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(71) Applicant: **BRIDGESTONE AMERICAS TIRE OPERATIONS, LLC** [US/US]; 535 Marriott Drive, Nashville, Tennessee 37214 (US).

(72) Inventor: **THOMPSON, Thaddeus T.**; 1020 Minuiteman Avenue, Massillon, Ohio 44646 (US).

(74) Agent: **JUPINA, Matthew W.** et al.; 10 East Firestone Blvd., Akron, Ohio 44317 (US).

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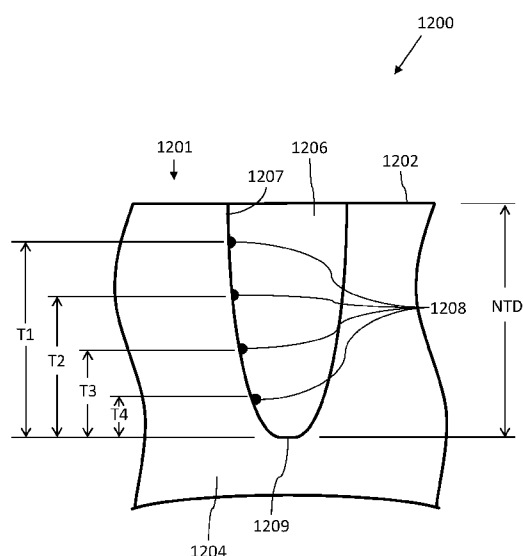


FIG. 12A

(57) Abstract: Various embodiments of a tire wear indicator are provided. In one embodiment, a tire having a tread is provided, comprising: a ground-contacting portion oriented at the radially outermost surface of the tire; at least one notch extending radially inward from the ground-contacting portion, wherein the at least one notch includes at least one notch sidewall and a notch base; at least one tire wear indicator extending from the at least one notch sidewall partially into the at least one notch; wherein the at least one tire wear indicator does not extend completely across the at least one notch; and wherein the at least one tire wear indicator does not directly contact the notch base.

TIRE WEAR INDICATOR

BACKGROUND

[0001] Vehicle tires include a ground-contacting portion typically oriented at a radially-outermost surface. The ground-contacting portion is that portion of the tire that engages a running surface, which may be any of a variety of surfaces, including a roadway, floor, turf, soil, and the like. The ground-contacting portion of the tire tends to wear away with use of the tire; ground-contacting portion wear is often a key factor in determining the service life remaining in a tire while maintaining its safe operation.

[0002] Many vehicle tires experience uneven wear during the service life of the tire. As a simplified example, a ground-contacting portion may be divided into three sections, including for example an outboard section, a central section, and an inboard section (it is understood that a ground-contacting portion may experience wear differential in any number of “sections”). During its service life, a tire may experience more or less wear in any of the aforementioned sections. For example, an outboard section of the ground-contacting portion may wear more than an inboard section, and either the outboard section or the inboard section may wear more or less than a central section. A variety of factors may cause uneven wear in a tire, including for example, incorrect inflation pressure, wheel caster angle, wheel camber angle, wheel toe angle, vehicle load distribution, running surface roughness, and the like. As a result, tires are often rotated (either via a change in tire position on the vehicle, a change in tire orientation (e.g., turning the tire around), or both) to allow tires to wear more evenly so as to increase service life of the tire and ultimately the safety associated with the use of the tire.

[0003] Measuring tire wear of a tire mounted on a vehicle, including wear of a ground-contacting portion, often requires the vehicle to be taken out of service for a period of time, while a technician measures the wear of the tire at one or more points on its ground-contacting portion.

[0004] What is needed is a tire wear indicator to allow one to quickly and simply check the overall wear and/or uneven wear of a tire.

SUMMARY

[0005] In one embodiment, a tire having a tread is provided, comprising: a ground-contacting portion oriented at the radially outermost surface of the tire; at least one notch extending radially inward from the ground-contacting portion, wherein the at least one notch

includes at least one notch sidewall and a notch base; at least one tire wear indicator extending from the at least one notch sidewall partially into the at least one notch; wherein the at least one tire wear indicator does not extend completely across the at least one notch; and wherein the at least one tire wear indicator does not directly contact the notch base.

[0006] In another embodiment, a tire having a tread is provided, comprising: a ground-contacting portion oriented at the radially outermost surface of the tire; at least one notch extending radially inward from the ground-contacting portion, wherein the at least one notch includes at least one notch sidewall and a notch base; a plurality of tire wear indicators extending from the at least one notch sidewall partially into the at least one notch; wherein the plurality of tire wear indicators is oriented in a circumferential position on the tire; wherein each of the plurality of tire wear indicators is oriented in a series of differing radial heights in the circumferential position; wherein the at least one tire wear indicator does not extend completely across the at least one notch; and wherein the at least one tire wear indicator does not directly contact the notch base.

[0007] In another embodiment, a tire having a tread is provided, comprising: a ground-contacting portion oriented at the radially outermost surface of the tire; at least one groove extending radially inward from the ground-contacting portion, wherein the at least one groove includes at least one groove sidewall and a groove base; at least one tire wear indicator extending from the at least one groove sidewall partially into the at least one groove; wherein the at least one tire wear indicator does not extend completely across the at least one groove; and wherein the at least one tire wear indicator does not directly contact the groove base.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] The accompanying figures, which are incorporated in and constitute a part of the specification, illustrate various example configurations, and are used merely to illustrate various example embodiments. In the figures, like elements bear like reference numerals.

[0009] **FIG. 1** illustrates a perspective view of an example embodiment of a tire **100** having at least one tire wear indicator **108**.

[0010] **FIG. 2** illustrates a perspective view of an example embodiment of a tire **200** having at least one tire wear indicator **208**.

[0011] **FIG. 3** illustrates a partial view of an example embodiment of a tire **300** having at least one tire wear indicator **308**.

[0012] **FIG. 4** illustrates a partial elevational view of an example embodiment of a tire **400** having at least one tire wear indicator **408**.

[0013] **FIG. 5** illustrates a partial elevational view of an example embodiment of a tire **500** having at least one tire wear indicator **508**.

[0014] **FIG. 6** illustrates a partial elevational view of an example embodiment of a tire **600** having at least one tire wear indicator **608**.

[0015] **FIG. 7** illustrates a partial elevational view of an example embodiment of a tire **700** having at least one tire wear indicator **708**.

[0016] **FIG. 8** illustrates a partial plan view of an example embodiment of a tire **800** having at least one tire wear indicator **808**.

[0017] **FIG. 9** illustrates a partial plan view of an example embodiment of a tire **900** having at least one tire wear indicator **908**.

[0018] **FIG. 10** illustrates a partial plan view of an example embodiment of a tire **1000** having at least one tire wear indicator **1008**.

[0019] **FIG. 11** illustrates a partial plan view of an example embodiment of a tire **1100** having at least one tire wear indicator **1108**.

[0020] **FIG. 12A** illustrates a partial elevational view of an example embodiment of a tire **1200** having at least one tire wear indicator **1208**.

[0021] **FIG. 12B** illustrates a partial elevational view of an example embodiment of tire **1200** having at least one tire wear indicator **1208**.

[0022] **FIG. 13** illustrates a plan view of an example embodiment of a tire **1300** having at least one tire wear indicator **1308**.

[0023] **FIG. 14** illustrates a plan view of an example embodiment of at least one tire **1400** having at least one tire wear indicator **1408**.

[0024] **FIG. 15A** illustrates a plan view of an example embodiment of at least one tire **1500** having at least one tire wear indicator **1508**.

[0025] **FIG. 15B** illustrates a plan view of an example embodiment of at least one tire **1500** having at least one tire wear indicator **1508**.

[0026] **FIG. 16** illustrates a perspective view of an example embodiment of a tire mold element **1620** used in molding at least one tire wear indicator.

DETAILED DESCRIPTION

[0027] Vehicle tires are often made up at least in part by a polymer material. The polymer material may include a rubber material. Vehicle tires often include a rubber ground-contacting portion. Vehicle tires may be pneumatic, non-pneumatic, or some hybrid of pneumatic and non-pneumatic in nature.

[0028] Vehicle tires may lack tread patterns found on common automobile tires, and as such, may be difficult to visually inspect for wear. For example, some off-the-road tires, including for example, port forklift trucks, mining tires, and the like, may have very large and very few tread blocks about the circumference of the ground-contacting portion. Alternatively, some off-the-road tires may include only one or two notches in an otherwise “slick” ground-contacting portion.

[0029] **FIG. 1** illustrates a perspective view of an example embodiment of a tire **100** having at least one tire wear indicator **108**. Tire **100** may include a tire tread **101**. Tire **100** may include a ground-contacting portion **102**. Ground-contacting portion **102** may be the radially outermost portion of tire **100**. Tire **100** may include one or more sidewall **104**. In one embodiment, tire **100** includes two sidewalls **104** oriented on either side of ground-contacting portion **102**. Tire **100** may include at least one notch **106**. At least one tire wear indicator **108** may be oriented in at least one notch **106**.

