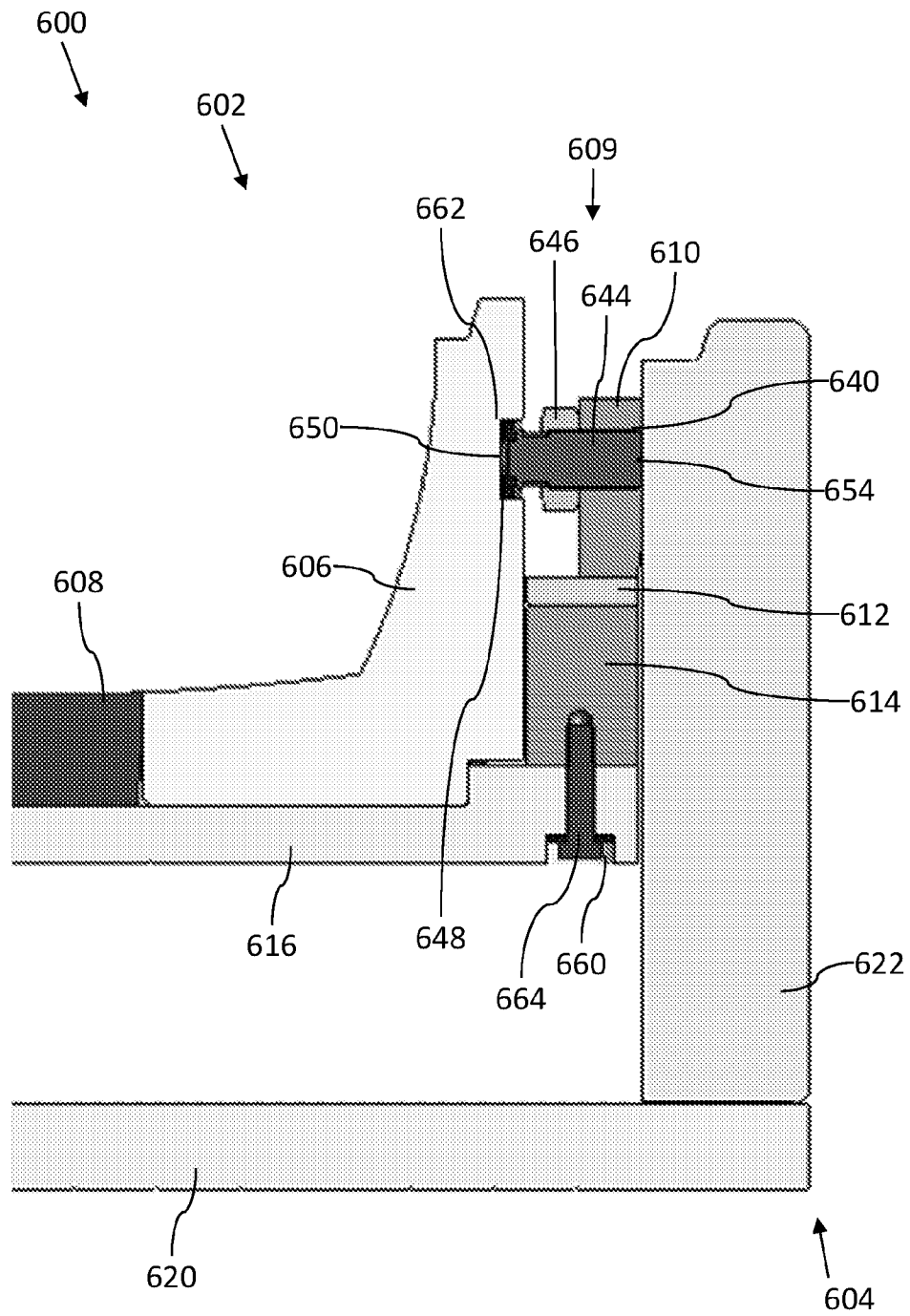


