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(54) **WHEEL THEFT PREVENTION SYSTEM**

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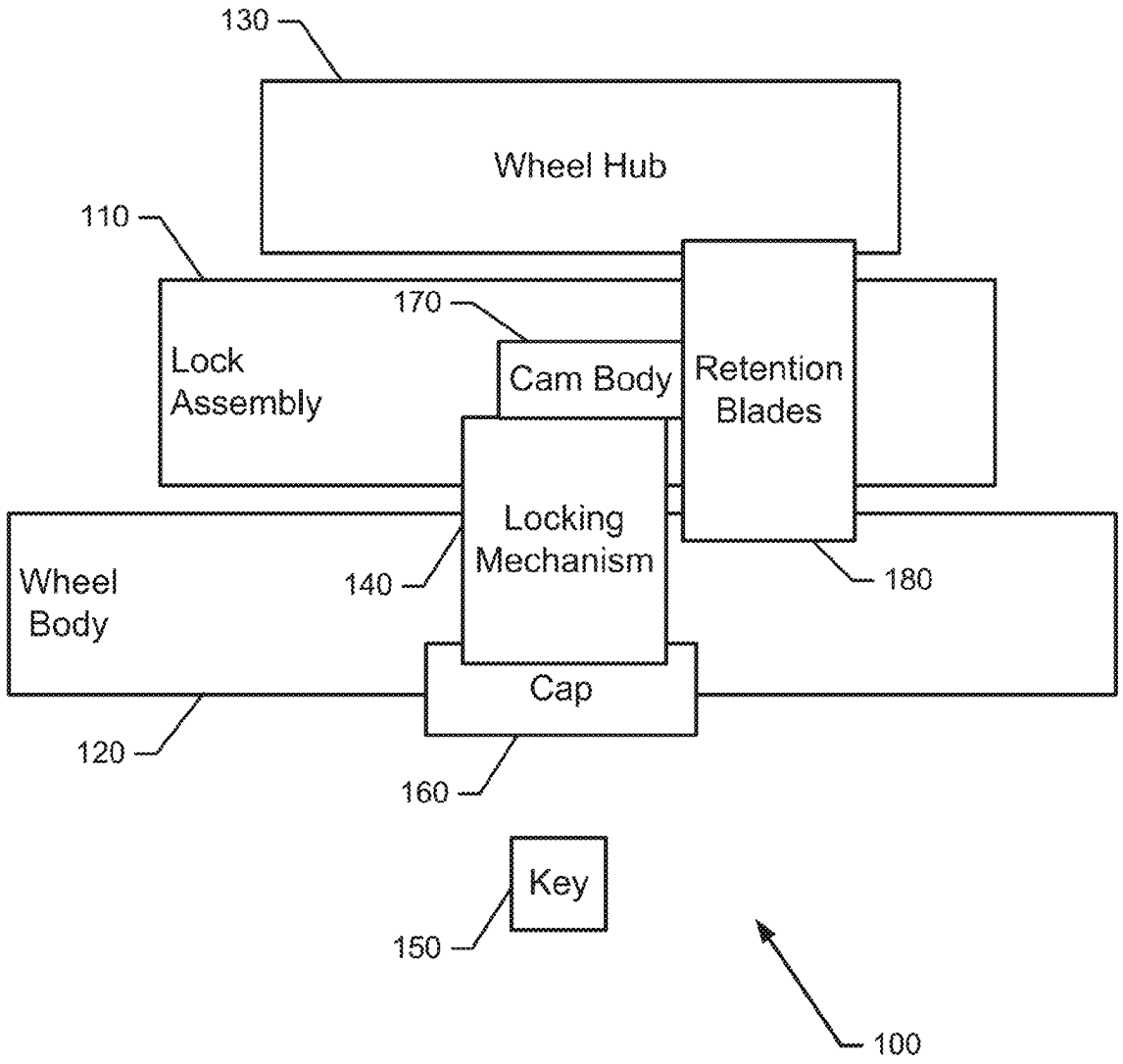
CPC ***B60B 7/16*** (2013.01); ***E05B 81/06*** (2013.01); ***E05B 81/42*** (2013.01); *E05B 2047/0094* (2013.01)

(57) **ABSTRACT**

An anti-theft system for a wheel assembly may include a wheel body having a rim portion on which a tire is mountable and a rotational axis, a wheel hub operably coupled to a shaft or axle of the vehicle and to which the wheel body is mountable, and a lock assembly having a locked state in which the lock assembly engages both the wheel hub and the wheel body to prevent removal of the wheel body from the wheel hub, and having an unlocked state in which at least one of the wheel hub or the wheel body is not engaged by the lock assembly to enable removal of the wheel bod from the wheel hub. The lock assembly may be disposed between the wheel hub and the wheel body and blocked from view by the wheel body.



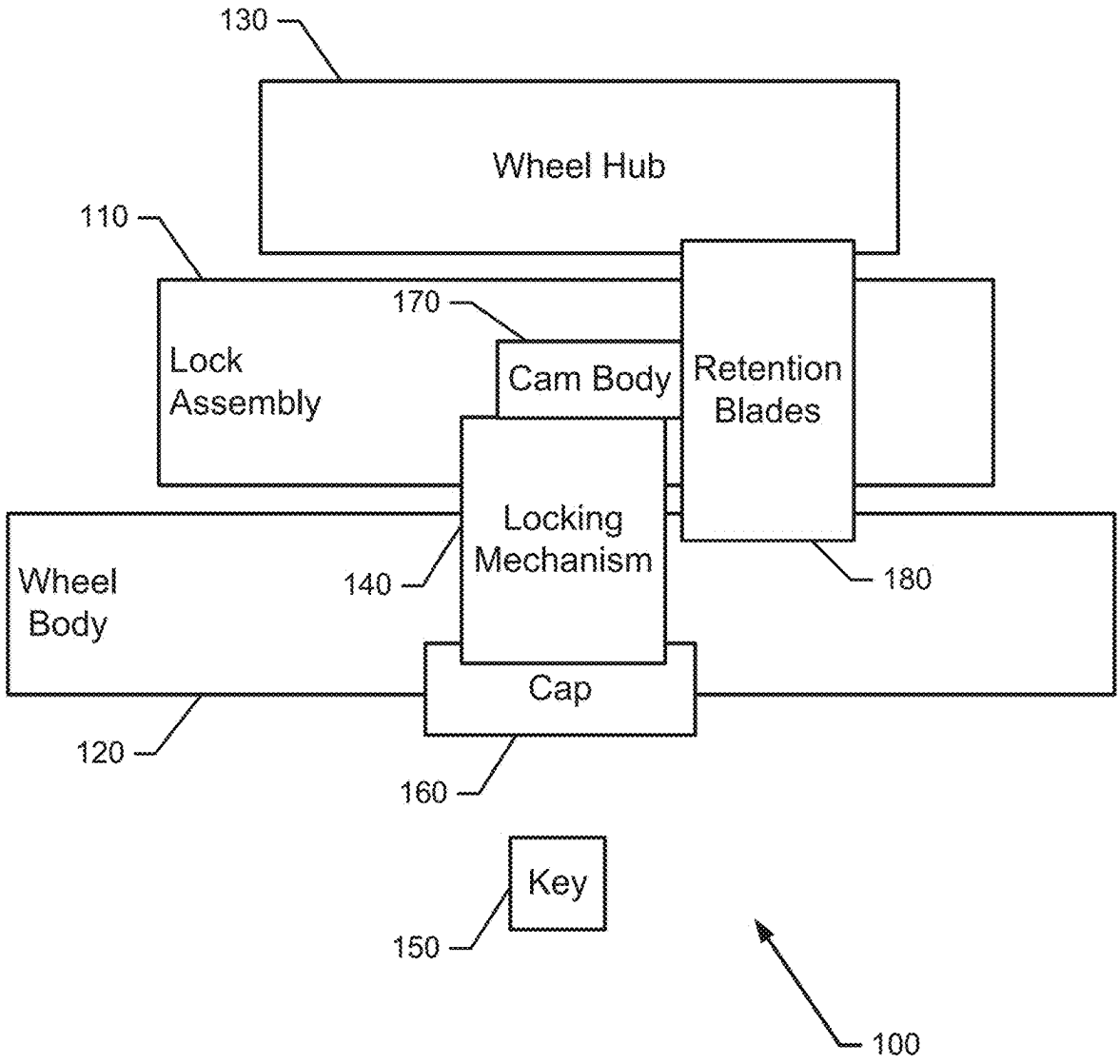

130
Wheel Hub
110
170
Lock
Assembly
Cam Body
Retention
Blades
Locking
Mechanism
Wheel
Body
140
180
Cap
120
160
Key
150
100