[0030] In one embodiment, tire **100** includes a single notch **106**. In another embodiment, tire **100** includes two notches **106**. In another embodiment, tire **100** includes more than two notches **106**. Tire **100** may include at least one notch **106** on each side of tire **100**. For example, tire **100** includes a first axial side and a second axial side, and at least one notch **106** extends at least partially across the width of tire **100** from each axial side. Notch **106** may extend radially inward from ground-contacting portion **102**.

[0031] In one embodiment, notch **106** extends completely across the width of ground-contact portion **102**. In another embodiment, at least one notch **106** may extend about 40% across the width of ground-contact portion **102**. In another embodiment, at least one notch **106** extends partially across the width of ground-contact portion **102**.

[0032] Tire **100** may include tire tread **101**, which is inclusive of ground-contact portion **102**. Tread **101** may have a tread depth, or thickness, past which tire **100** cannot wear within

its practical service life. Stated differently, tire **100** would be deemed to have surpassed its practical service life after wearing completely through its tread depth, and would thus be removed from service. In one embodiment, notch **106** has a depth that is substantially equal to the tread depth of tread **101**. In another embodiment, notch **106** has a depth that is less than the tread depth of tread **101**. In another embodiment, notch **106** has a depth that is greater than the tread depth of tread **101**.

[0033] **FIG. 2** illustrates a perspective view of an example embodiment of a tire **200** having at least one tire wear indicator **208**. Tire **200** may include a tire tread **201**. Tire **200** may include a ground-contacting portion **202**. Tire **200** may include one or more sidewall **204**. In one embodiment, tire **200** includes two sidewalls **204** oriented on either side of ground-contacting portion **202**. Tire **200** may include at least one groove **206**. At least one tire wear indicator **208** may be oriented in at least one groove **206**.

[0034] Groove **206** may be a substantially circumferential groove. In addition, or in the alternative, tire **200** may include axial grooves (not shown), or grooves inclined relative to the central plane of the tire. Groove **206** may include a groove base and at least one groove sidewall. At least one tire wear indicator **208** may be oriented on a groove sidewall **207**.

[0035] Tire **200** may include a series of grooves **206**, forming a plurality of tread ribs (not shown) having sidewalls. At least one of the rib sidewalls may include at least one tire wear indicator **208**.

[0036] Tire **200** may include a series of interconnected grooves (not shown), forming a plurality of tread blocks (not shown) having sidewalls. At least one of the tread block sidewalls may include at least one tire wear indicator **208**.

[0037] Groove **206** may include at least one groove sidewall **207** and a groove base (not shown). Tire wear indicators **208** may extend from groove sidewall **207** partially into groove **206**, but may not extend (i.e., bridge) completely across the width of groove **206**. Tire wear indicators **208** may not directly contact notch base **209**.

[0038] In one embodiment, tire **200** may include an agricultural tire with a common pattern of tread blocks or tread lugs having sidewalls oriented about its circumference. For example, tire **200** may be a drive tire for a tractor, loader, combine, irrigation system, or other piece of agricultural equipment. At least one of the tread block or tread lug sidewalls may include at least one tire wear indicator **208**.

[0039] Tire **200** may include any of a variety of tires, including for example, an agricultural tire, an off-the-road equipment tire, a passenger tire, a truck tire, a bus tire, an ATV tire, a UTV tire, a motorcycle tire, an airplane tire, and the like.

[0040] **FIG. 3** illustrates a partial view of an example embodiment of a tire **300** having at least one tire wear indicator **308**. Tire **300** may include a tire tread **301**. Tire **300** may include a ground-contacting portion **302**. Tire **300** may include one or more sidewall **304**. Tire **300** may include at least one notch **306**. At least one tire wear indicator **308** may be oriented in at least one notch **306**.

[0041] Notch **306** may include a notch sidewall **307** that is substantially radially oriented. At least one tire wear indicator **308** may include a series of tire wear indicators **308**. Each tire wear indicator **308** may include an element extending from notch sidewall **307** partially into notch **306**. Alternatively, each tire wear indicator **308** may include an element extending into notch sidewall **307**. Alternatively, tire wear indicators **308** may include some tire wear indicators **308** extending from notch sidewall **307**, and some tire wear indicators **308** extending into notch sidewall **307**. For example, every other tire wear indicator **308** in a series of tire wear indicators **308** may extend into notch sidewall **307**, while the remaining tire wear indicators **308** may extend out of notch sidewall **307**. Notch **306** may include a notch base **309**.

[0042] Tire wear indicators **308** may extend from notch sidewall **307** partially into notch **306**, but may not extend (i.e., bridge) completely across the width of notch **306**. Tire wear indicators **308** may not directly contact notch base **309**. At least one tire wear indicator **308** may include a plurality of tire wear indicators oriented at a circumferential position on the tire and oriented in a radially spaced series.

[0043] At least one tire wear indicator **308** may include a substantially axially-aligned elongated element (e.g., a ridge) extending from notch sidewall **307**.

[0044] Alternatively, at least one tire wear indicator **308** may include a substantially circular “bump” extending from notch sidewall **307**. At least one tire wear indicator **308** may include any of a variety of shapes and cross-sections, including for example, a circle, a semicircle, a square, a rectangle, a triangle, a groove, a ridge, a regular shape, an irregular shape, and the like.

[0045] At least one tire wear indicator **308** may be visually observed by a user of tire **300**, such that the user can confirm how many tire wear indicators are visible on notch sidewall

307, which informs the user approximately how much tread depth of tread **301** is remaining in tire **300**, and thus how much service life is left in tire **300**.

[0046] At least one tire wear indicator **308** may be tactilely observed by a user of tire **300**, such that the user can feel at least one tire wear indicator **308** (or note the absence of at least one tire wear indicator **308**) and confirm how many tire wear indicators are visible on notch sidewall **307**, which informs the user approximately how much tread depth of tread **301** is remaining in tire **300**, and thus how much service life is left in tire **300**.

[0047] In one embodiment, tire **300** includes two notches **306**, wherein one notch **306** is oriented on a first side of tire **300**, and wherein another notch **306** is oriented on a second side of tire **300**. A user may compare the number of tread wear indicators **308** remaining in a first notch **306** to the number of tread wear indicators **308** remaining in a second notch **306**. Wherein the number of tread wear indicators **308** in the first and second notch **306** are different, tire **300** may be wearing unevenly. Wherein the number of tread wear indicators **308** in the first and second notch **306** are the same, tire **300** may be wearing evenly.

[0048] **FIG. 4** illustrates a partial elevational view of an example embodiment of a tire **400** having at least one tire wear indicator **408**. Tire **400** may include a tire tread **401**. Tire **400** may include a ground-contacting portion **402**. Tire **400** may include one or more sidewall **404**. Tire **400** may include at least one notch **406**. At least one tire wear indicator **408** may be oriented in at least one notch **406**. Notch **406** may include at least one notch sidewall **407** from which at least one tire wear indicator **408** may extend. Notch **406** may include a notch base **409**.

[0049] As illustrated, a series of tire wear indicators **408** may extend along two notch sidewall **407** at varying radial heights. As such, a user can observe (visually or tactilely) the number of tire wear indicators **408** remaining in notch **406** from various angles relative to the tire wear indicators **408**.

[0050] **FIG. 5** illustrates a partial elevational view of an example embodiment of a tire **500** having at least one tire wear indicator **508**. Tire **500** may include a tire tread **501**. Tire **500** may include a ground-contacting portion **502**. Tire **500** may include one or more sidewall **504**. Tire **500** may include at least one notch **506**. At least one tire wear indicator **508** may be oriented in at least one notch **506**. Notch **506** may include at least one notch sidewall **507** from which at least one tire wear indicator **508** may extend. Notch **506** may include a notch base **509**.

[0051] As illustrated, a series of tire wear indicators **508** may extend along one notch sidewall **507** at varying radial heights. As such, a user can observe (visually or tactilely) the number of tire wear indicators **508** remaining in notch **506**.

[0052] **FIG. 6** illustrates a partial elevational view of an example embodiment of a tire **600** having at least one tire wear indicator **608**. Tire **600** may include a tire tread **601**. Tire **600** may include a ground-contacting portion **602**. Tire **600** may include one or more sidewall **604**. Tire **600** may include at least one notch **606**. At least one tire wear indicator **608** may be oriented in at least one notch **606**. Notch **606** may include at least one notch sidewall **607** from which at least one tire wear indicator **608** may extend. Notch **606** may include a notch base **609**.

[0053] As illustrated, a series of tire wear indicators **608** may extend along various notch sidewalls **607** at varying radial heights. As such, a user can observe (visually or tactilely) the number of tire wear indicators **608** remaining in notch **606** from various positions relative to wear tire wear indicators **608**.