FIG. 6

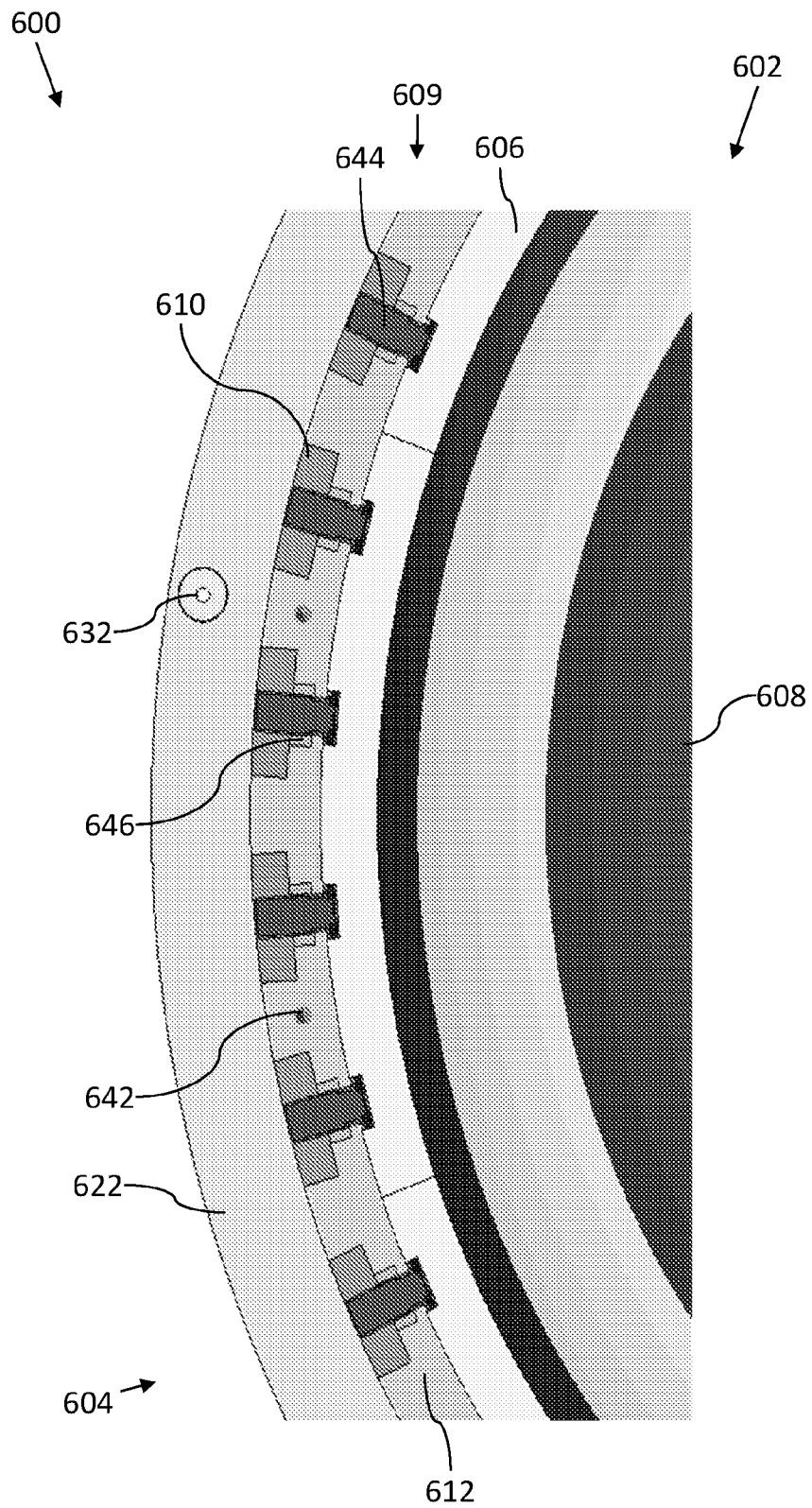