FIG. 1

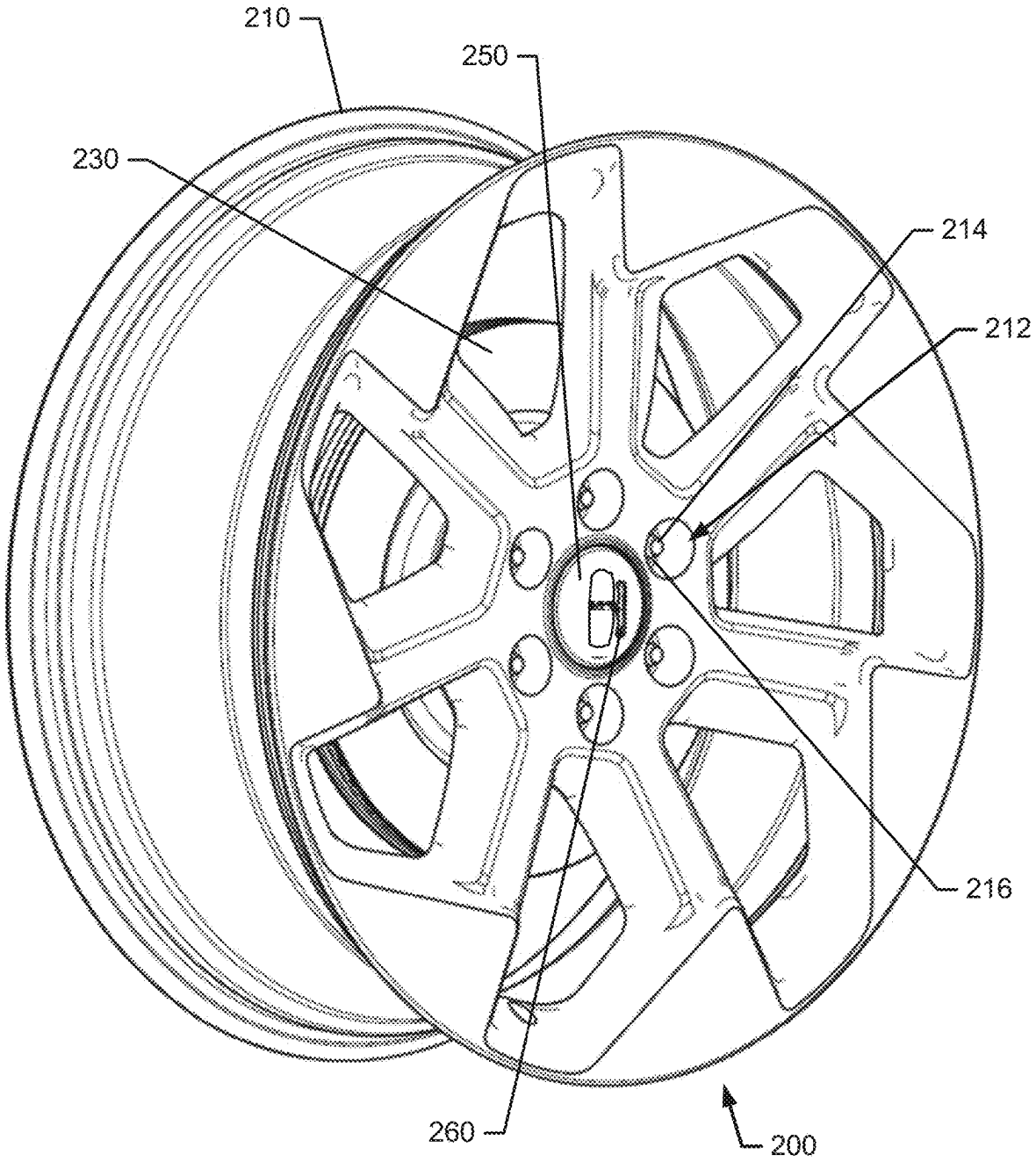


FIG. 2

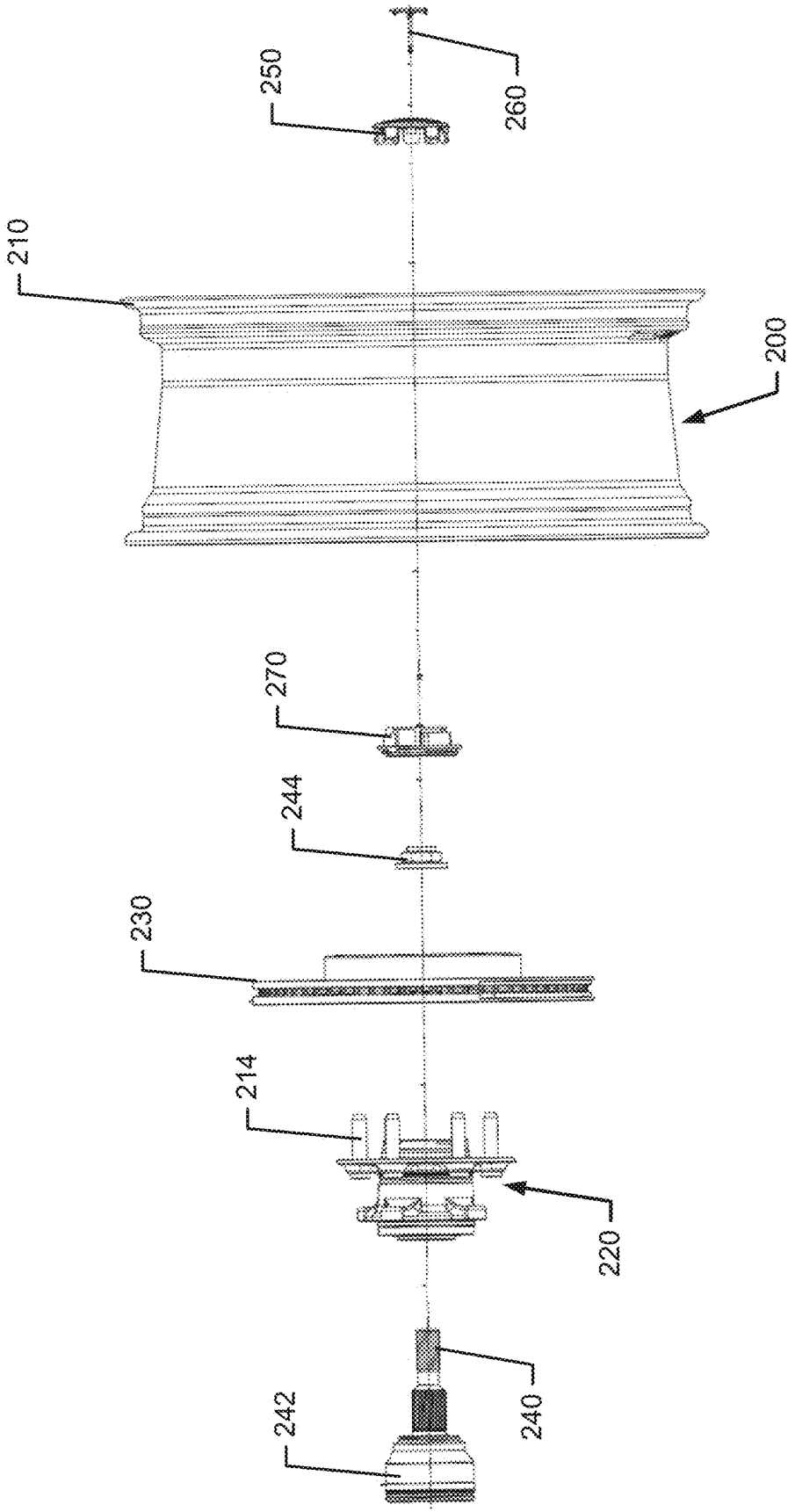


FIG. 3

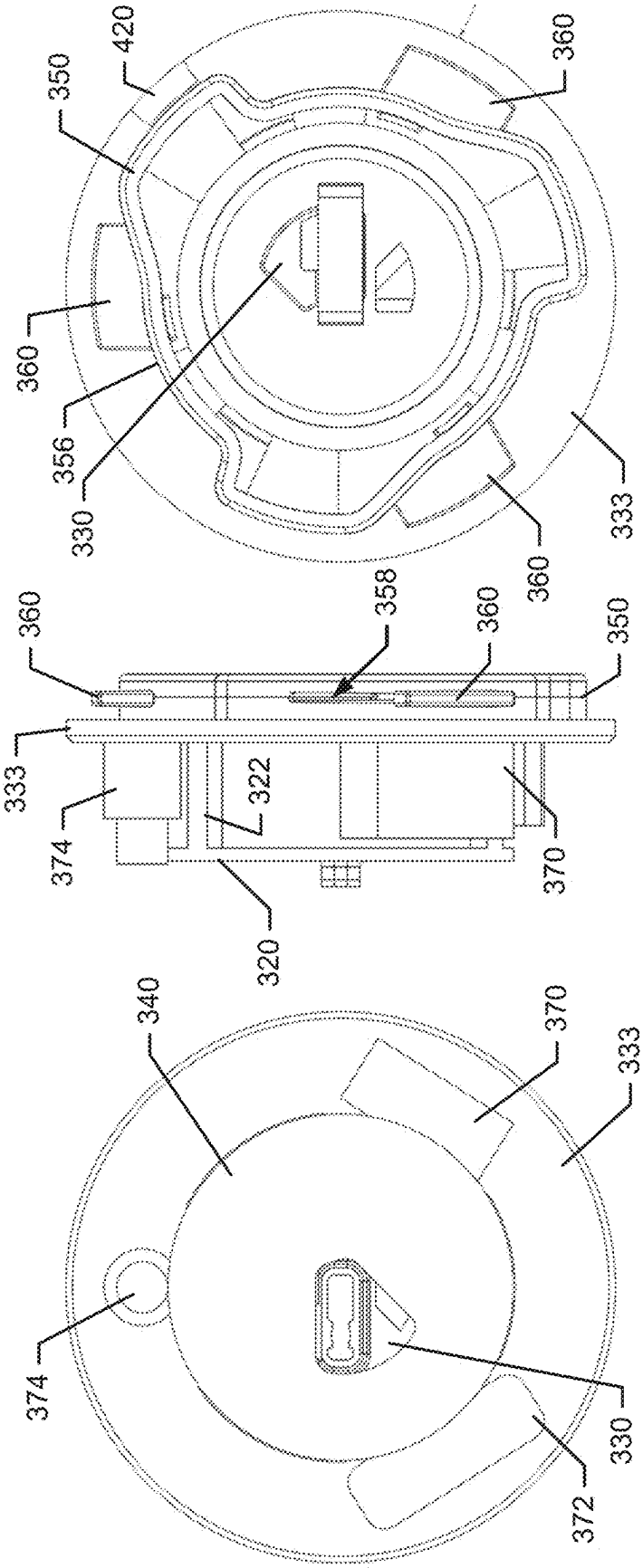