[0054] **FIG. 7** illustrates a partial elevational view of an example embodiment of a tire **700** having at least one tire wear indicator **708**. Tire **700** may include a tire tread **701**. Tire **700** may include a ground-contacting portion **702**. Tire **700** may include one or more sidewall **704**. Tire **700** may include at least one notch **706**. At least one tire wear indicator **708** may be oriented in at least one notch **706**. Notch **706** may include at least one notch sidewall **707** from which at least one tire wear indicator **708** may extend. Notch **706** may include a notch base **709**.

[0055] As illustrated, a series of tire wear indicators **708** may extend along one notch sidewall **707** at varying radial heights. As such, a user can observe (visually or tactilely) the number of tire wear indicators **708** remaining in notch **706**. At least one tire wear indicator **708** may extend from the axially-innermost notch sidewall **707**.

[0056] **FIG. 8** illustrates a partial plan view of an example embodiment of a tire **800** having at least one tire wear indicator **808**. Tire **800** may include a tire tread **801**. Tire **800** may include a ground-contacting portion **802**. Tire **800** may include at least one notch **806**. At least one tire wear indicator **808** may be oriented in at least one notch **806**. Notch **806** may include at least one notch sidewall **807** from which at least one tire wear indicator **808** may extend. Notch **806** may include a notch base **809**.

[0057] As illustrated, at least one tire wear indicator **808** may be oriented so as to extend partially along one of notch sidewalls **807**. At least one tire wear indicator **808** may extend from an axially-outermost portion of notch sidewall **807**.

[0058] **FIG. 9** illustrates a partial plan view of an example embodiment of a tire **900** having at least one tire wear indicator **908**. Tire **900** may include a tire tread **901**. Tire **900** may include a ground-contacting portion **902**. Tire **900** may include at least one notch **906**. At least one tire wear indicator **908** may be oriented in at least one notch **906**. Notch **906** may include at least one notch sidewall **907** from which at least one tire wear indicator **908** may extend. Notch **906** may include a notch base **909**.

[0059] As illustrated, at least one tire wear indicator **908** may be oriented so as to extend partially along two of notch sidewalls **907**. At least one tire wear indicator **908** may extend from an axially-outermost portion of notch sidewall **907**.

[0060] **FIG. 10** illustrates a partial plan view of an example embodiment of a tire **1000** having at least one tire wear indicator **1008**. Tire **1000** may include a tire tread **1001**. Tire **1000** may include a ground-contacting portion **1002**. Tire **1000** may include at least one notch **1006**. At least one tire wear indicator **1008** may be oriented in at least one notch **1006**. Notch **1006** may include at least one notch sidewall **1007** from which at least one tire wear indicator **1008** may extend. Notch **1006** may include a notch base **1009**.

[0061] As illustrated, at least one tire wear indicator **1008** may be oriented so as to extend partially along one of notch sidewalls **1007**. Tire wear indicator **1008** may be oriented to extend from an axially inner notch sidewall **1007** to permit viewing of tire wear indicator **1008** from the side of tire **1000**, the top of tire **1000**, and the like.

[0062] **FIG. 11** illustrates a partial plan view of an example embodiment of a tire **1100** having at least one tire wear indicator **1108**. Tire **1100** may include a tire tread **1101**. Tire **1100** may include a ground-contacting portion **1102**. Tire **1100** may include at least one notch **1106**. At least one tire wear indicator **1108** may be oriented in at least one notch **1106**. Notch **1106** may include at least one notch sidewall **1107** from which at least one tire wear indicator **1108** may extend. Notch **1106** may include a notch base **1109**.

[0063] As illustrated, at least one tire wear indicator **1108** may be oriented so as to extend partially along one of notch sidewalls **1107**. Tire wear indicator **1108** may be oriented to extend from an axially inner notch sidewall **1107** to permit viewing of tire wear indicator **1108** from various angles relative to tire wear indicator **1108**.

[0064] **FIGS. 12A and 12B** illustrate partial elevational views of an example embodiment of a tire **1200** having at least one tire wear indicator **1208**. Tire **1200** may include a tire tread **1201**. Tire **1200** may include a ground-contacting portion **1202**. Tire **1200** may include one or more sidewall **1204**. Tire **1200** may include at least one notch **1206**. At least one tire wear indicator **1208** may be oriented in at least one notch **1206**. Notch **1206** may include at least one notch sidewall **1207** from which at least one tire wear indicator **1208** may extend. Notch **1206** may include a notch base **1209**.

[0065] As illustrated, a series of tire wear indicators **1208** may extend along notch sidewall **1207** at varying radial heights. The series of tire wear indicators **1208** may be oriented at a circumferential position on tire **1200**. Notch **1206** may have a radial height equal to a new tread depth **NTD**. A plurality of tire wear indicators **1208** may be oriented in a series at differing radial heights corresponding to different radial thicknesses. That is, a radially outermost tire wear indicator **1208** may be oriented at thickness **T1**. Radially below another tire wear indicator **1208** may be oriented at thickness **T2**, with another at thickness **T3** oriented therebelow. Finally, the radially innermost tire wear indicator **1208** may have oriented at a thickness **T4**. It is understood that tire **1200** may include any number of tire wear indicators **1208**.

[0066] As illustrated in **FIG. 12A**, tire **1200** includes a new tread depth **NTD**. As illustrated in **FIG. 12B**, a portion of tread **1201** has been worn away, for example through use of the tire. As illustrated in **FIG. 12B**, tire **1200** includes a worn tread depth **WTD**, and the tire wear indicator **1208** oriented at thickness **T1** has been worn away with tread **1201**.

[0067] The radial distance between tire wear indicators **1208** may be a set distance, and is known by the individual(s) responsible for checking tire wear. In this manner, a user can visually or tactilely identify the number of remaining tire wear indicators **1208** on notch sidewall **1207**, and thus know approximately how much tread depth remains in tire **1200**. As such, a user can estimate approximately how much service life remains in tire **1200**. Likewise, a user can compare the number of tread wear indicators **1208** on a first side of tire **1200** to the number of tread wear indicators **1208** on a second side of tire **1200**, and thus identify an uneven wear situation.

[0068] The radial distance between tire wear indicators **1208** may be any of a variety of distances. The radial distance between tire wear indicators **1208** may be about 12.7 mm (0.5 in.). The radial distance between tire wear indicators **1208** may be 12.7 mm (0.5 in.). The

radial distance between tire wear indicators **1208** may be between about 2.5 mm (0.1 in.) and about 25.4 mm (1.0 in.). The radial distance between tire wear indicators **1208** may be between 2.5 mm (0.1 in.) and 25.4 mm (1.0 in.). The radial distance between tire wear indicators **1208** may be between about 7.6 mm (0.3 in.) and about 17.8 mm (0.7 in.). The radial distance between tire wear indicators **1208** may be between 7.6 mm (0.3 in.) and 17.8 mm (0.7 in.).

[0069] **FIG. 13** illustrates a plan view of an example embodiment of a tire **1300** having at least one tire wear indicator **1308**. Tire **1300** may include a tire tread **1301**. Tire **1300** may include a ground-contacting portion **1302**. Tire **1300** may include one or more sidewall **1304**. Tire **1300** may include at least one notch **1306**. At least one tire wear indicator **1308** may be oriented in at least one notch **1306**.

[0070] Tire **1300** may exhibit uneven wear, such that the worn depth of tread **1301** on a first side of tire **1300** is less than the worn depth of tread **1301** on a second side of tire **1300**. A user may observe uneven wear in tire **1300** by comparing the number of tread wear indicators **1308** remaining in notch **1306** on a first side of tire **1300** to the number of tread wear indicators **1308** remaining in notch **1306** on a second side of tire **1300**. For example, two tread wear indicators **1308** may remain in notch **1306** on a first side of tire **1300**, while three tread wear indicators **1308** may remain in notch **1306** on a second side of tire **1300**. A user may easily know to rotate, reposition, modify the alignment of, or otherwise address the uneven wear of tire **1300** before the wear becomes so uneven as to cut short the service life of tire **1300** or cause a safety concern in the use of tire **1300**.

[0071] **FIG. 14** illustrates a plan view of an example embodiment of at least one tire **1400** having at least one tire wear indicator **1408**. Each tire **1400** may include a tire tread **1401**. Tires **1400** may include a ground-contacting portion **1402**. Tires **1400** may include one or more sidewall **1404**. Tires **1400** may include at least one notch **1406**. At least one tire wear indicator **1408** may be oriented in at least one notch **1406**.

[0072] Tires **1400** may be oriented as dual tires, such that each tire **1400** is mounted on a wheel adjacent to the other to form a dual tire and wheel assembly.

[0073] **FIGS. 15A** and **15B** illustrate a plan view of an example embodiment of at least one tire **1500** having at least one tire wear indicator **1508**. Each tire **1500** may include a tire tread **1501**. Tires **1500** may include a ground-contacting portion **1502**. Tires **1500** may

include one or more sidewall **1504**. Tires **1500** may include at least one notch **1506**. At least one tire wear indicator **1508** may be oriented in at least one notch **1506**.