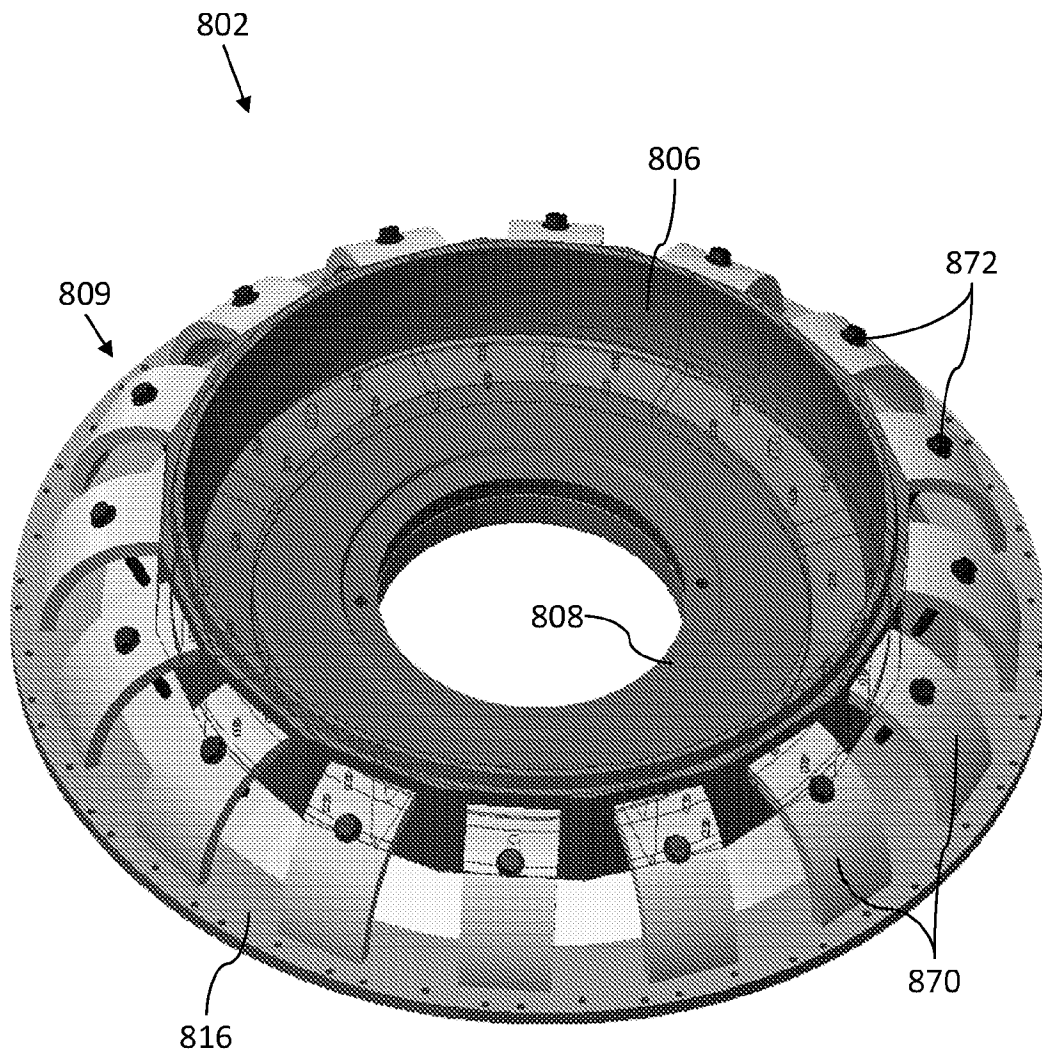