FIG. 4A

FIG. 4B

FIG. 4C

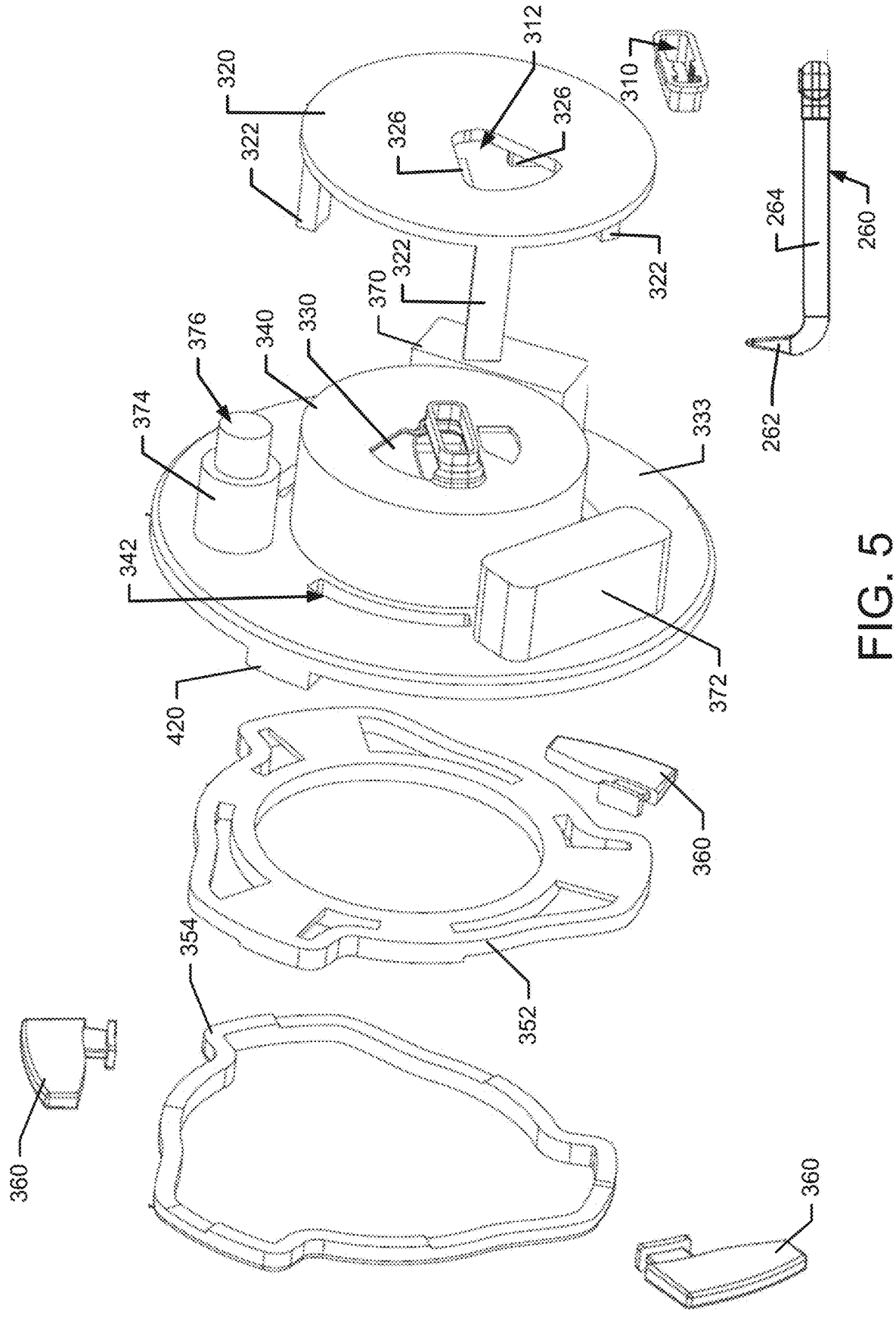
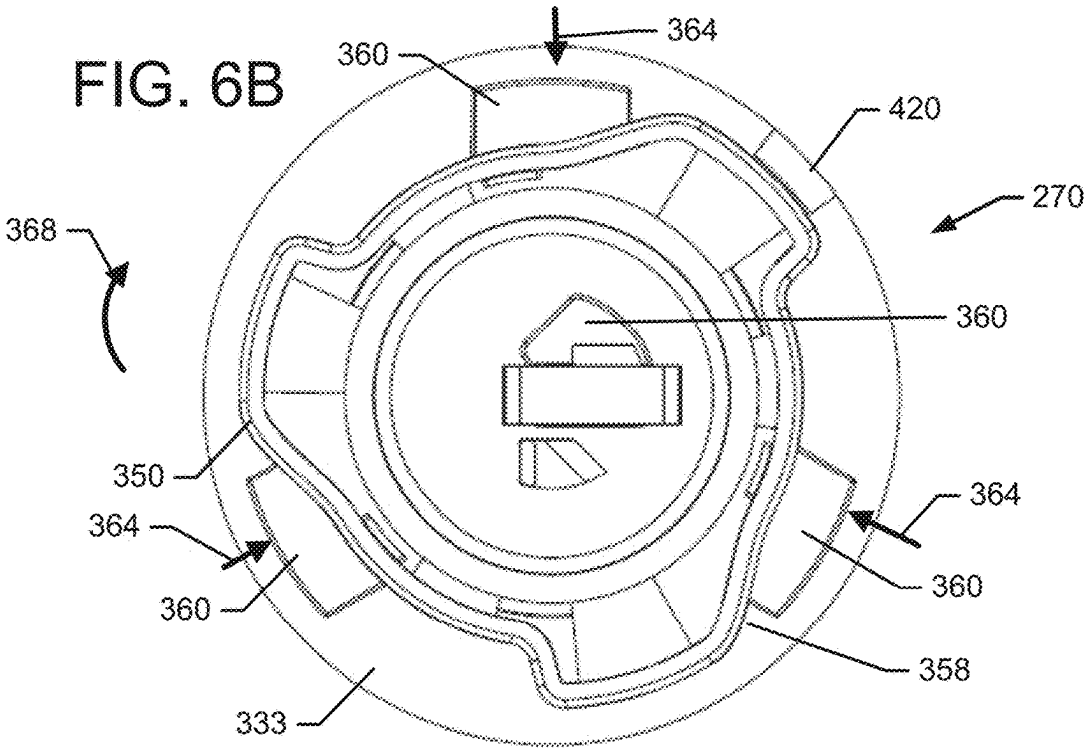