[0074] In some applications of tires **1500**, extreme loading may cause dual tire and wheel assemblies to wear unevenly between the two tires **1500**. That is, the worn depth of treads **1501** on the sides of tires **1500** that are adjacent to one another may be less than the worn depth of treads **1501** on the sides of tires **1500** that are oriented away from one another. As such, when the dual tire and wheel assembly is mounted on a vehicle, it may appear from the outboard side of the vehicle that the dual tire and wheel assembly is not wearing unevenly. However, the use of at least one wear indicator **1508** in notches **1506** may allow one to readily discern by inspecting tires **1500** (visually or tactilely) radially outward of the dual tire and wheel assembly that uneven wear is occurring.

[0075] As illustrated in **FIG. 15B**, tires **1500** may wear unevenly in the opposite manner as is illustrated in **FIG. 15A**. However, the use of at least one wear indicator **1508** in notches **1506** may allow one to readily discern by inspecting tires **1500** (visually or tactilely) radially outward of the dual tire and wheel assembly that uneven wear is occurring.

[0076] **FIG. 16** illustrates a perspective view of an example embodiment of a tire mold element **1620** used in molding at least one tire wear indicator. Mold element **1620** may include at least one tire wear indicator molding feature **1622**, which may be a negative of the desired tire wear indicator (not shown) to be molded into a tire. Mold element **1620** may be integrally connected to, or bolted into, a tire mold. Mold element **1620** may include bolt apertures **1624** which may permit a user to selectively attach mold element **1620** to a mold.

[0077] In one embodiment, any of the tires illustrated in **FIG. 1** and **FIGS. 3 – 15B** may be manufactured using a press mold. As such, any tire wear indicator oriented along the axial direction of the tire, or extending from the tire in the axial direction, may be oriented in the “release direction” of the press mold, and thus may be less likely to tear during removal of the tire from the tire mold.

[0078] In one embodiment, any of the tires illustrated and described herein may be manufactured using a pot heater. As such, any tire wear indicator oriented along the axial direction of the tire, or extending from the tire in the axial direction, may be oriented in the “release direction” of the tire mold in the pot heater, and thus may be less likely to tear during removal of the tire from the tire mold.

[0079] 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. Cartesian coordinates referenced herein are intended to comply with the SAE tire coordinate system.

[0080] 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 tire having a tire tread, comprising:
a ground-contacting portion oriented at the radially outermost surface of the tire;
at least one notch extending radially inward from the ground-contacting portion,
wherein the at least one notch includes at least one notch sidewall and a notch base;
at least one tire wear indicator extending from the at least one notch sidewall partially into the at least one notch;
wherein the at least one tire wear indicator does not extend completely across the at least one notch; and
wherein the at least one tire wear indicator does not directly contact the notch base.
2. The tire of claim 1, wherein the at least one tire wear indicator includes a plurality of tire wear indicators.
3. The tire of claim 2, wherein the plurality of tire wear indicators is oriented in a circumferential position on the tire.
4. The tire of claim 3, wherein each of the plurality of tire wear indicators is oriented in a series of differing radial heights in the circumferential position.
5. The tire of claim 1, wherein the at least one tire wear indicator is an axially-aligned elongated element.
6. The tire of claim 1, wherein the at least one tire wear indicator extends from an axially-innermost portion of the notch sidewall.
7. The tire of claim 1, wherein the at least one tire wear indicator extends from an axially-outermost portion of the notch sidewall.
8. The tire of claim 2, wherein the plurality of tire wear indicators extend from both an axially-innermost portion of the notch sidewall, and an axially-outermost portion of the notch sidewall.
9. The tire of claim 4, wherein a radial distance between adjacent tire wear indicators is about 12.7 mm.
10. The tire of claim 4, wherein a radial distance between adjacent tire wear indicators is between about 2.5 mm and about 25.4 mm.

11. The tire of claim 4, wherein a radial distance between adjacent tire wear indicators is between about 7.6 mm and about 17.8 mm.
12. A tire having a tire tread, comprising:
 - a ground-contacting portion oriented at the radially outermost surface of the tire;
 - at least one notch extending radially inward from the ground-contacting portion,
 - wherein the at least one notch includes at least one notch sidewall and a notch base;
 - a plurality of tire wear indicators extending from the at least one notch sidewall partially into the at least one notch;
 - wherein the plurality of tire wear indicators is oriented in a circumferential position on the tire;
 - wherein each of the plurality of tire wear indicators is oriented in a series of differing radial heights in the circumferential position;
 - wherein the at least one tire wear indicator does not extend completely across the at least one notch; and
 - wherein the at least one tire wear indicator does not directly contact the notch base.
13. The tire of claim 12, wherein the plurality of tire wear indicators are axially-aligned elongated elements.
14. The tire of claim 12, wherein the plurality of tire wear indicators extend from an axially-innermost portion of the notch sidewall.
15. The tire of claim 12, wherein the plurality of tire wear indicators extend from an axially-outermost portion of the notch sidewall.
16. The tire of claim 12, wherein the plurality of tire wear indicators extend from both an axially-innermost portion of the notch sidewall, and an axially-outermost portion of the notch sidewall.
17. The tire of claim 12, wherein a radial distance between adjacent tire wear indicators is about 12.7 mm.
18. The tire of claim 12, wherein a radial distance between adjacent tire wear indicators is between about 2.5 mm and about 25.4 mm.
19. The tire of claim 12, wherein a radial distance between adjacent tire wear indicators is between about 7.6 mm and about 17.8 mm.

20. A tire having a tire tread, comprising:
- a ground-contacting portion oriented at the radially outermost surface of the tire;
 - at least one groove extending radially inward from the ground-contacting portion,
 - wherein the at least one groove includes at least one groove sidewall and a groove base;
 - at least one tire wear indicator extending from the at least one groove sidewall partially into the at least one groove;
 - wherein the at least one tire wear indicator does not extend completely across the at least one groove; and
 - wherein the at least one tire wear indicator does not directly contact the groove base.