FIG. 7

**FIG. 8**

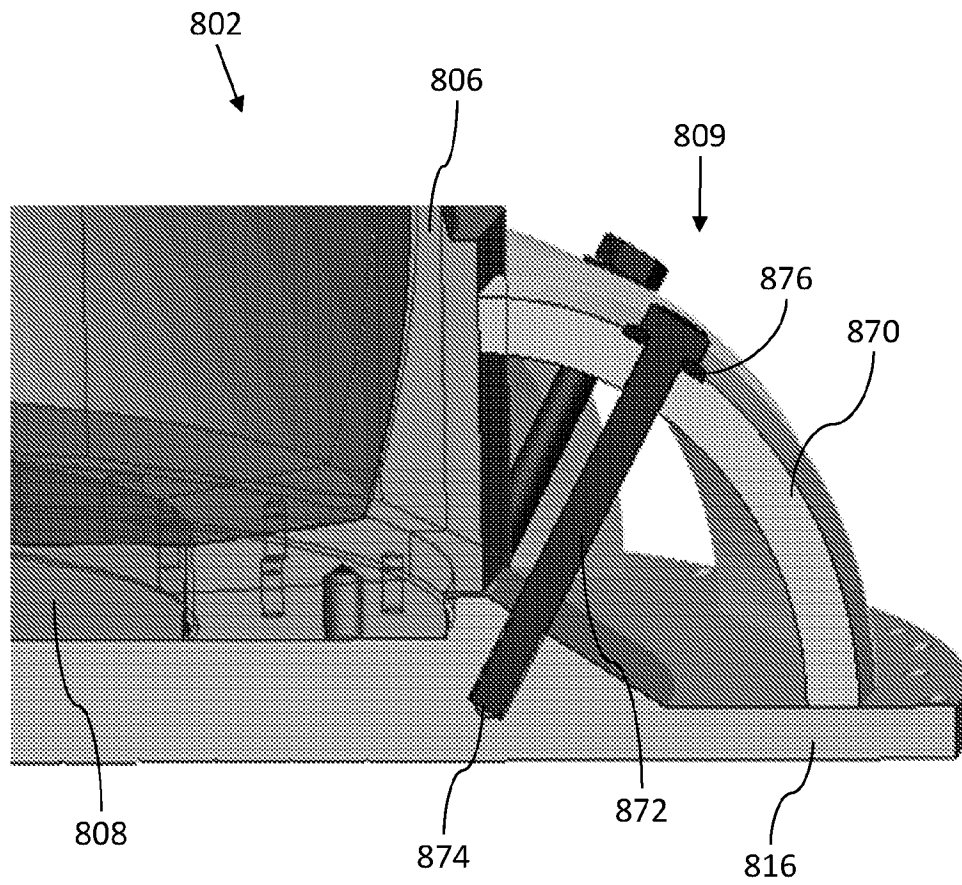
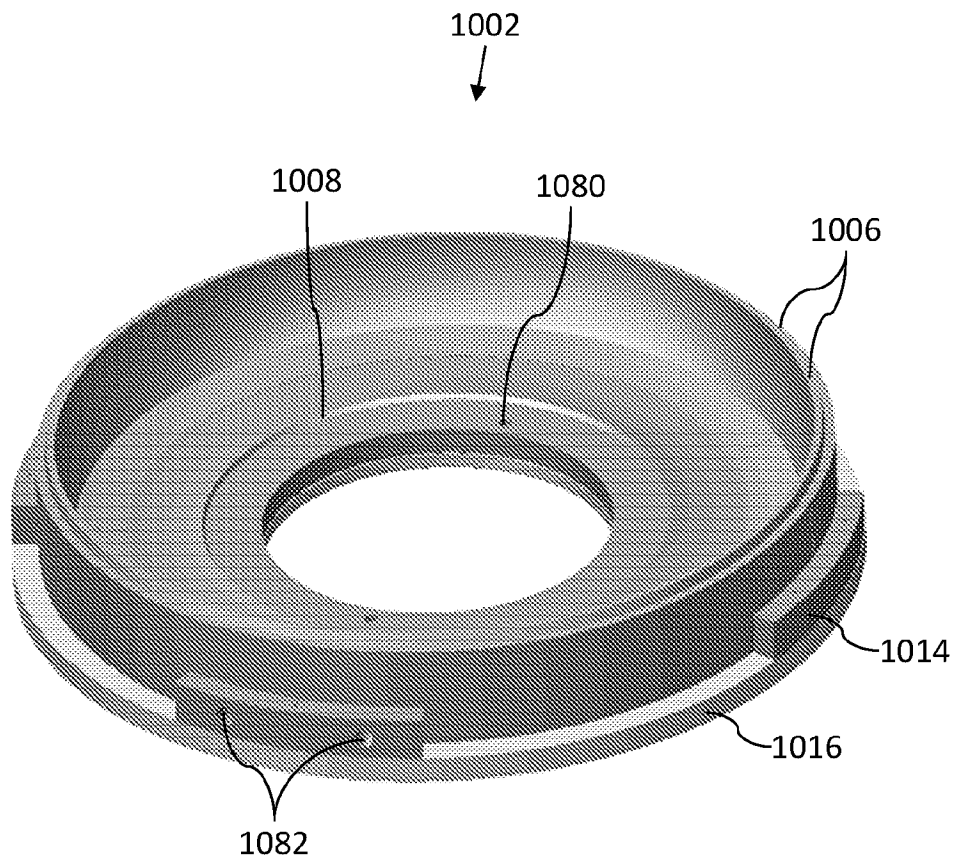