320
322
312
326
326
310
322
370
322
376
340
330
374
333
342
420
372
360
354
352
360
360
264
260
262

FIG. 5

FIG. 6B


364
360
420
270
368
360
350
364
364
360
360
358
333

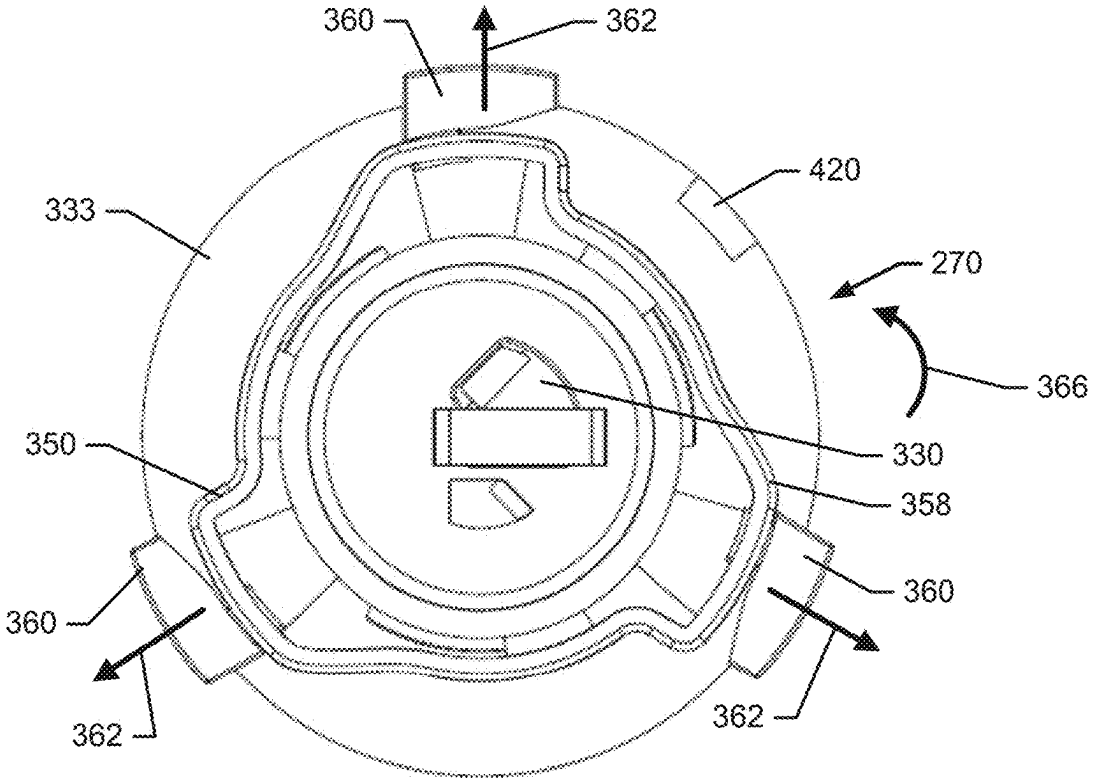
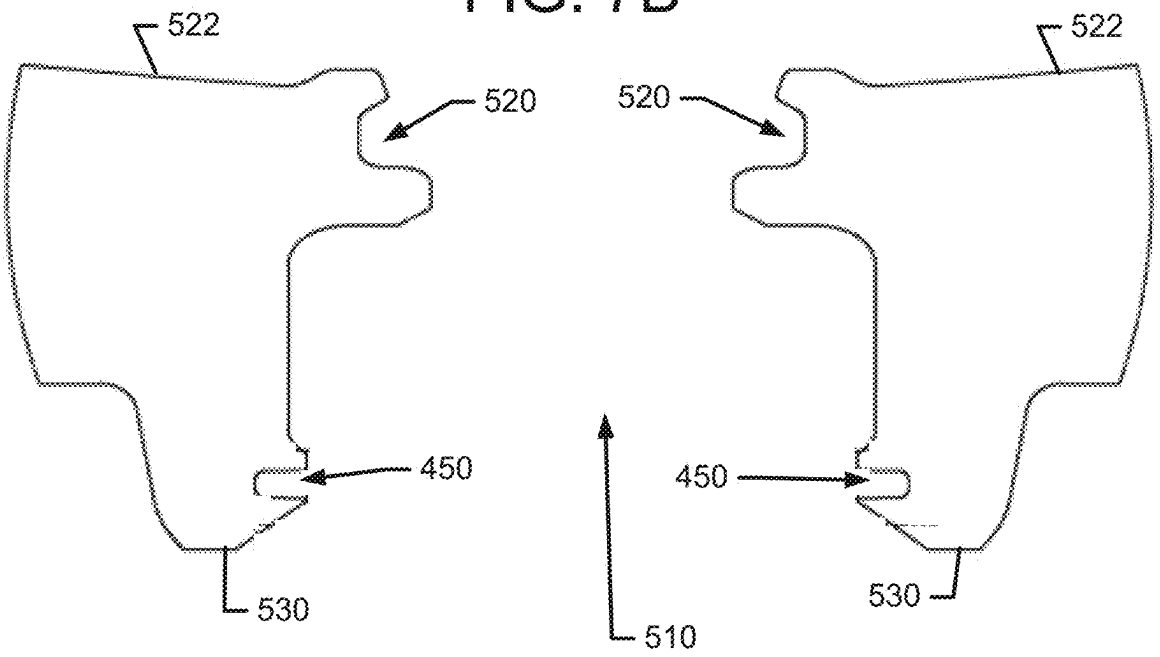