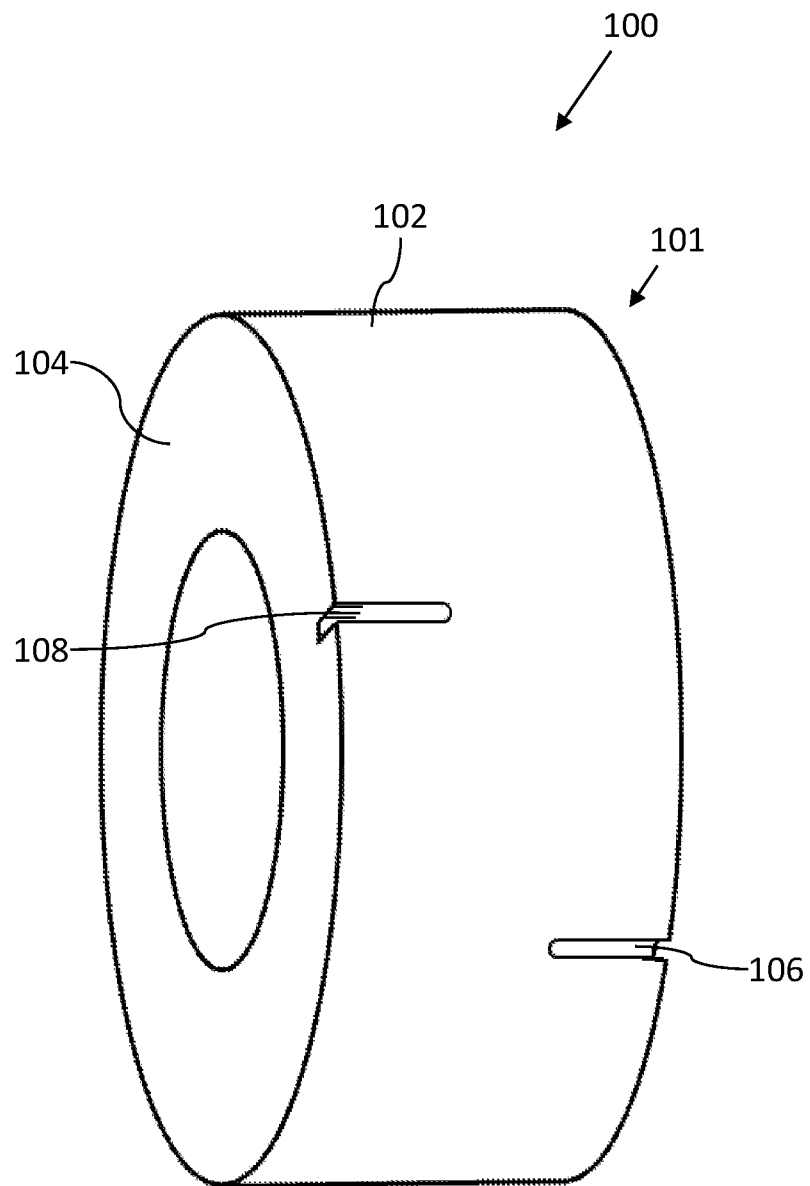


FIG. 1

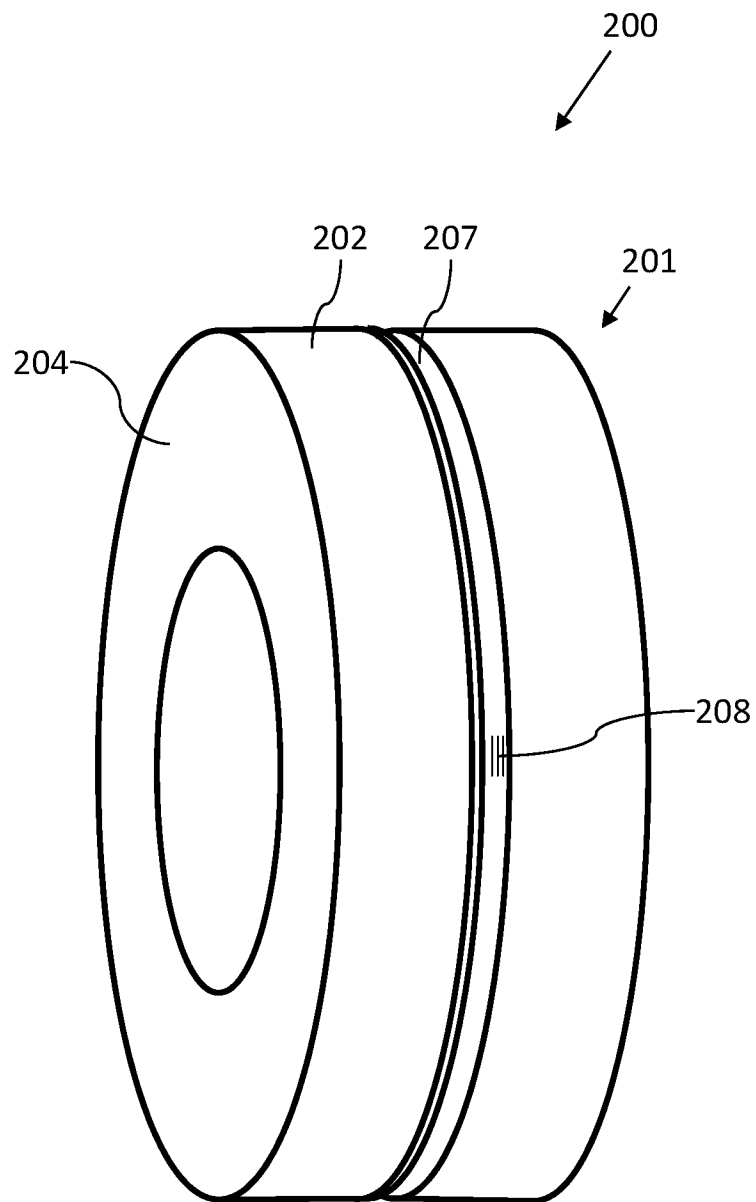


FIG. 2

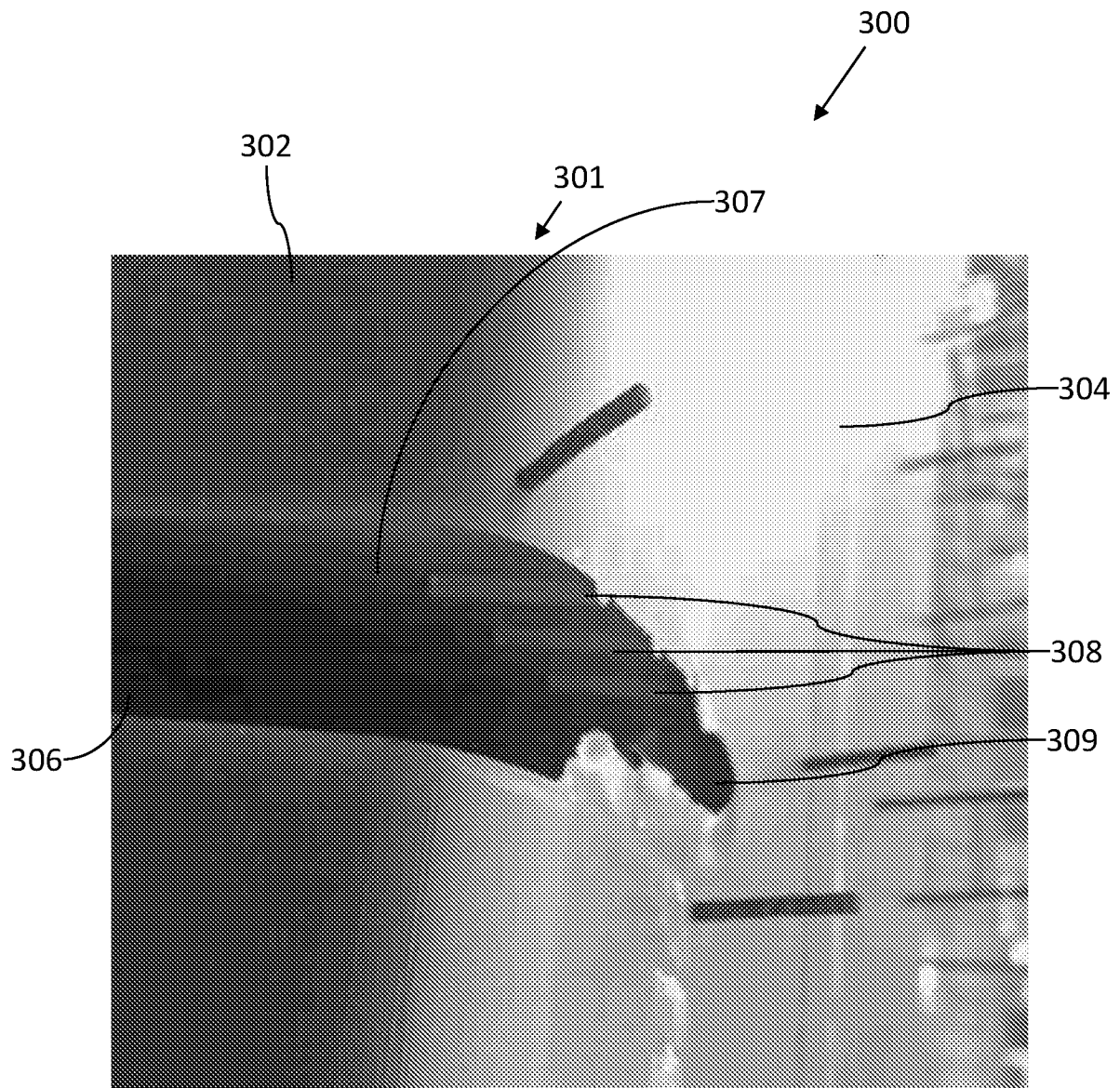


FIG. 3

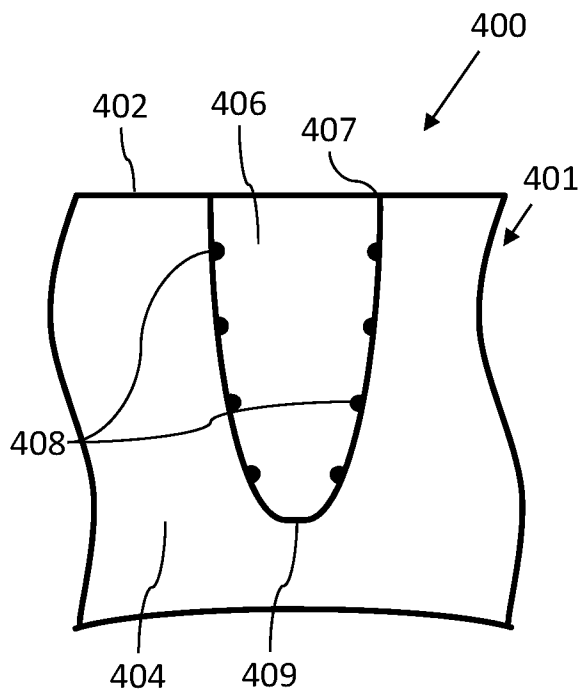


FIG. 4