FIG. 9

**FIG. 10**

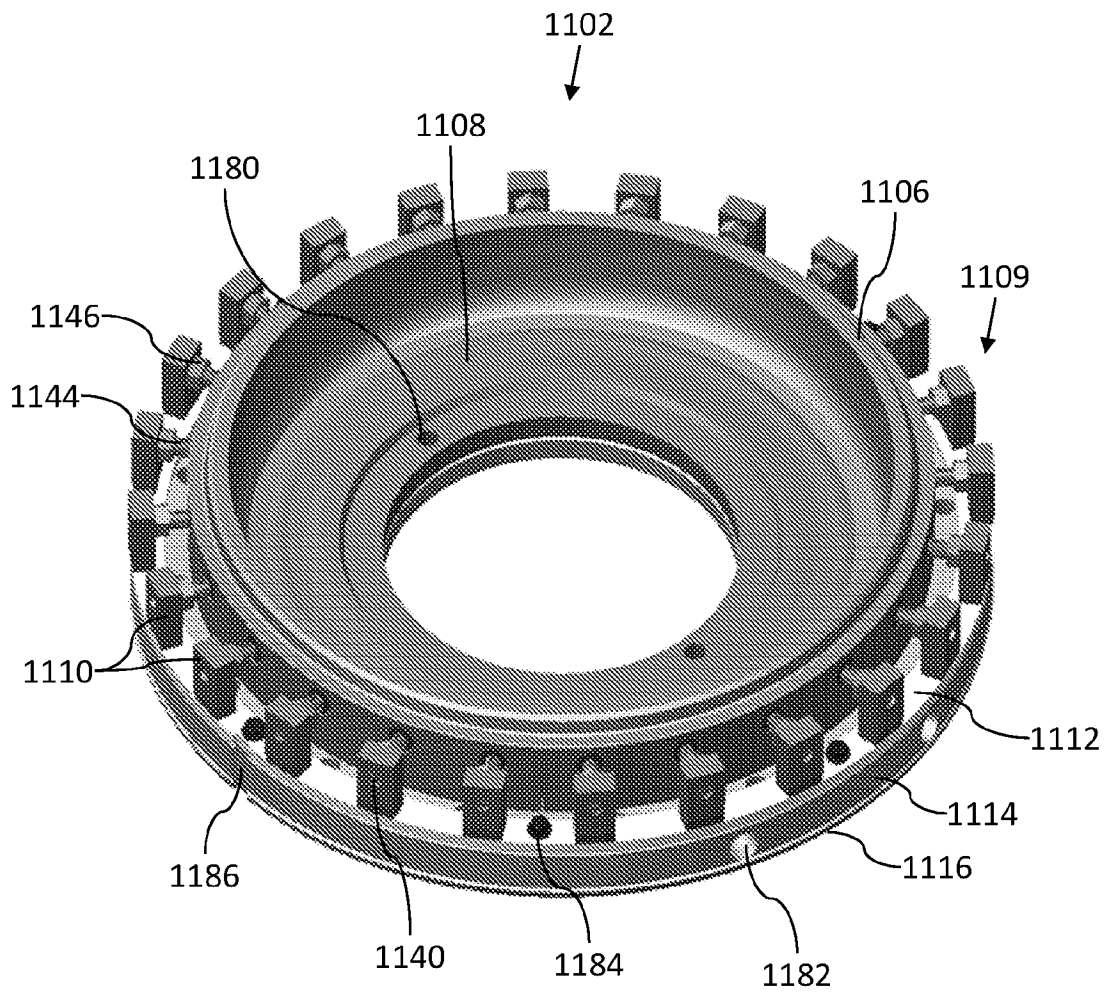


FIG. 11