360
362
420
333
270
366
350
330
358
360
360
362
362

FIG. 6A

FIG. 7B



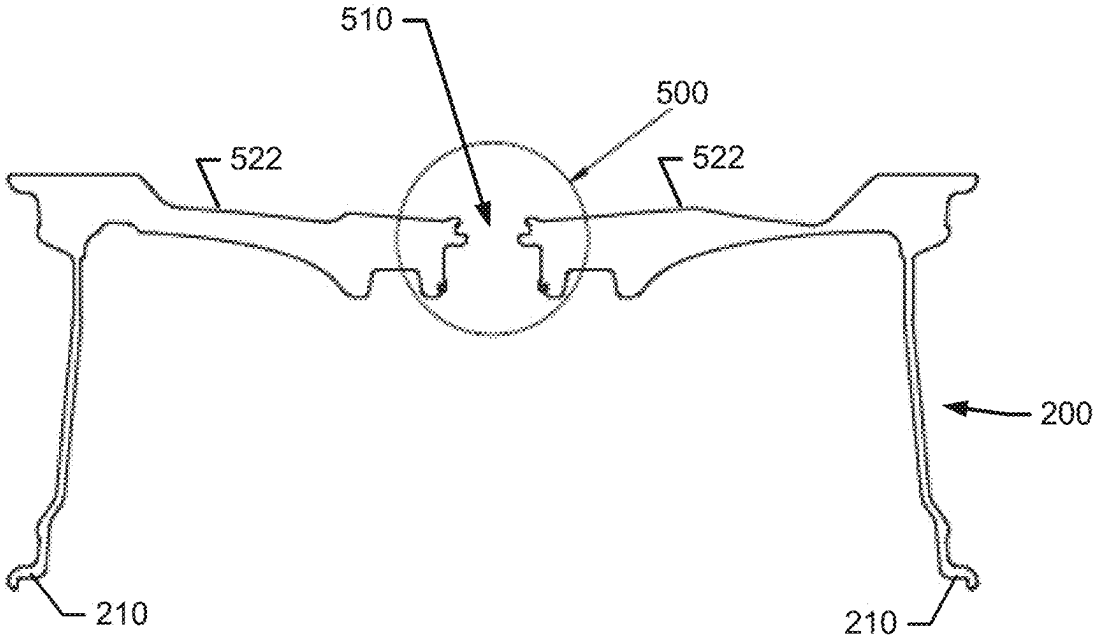


FIG. 7A

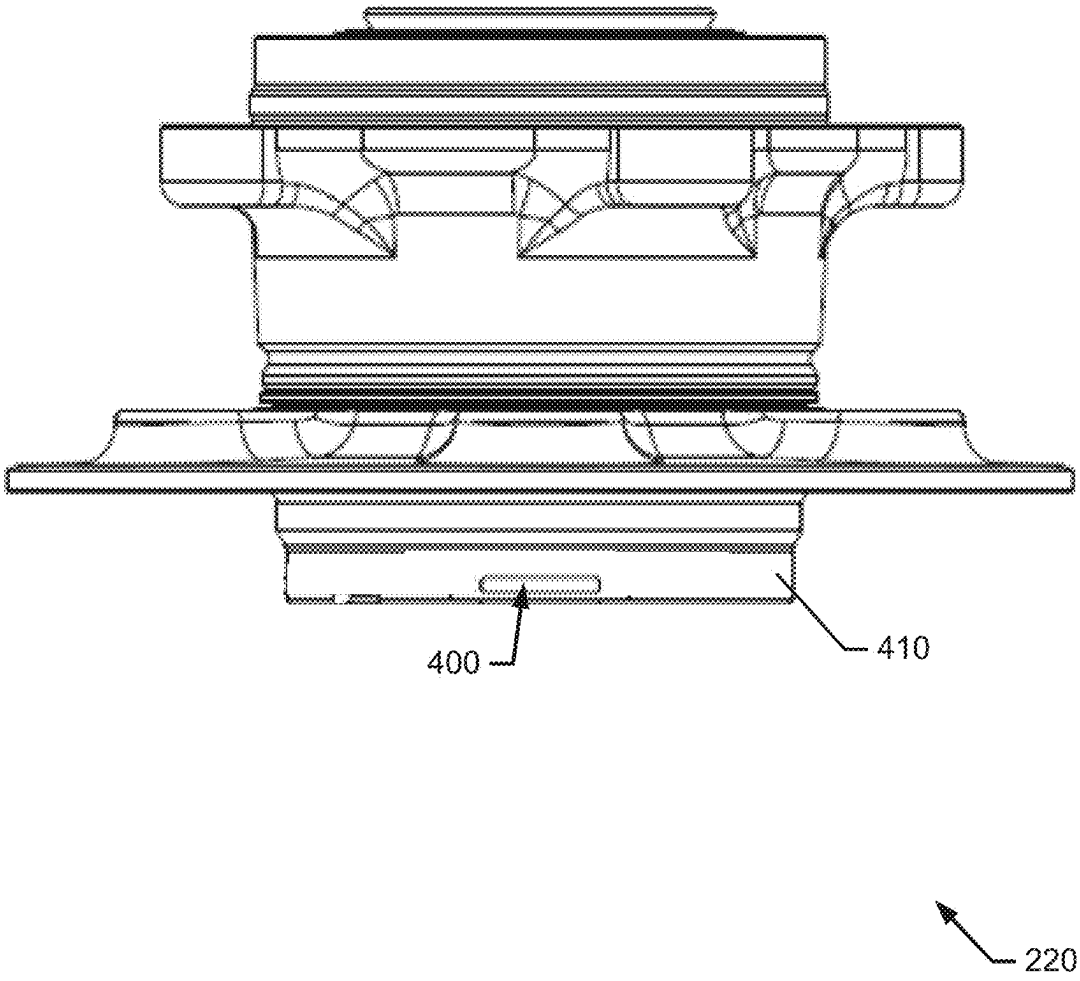


FIG. 8

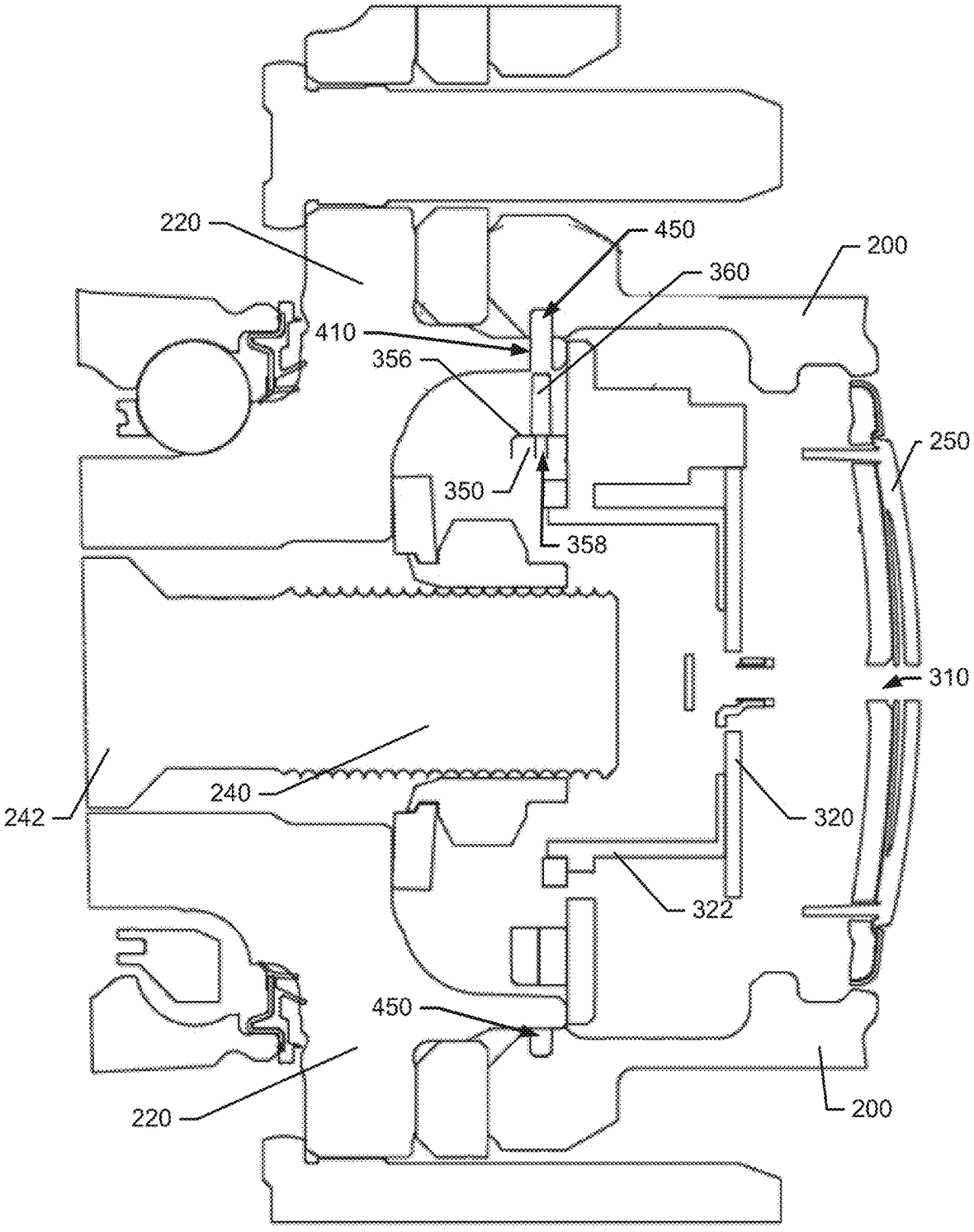

220
450
200
360
410
356
250
350
358
310
240
242
320
322
450
220
200

FIG. 9A

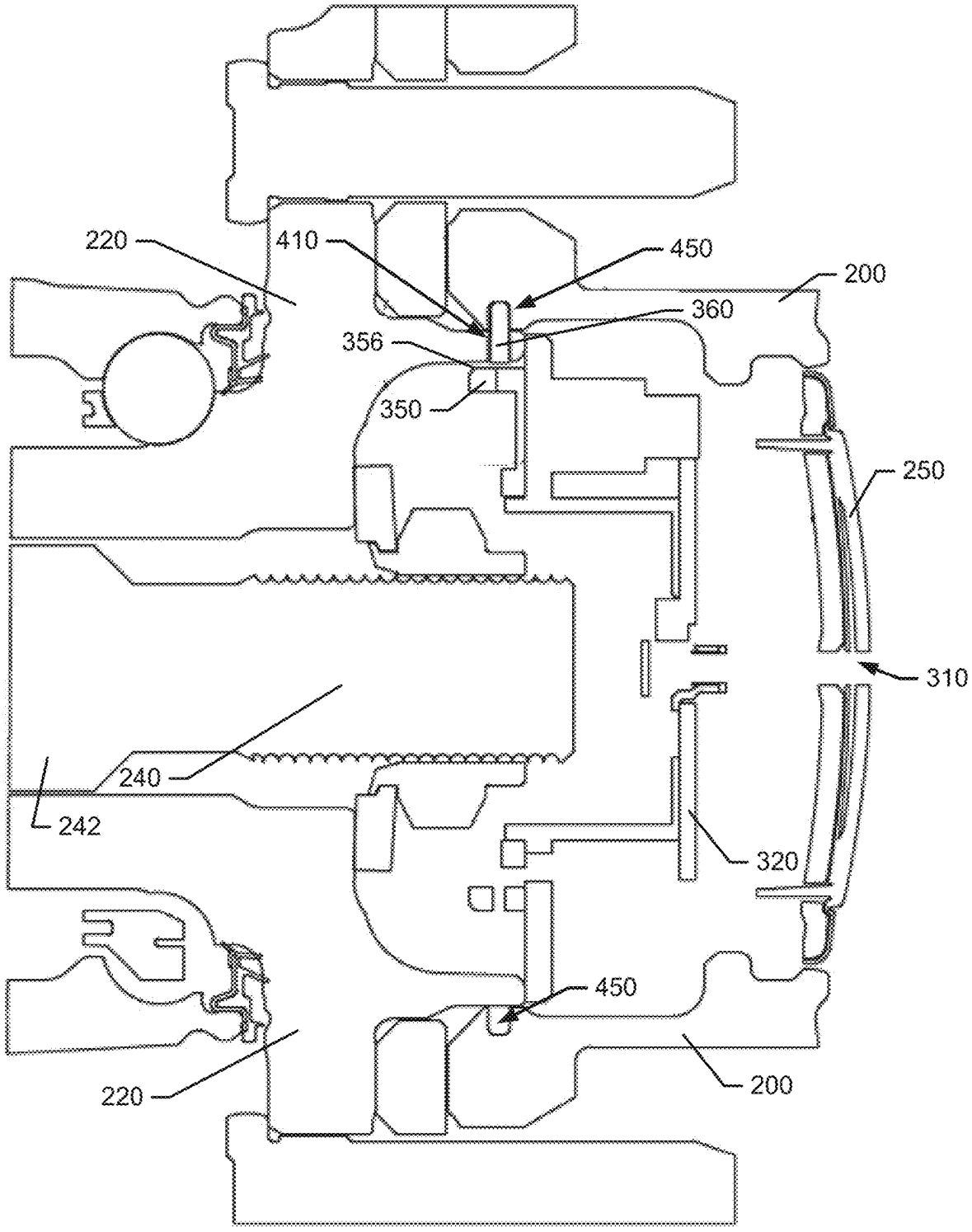


FIG. 9B

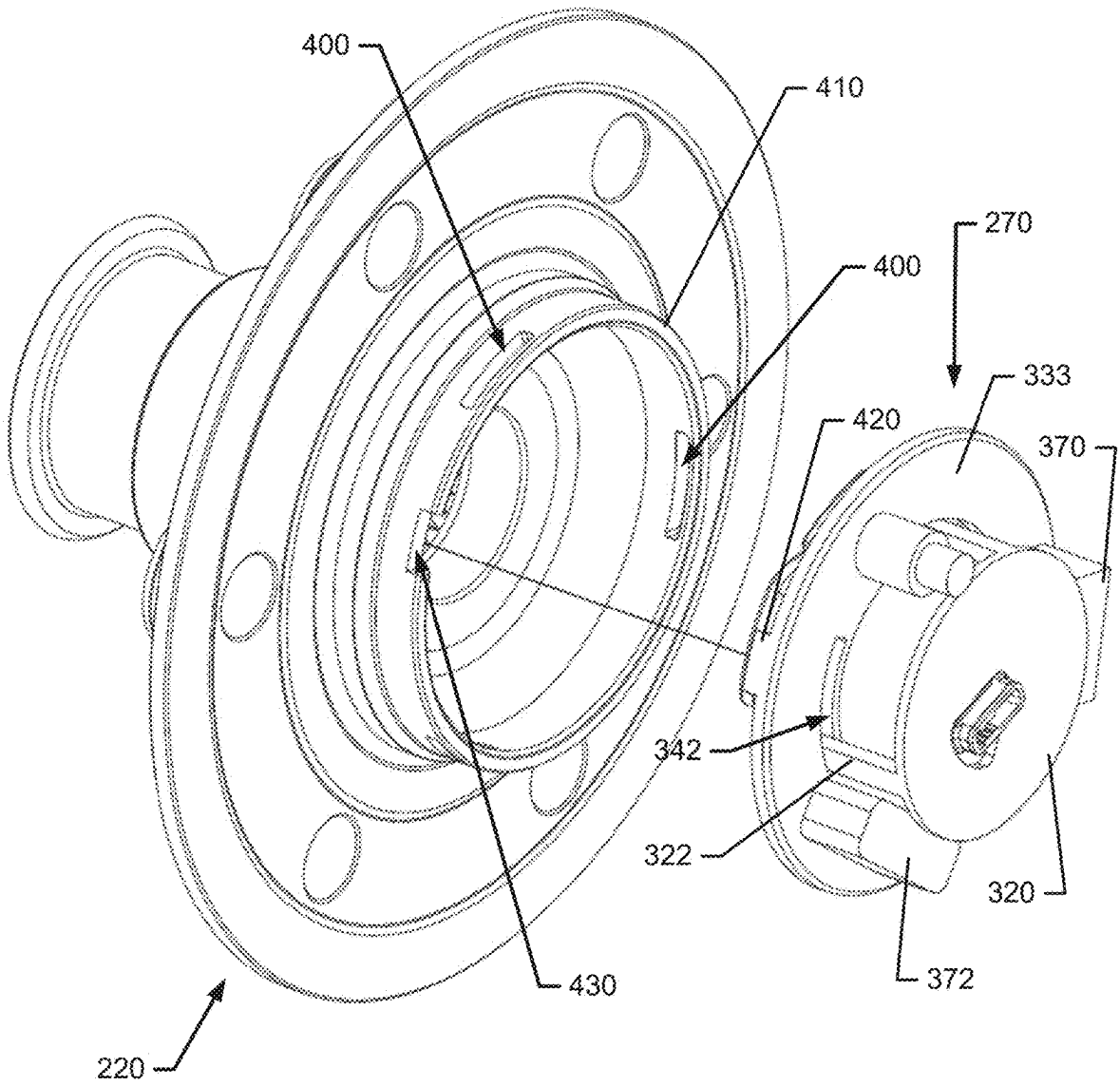


FIG. 10

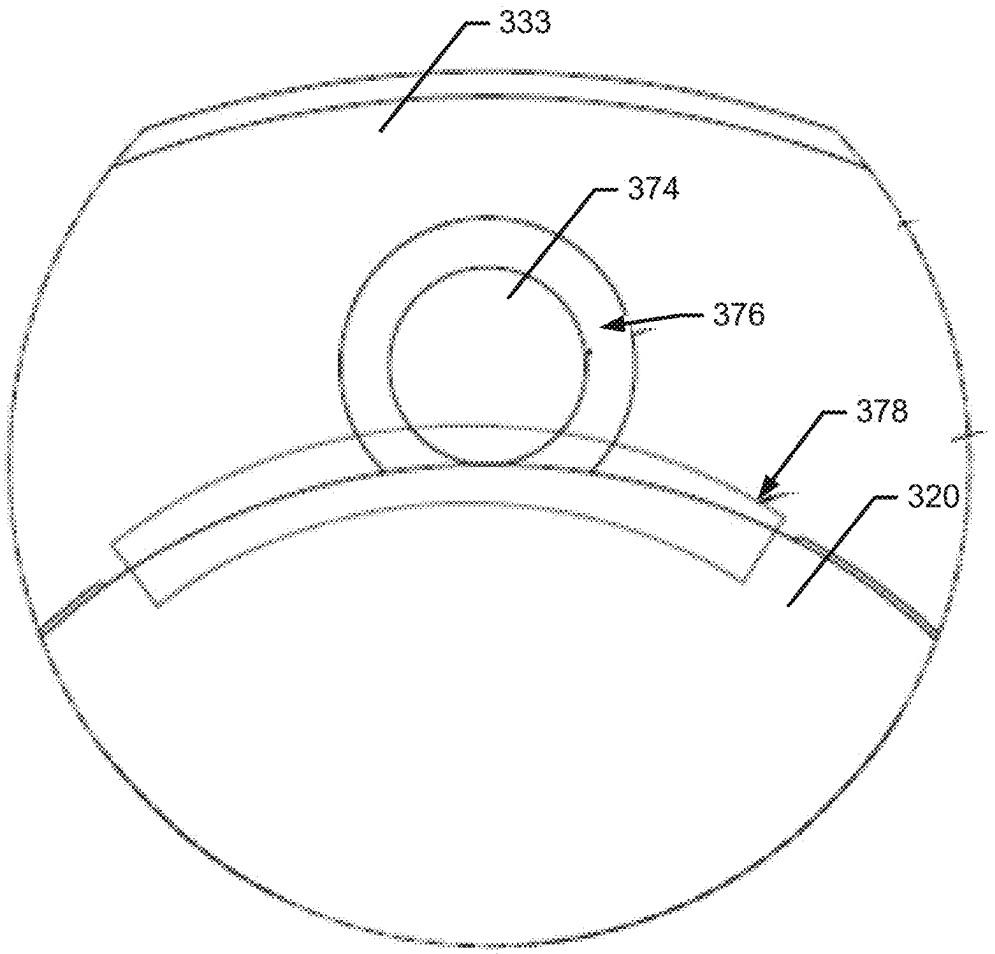


FIG. 11

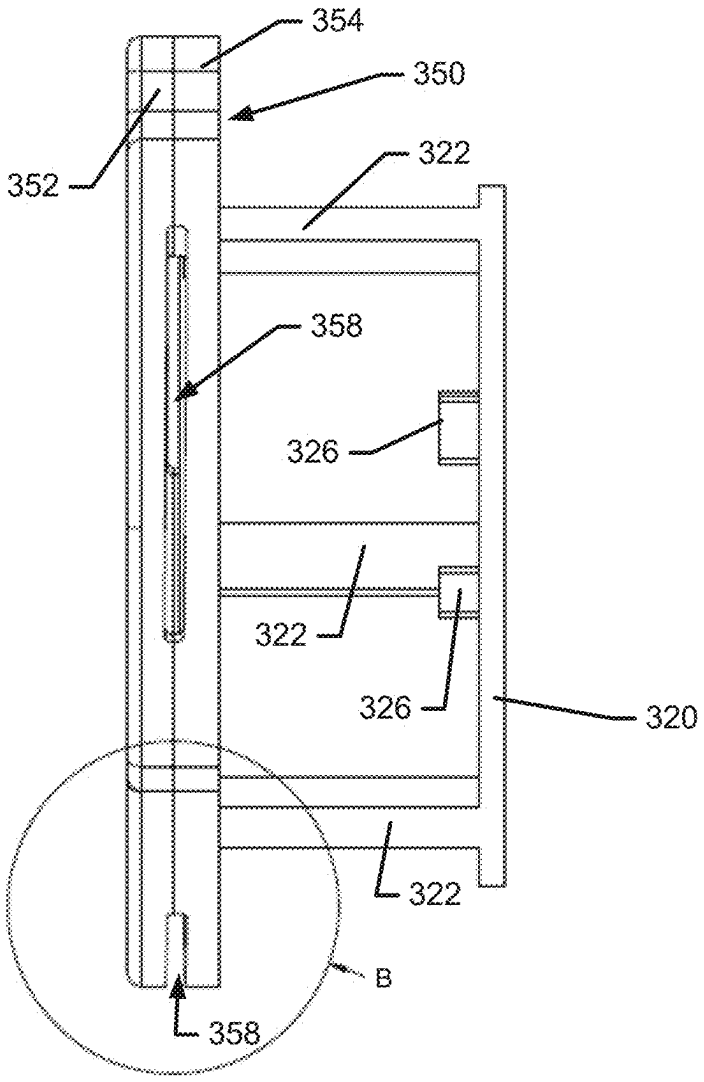


FIG. 12A

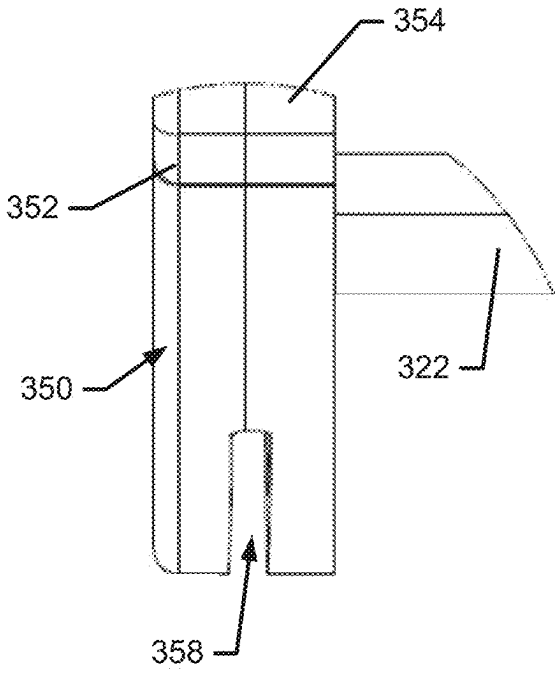


FIG. 12B

WHEEL THEFT PREVENTION SYSTEM

TECHNICAL FIELD

[0001] Example embodiments generally relate to vehicle wheel assemblies and, more particularly, relate to a wheel theft prevention system to prevent the theft of vehicle wheels.

BACKGROUND

[0002] On average, 950 complete sets of wheels are stolen daily in the US. This is generally because lug nuts can be removed and typical anti-theft devices can be forcibly removed from the outside of the wheel.

[0003] Accordingly, it may be desirable to provide an anti-theft design that cannot be accessed from outside the wheel. Moreover, if the design can further not even be visible from outside the wheel, additional security may be provided.

BRIEF SUMMARY OF SOME EXAMPLES

[0004] In accordance with an example embodiment, an anti-theft system for a wheel assembly may be provided. The system may include a wheel body having a rim portion on which a tire is mountable and a rotational axis, a wheel hub operably coupled to a shaft or axle of the vehicle and to which the wheel body is mountable, and a lock assembly having a locked state in which the lock assembly engages both the wheel hub and the wheel body to prevent removal of the wheel body from the wheel hub, and having an unlocked state in which at least one of the wheel hub or the wheel body is not engaged by the lock assembly to enable removal of the wheel bod from the wheel hub. The lock assembly may be disposed between the wheel hub and the wheel body and blocked from view by the wheel body.