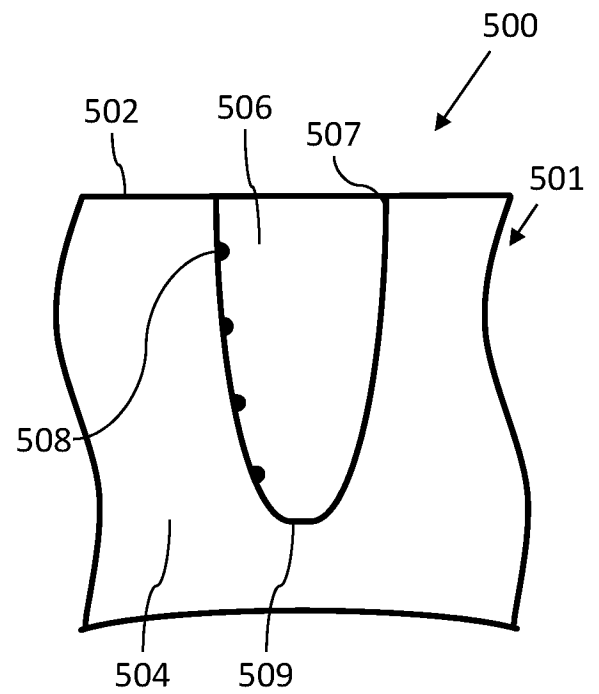


FIG. 5

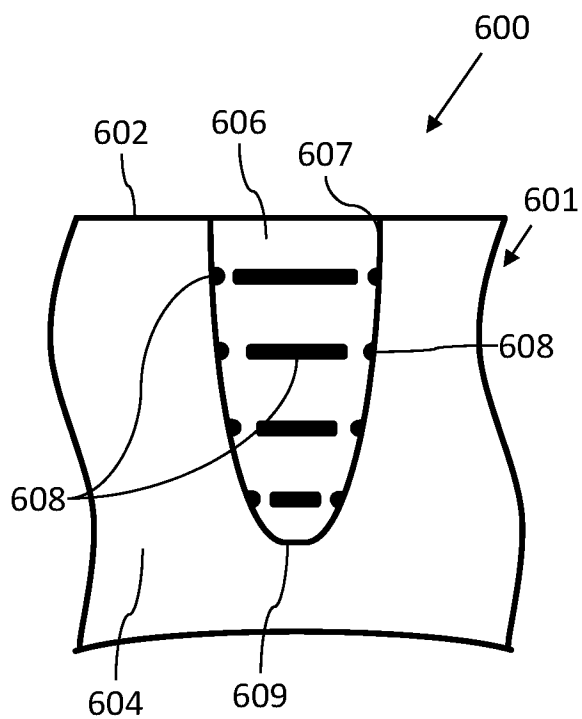


FIG. 6

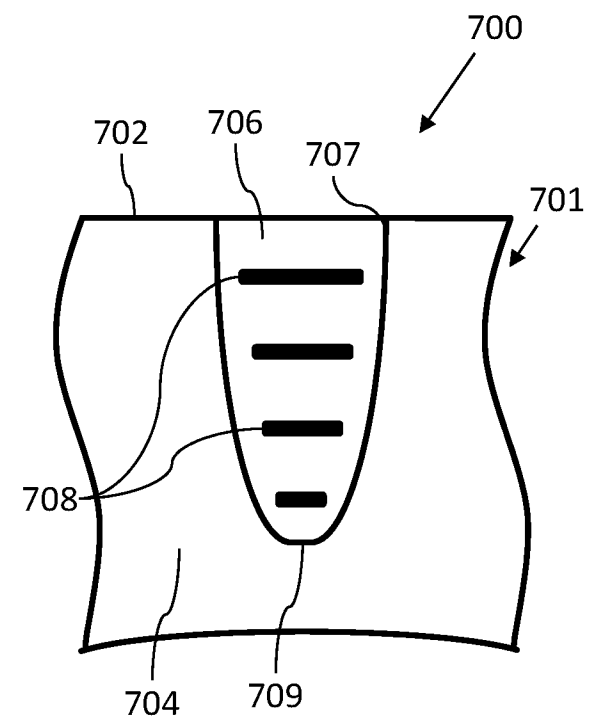


FIG. 7

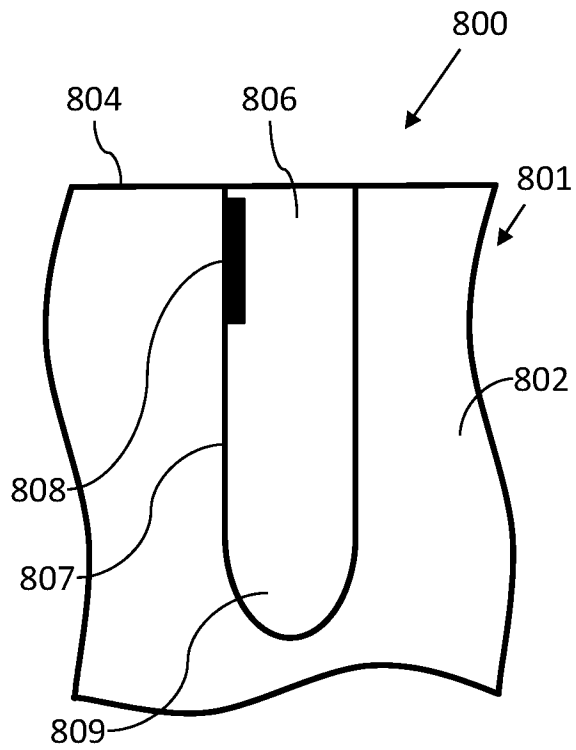


FIG. 8