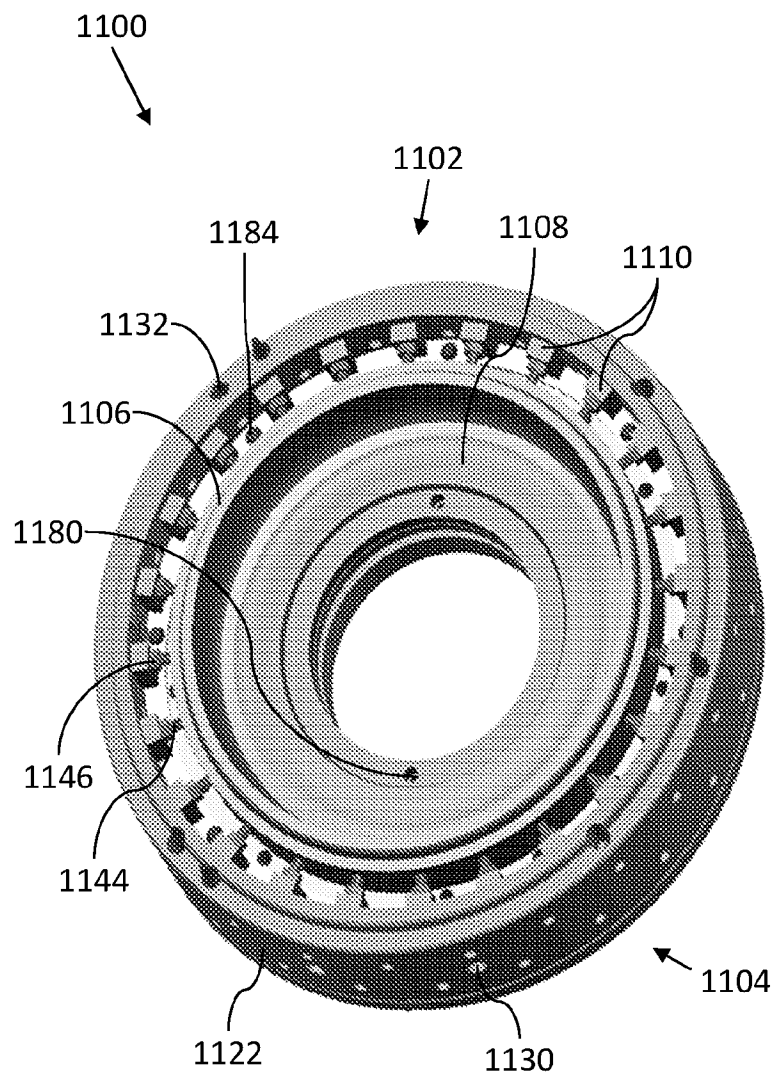
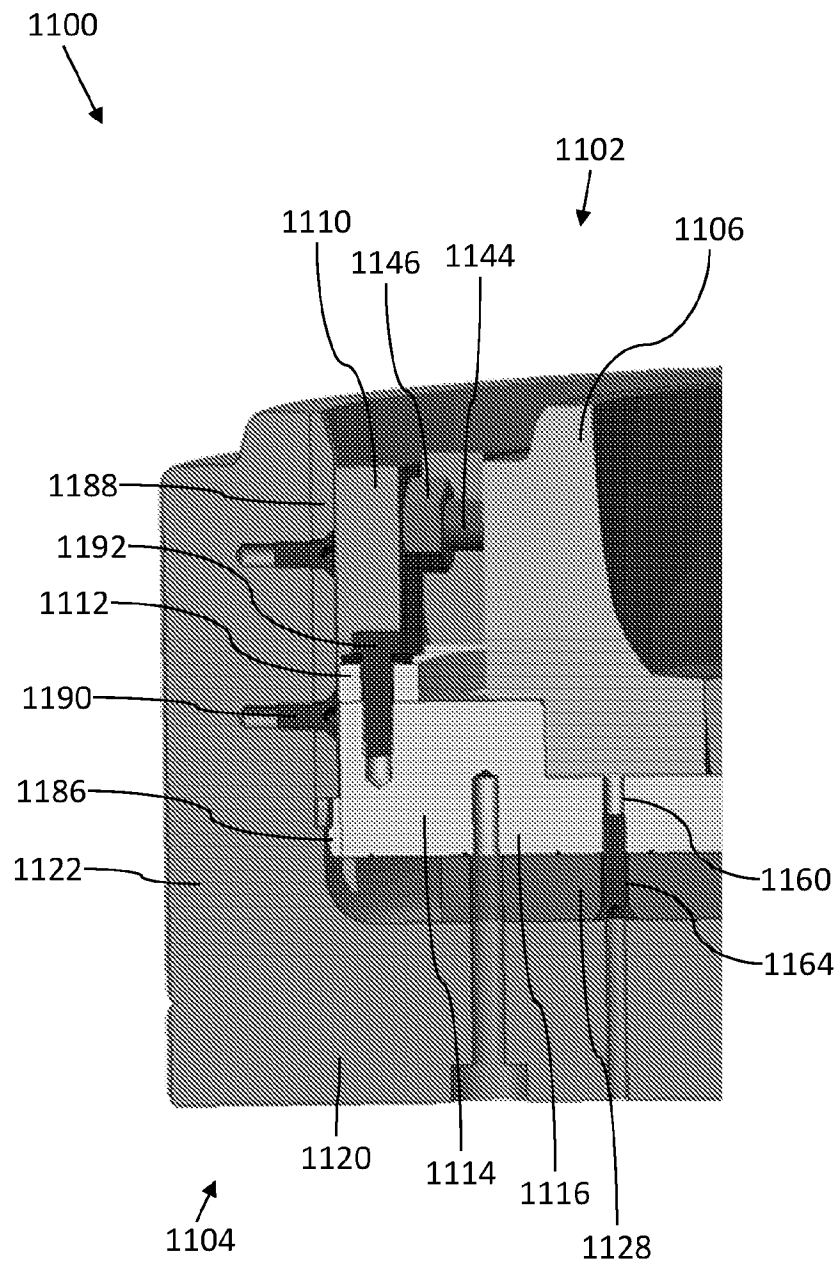


FIG. 12

**FIG. 13**

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2017/012832**A. CLASSIFICATION OF SUBJECT MATTER****B29D 30/06(2006.01)i**

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

B. FIELDS SEARCHEDMinimum documentation searched (classification system followed by classification symbols)
B29D 30/06; B29C 33/74; B29C 35/02; B29C 33/20; B29C 35/00; B29D 30/52; B29C 33/02Documentation 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 modelsElectronic data base consulted during the international search (name of data base and, where practicable, search terms used)
eKOMPASS(KIPO internal) & Keywords: tire modling, adjustment, ring, assembly**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 2014-136318 A (NAKAMURA YOSHINOBU et al.) 28 July 2014 See paragraphs [0007],[0011],[0015]-[0017], claims 1-5 and figures 1-5,7.	1-15
A	JP 2006-159669 A (YOKOHAMA RUBBER CO., LTD.) 22 June 2006 See claims 1-6 and figures 1-2.	1-15
A	US 5939002 A (JOHN F. HEINDEL) 17 August 1999 See claims 1,12 and figures 2-5.	1-15
A	US 2011-0129559 A1 (JAMES D. MAKINS) 02 June 2011 See claims 11-17,19-25 and figures 3,7.	1-15
A	US 5653847 A (MICHAEL J. KING et al.) 05 August 1997 See claims 1-4 and figures 10-13.	1-15



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"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)

"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

30 March 2017 (30.03.2017)

Date of mailing of the international search report

30 March 2017 (30.03.2017)

Name and mailing address of the ISA/KR

International Application Division

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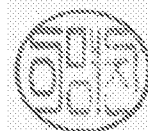
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INTERNATIONAL SEARCH REPORT

Information on patent family members

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