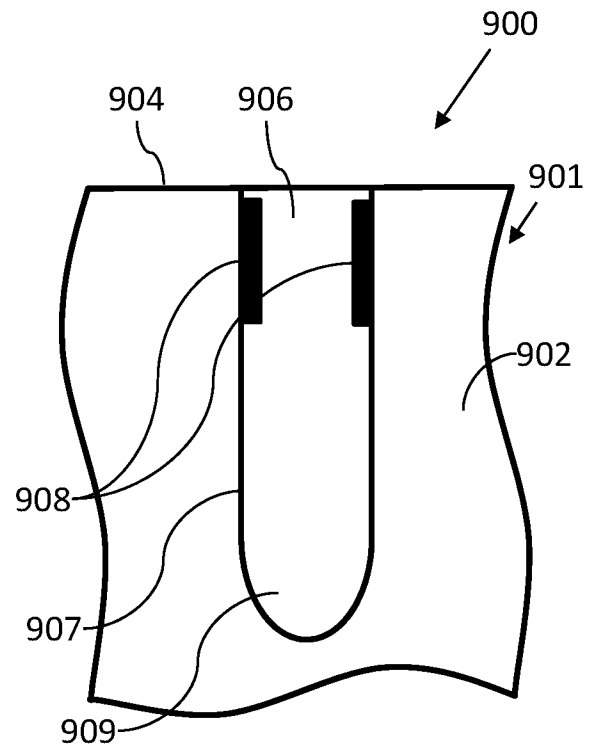


FIG. 9

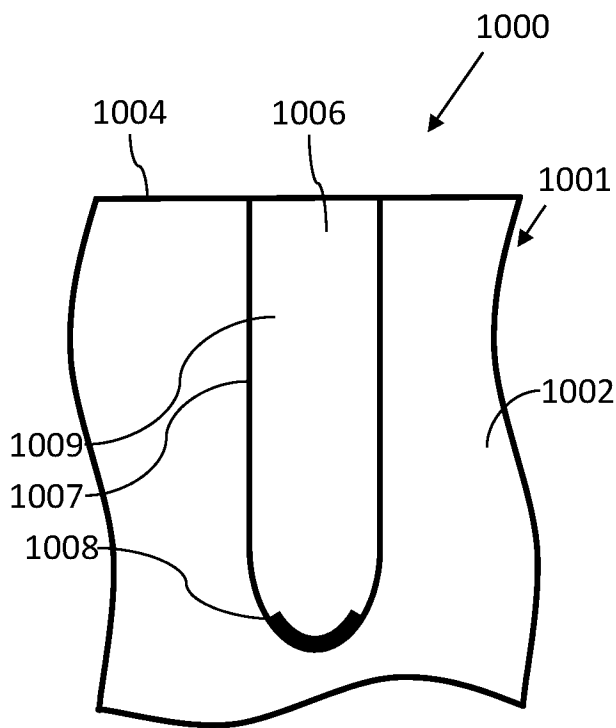


FIG. 10

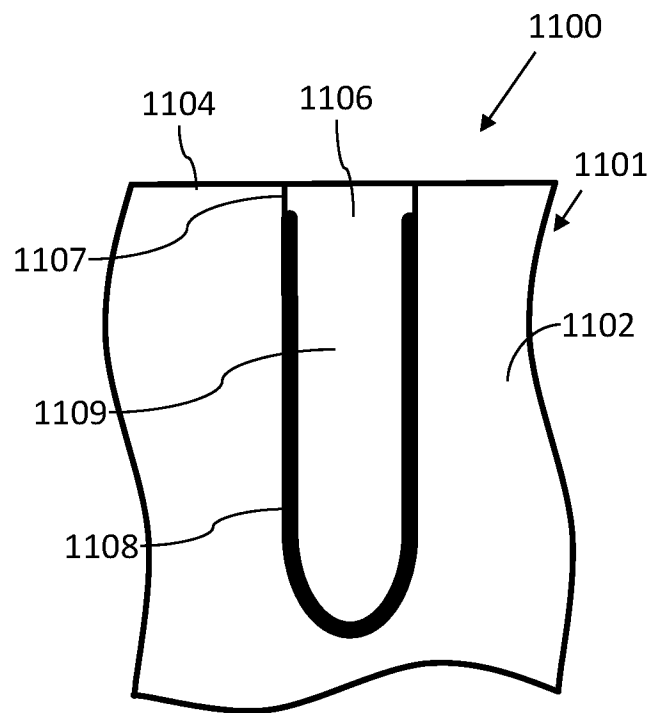
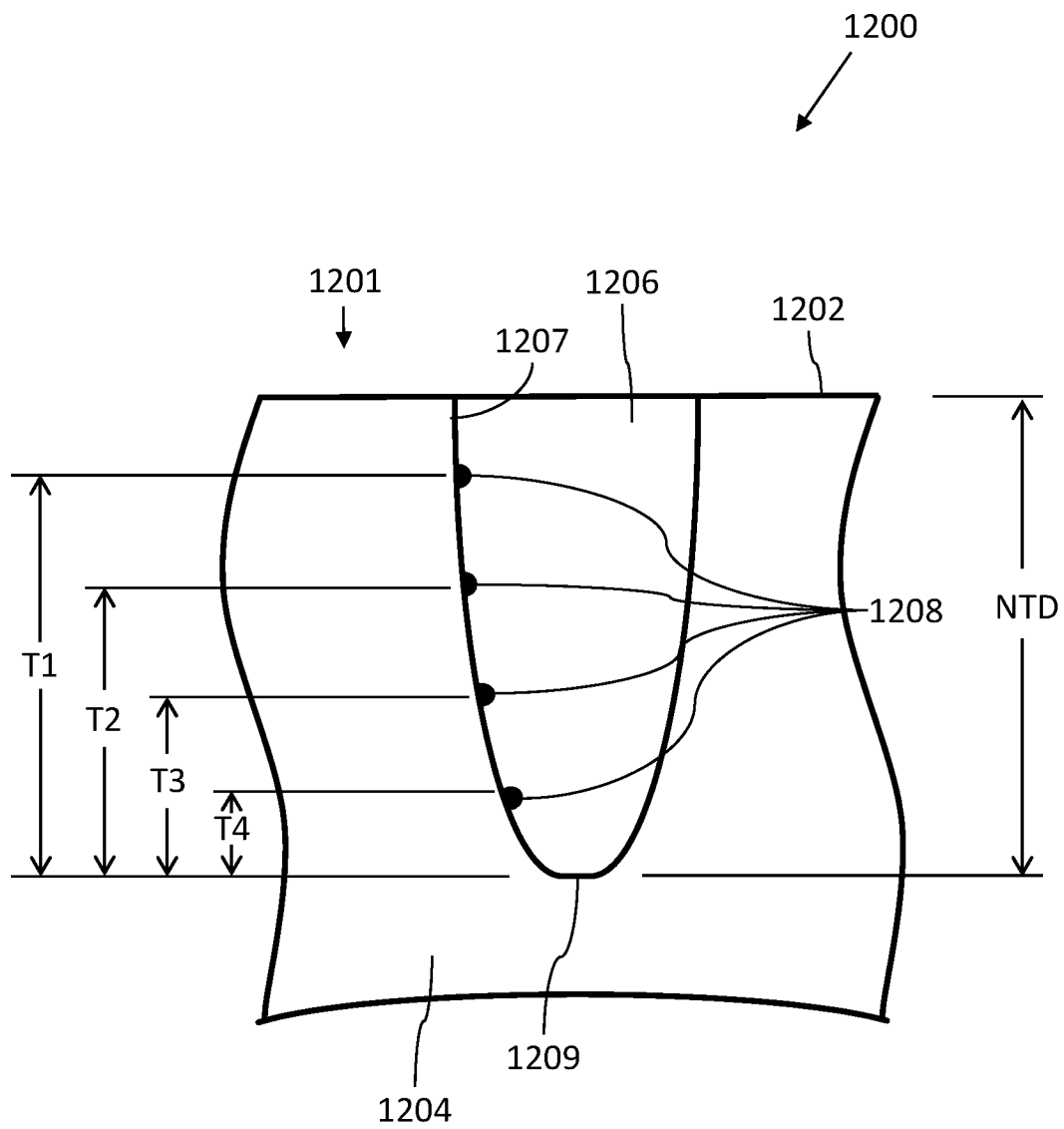
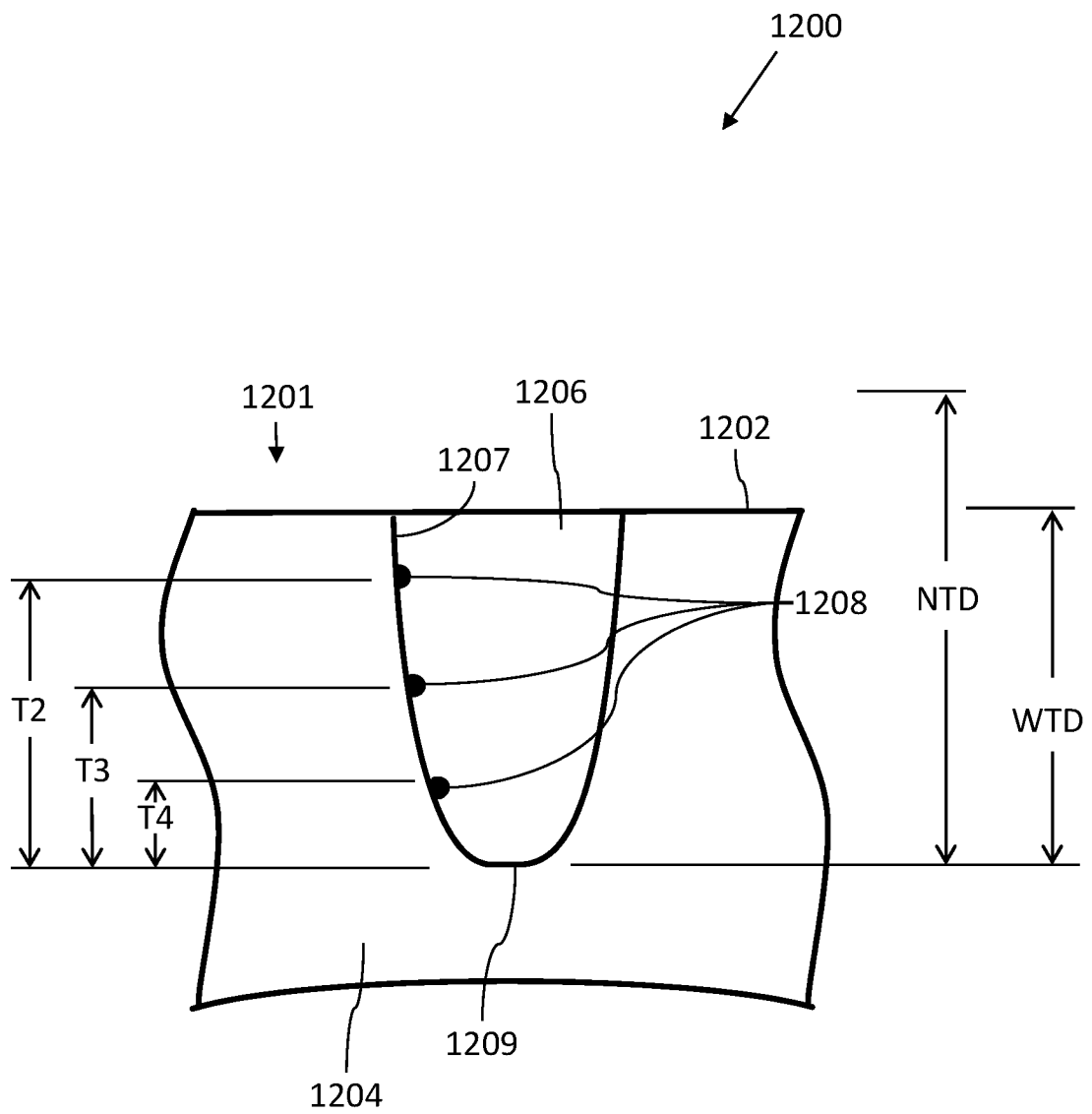


FIG. 11

**FIG. 12A**

**FIG. 12B**

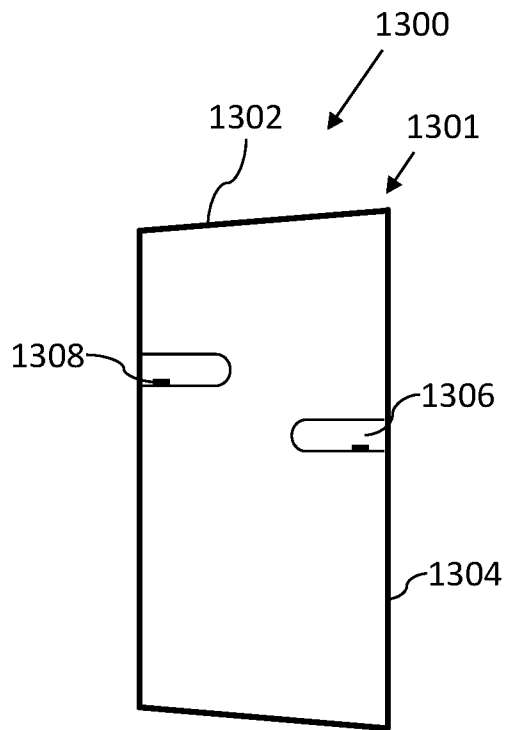


FIG. 13

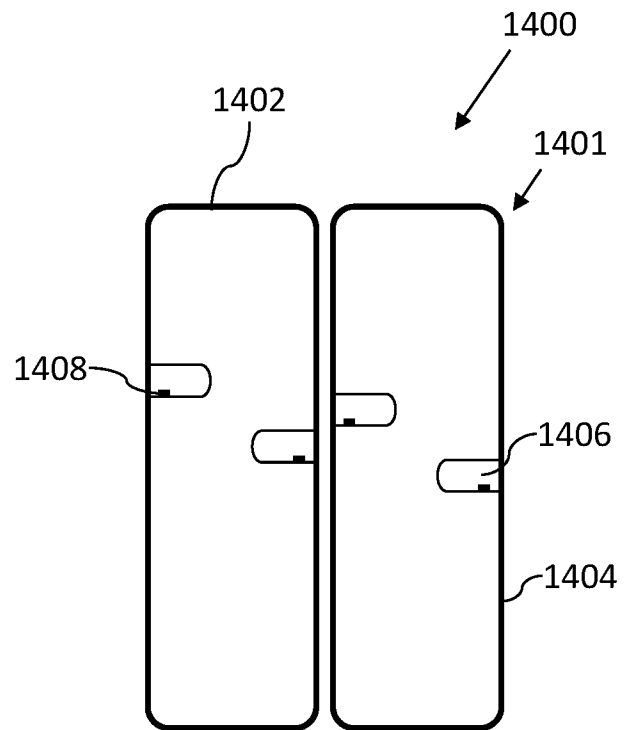


FIG. 14

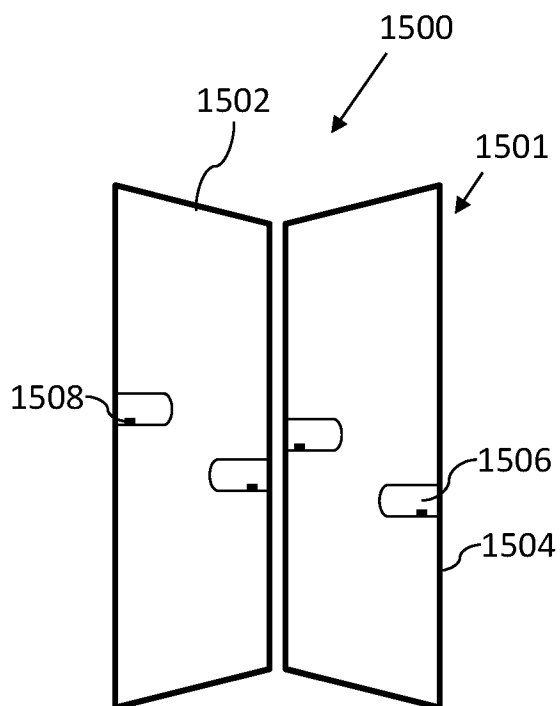


FIG. 15A

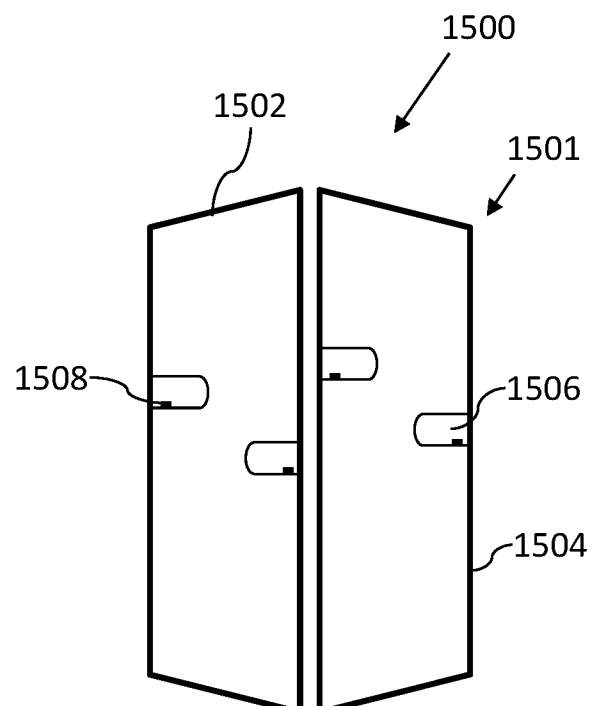


FIG. 15B

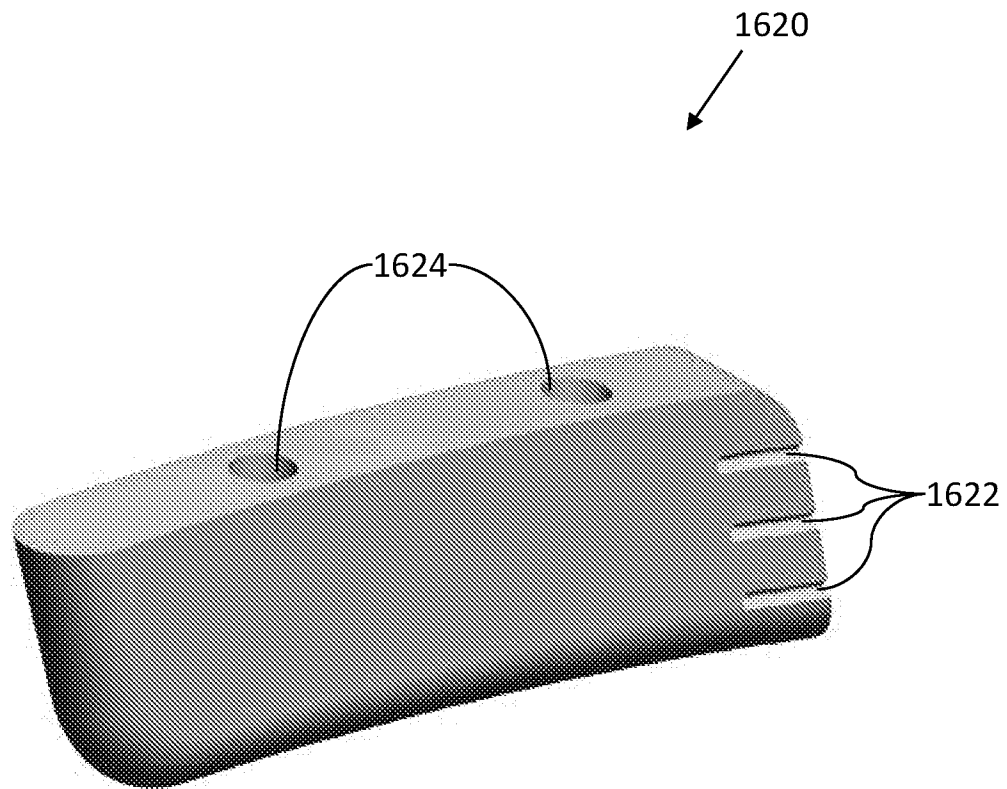


FIG. 16

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2017/026886**A. CLASSIFICATION OF SUBJECT MATTER****B60C 11/24(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 11/24; B60C 11/04; B60C 11/13; B60C 11/12

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:tire, wear, indicator, notch, tread, groove, sidewall

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 2013-147085 A (BRIDGESTONE CORP.) 01 August 2013 See paragraphs [0020]–[0027] and figures 1-2.	1-20
A	JP 2014-133486 A (YOKOHAMA RUBBER CO., LTD.) 24 July 2014 See paragraphs [0009]–[0020] and figure 3.	1-20
A	KR 10-2014-0077307 A (HANKOOK TIRE CO., LTD.) 24 June 2014 See paragraphs [0019]–[0032] and figure 2.	1-20
A	KR 20-1998-0041120 U (SAMSUNG MOTORS INC.) 15 September 1998 See page 2, lines 20-27 and figure 4.	1-20
A	US 2010-0307650 A1 (DE BENEDITTIS et al.) 09 December 2010 See paragraphs [0032]–[0049] and figure 1A.	1-20



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

29 June 2017 (29.06.2017)

Date of mailing of the international search report

03 July 2017 (03.07.2017)

Name and mailing address of the ISA/KR

International Application Division

Korean Intellectual Property Office

189 Cheongsa-ro, Seo-gu, Daejeon, 35208, Republic of Korea



Facsimile No. +82-42-481-8578

Authorized officer

BAE, Geun Tae

Telephone No. +82-42-481-3547



INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2017/026886

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