[0005] In another example embodiment, a lock assembly for providing an anti-theft function for a wheel assembly of a vehicle that includes a wheel body having a rim portion on which a tire is mountable and a rotational axis and a wheel hub operably coupled to a shaft or axle of the vehicle and to which the wheel body is mountable may be provided. The lock assembly includes a locking mechanism operable to transition the lock assembly between a locked state in which the lock assembly engages both the wheel hub and the wheel body to prevent removal of the wheel body from the wheel hub and an unlocked state in which at least one of the wheel hub or the wheel body is not engaged by the lock assembly to enable removal of the wheel bod from the wheel hub without removal of the wheel body. The lock assembly also includes a hub contact plate that interfaces with the wheel hub, and a carrying plate that interfaces with the locking mechanism to rotate and carry a portion of the lock assembly between the locked and unlocked states responsive to operation of the locking mechanism.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING(S)

[0006] Having thus described the invention in general terms, reference will now be made to the accompanying drawings, which are not necessarily drawn to scale, and wherein:

[0007] FIG. **1** illustrates a block diagram of an anti-theft system for vehicle wheels in accordance with an example embodiment;

[0008] FIG. **2** illustrates a perspective view of a wheel body to which a lock assembly of the anti-theft system may be applied in accordance with an example embodiment;

[0009] FIG. **3** illustrates an exploded view of components of an anti-theft system of vehicle wheels in accordance with an example embodiment;

[0010] FIG. **4**A illustrates a front view of portions of a lock assembly and locking mechanism of an example embodiment;

[0011] FIG. **4**B is a side view of the lock assembly and locking mechanism of FIG. **4**A in accordance with an example embodiment;

[0012] FIG. **4**C illustrates a back view of the lock assembly and locking mechanism of FIG. **4**A in accordance with an example embodiment;

[0013] FIG. **5** illustrates an exploded perspective view of the lock assembly and locking mechanism components in accordance with an example embodiment;

[0014] FIG. **6**A shows an isolated back view of the lock assembly in a locked state in accordance with an example embodiment;

[0015] FIG. **6**B illustrates an isolated back view of the lock assembly in an unlocked state in accordance with an example embodiment;

[0016] FIG. **7**A illustrates a cross sectional view of a wheel body having a highlight region A circled therein in accordance with an example embodiment;

[0017] FIG. **7**B illustrates a cross sectional view of the highlight region A of FIG. **6**A in accordance with an example embodiment;

[0018] FIG. **8** shows a side view of a hub assembly with a retention blade slot formed in a cup portion thereof in accordance with an example embodiment;

[0019] FIG. **9**A is a cross section view of components of the anti-theft system in which the lock assembly is in an unlocked state in accordance with an example embodiment;

[0020] FIG. **9**B is a cross section view of components of the anti-theft system in which the lock assembly is in a locked state in accordance with an example embodiment;

[0021] FIG. **10** is an exploded perspective view of the interface between the wheel hub and the lock assembly in accordance with an example embodiment;

[0022] FIG. **11** is a detailed view of the interface between an electric motor and the carrying plate in accordance with an example embodiment;

[0023] FIG. **12**A is a side view of the carrying plate and cam body in isolation in accordance with an example embodiment;; and

[0024] FIG. **12**B is a side view of a highlighted portion of FIG. **12**A in accordance with an example embodiment.

DETAILED DESCRIPTION

[0025] Some example embodiments now will be described more fully hereinafter with reference to the accompanying drawings, in which some, but not all example embodiments are shown. Indeed, the examples described and pictured herein should not be construed as being limiting as to the scope, applicability or configuration of the present disclosure. Rather, these example embodiments are provided so that this disclosure will satisfy applicable requirements. Like reference numerals refer to like elements throughout. Furthermore, as used herein, the term "or" is to be interpreted as a logical operator that results in true whenever one or more of its operands are true. As used herein, operable

coupling should be understood to relate to direct or indirect connection that, in either case, enables functional interconnection of components that are operably coupled to each other.

[0026] Some example embodiments described herein may enhance the performance of a vehicle wheel anti-theft system by introducing a locking mechanism that is not visible and cannot be accessed without taking of a center cap that is also lockable itself. Such a locking mechanism may provide an effective solution to wheel thefts that allows vehicle owners to be comfortable in the security of their wheels. Not only may the solution give peace of mind to vehicle owners, but proliferation of the solution may discourage potential thieves due to its complex design and hidden location.

[0027] FIG. **1** illustrates a block diagram of a wheel assembly **100** employing a lock assembly **110** of an example embodiment. The wheel assembly **100** may include a wheel body **120** and a wheel hub **130**. The wheel body **120** may include a rim to which tires of the vehicle are operably coupled, and may include retention holes through which lugs pass that operably couple the wheel body **120** to the wheel hub via attachment of lug nuts to the lugs. These lug nuts, even if designed to be so-called anti-theft lug nuts, are typically visible and accessible from outside the wheel body **120** and are therefore typically able to be forced off by thieves. This vulnerability is what the lock assembly **110** aims to address.

[0028] To accomplish this, the lock assembly **110** may be entirely hidden from view behind the wheel body **120**, and may lock the wheel hub **130** to the wheel body **120**. However, the lock assembly **110** may be operable via a locking mechanism **140** either electronically or via an external key **150** that accesses/operates the locking mechanism **140** from outside the wheel body **120**. When operated electronically, an onboard motor may be remotely actuated to operate the locking mechanism **140**. If power is lost, if the onboard motor is otherwise inoperable, or if desired, the key **150** may be used to interact physically with the locking mechanism **140** either through a cap **160** at a center of the wheel body **120** or behind the cap **160**. The cap **160** may otherwise be similar to a normal wheel cap that has branding or other decorative features thereon.

[0029] When the locking mechanism **140** is operated to lock or unlock the lock assembly **110**, some embodiments may employ a cam body **170** that actuates retention blades **180**. When the locking mechanism **140** is locked (or shifted to a locked state), the cam body **170** may rotate to urge the retention blades **180** to extend and engage both the wheel body **120** and the wheel hub **130**. When the locking mechanism **140** is unlocked (or shifted to an unlocked state), the cam body **170** may rotate to draw the retention blades **180** inward such that at least one, and sometimes both, of the wheel body **120** and the wheel hub **130** are no longer engaged by the retention blades **180**. FIGS. **2**-**12**B illustrate some physical examples of structures that may be employed to implement the components discussed generally above in reference to FIG. **1**.

[0030] FIG. **2** illustrates a perspective view of a wheel body **200** (an example of wheel body **120** in FIG. **1**), and FIG. **3** illustrates an exploded view of the wheel body **200** and various other components of, or that interface with, an anti-theft system employing an example implementation of the lock assembly **110** of FIG. **1**. The wheel body **200** includes a rim portion **210** to which a tire may be attached, and a plurality of retention holes **212** through which lugs **214** pass that operably couple the wheel body **200** to a wheel hub and bearing assembly **220** (e.g., an example of the wheel hub **130** of FIG. **1**) via attachment of lug nuts **216** to the lugs **214**. The lugs **214** may also pass through a portion of a brake disc **230** and both the wheel hub and bearing assembly **220** and the brake disc **230** may be secured to the vehicle via a threaded shaft portion **240** of a shaft (or half shaft) of an axle **242**. In this regard, a retention nut **244** may attach to the threaded shaft portion **240** to secure the axle **242** to the wheel hub and bearing assembly **220** and the brake disc **230**.

[0031] FIGS. **2** and **3** also show an example of a cap **250** that may insert into a center portion of the wheel body **200**, and a key **260** that can pass through a keyway or key hole located in the cap **250**. The cap **250** is an example of the cap **160** and the key **260** is an example of the key **150** of FIG. **1**. Meanwhile, the lock assembly **110** of FIG. **1** is exemplified by lock assembly **270** in FIG. **3**. Notably, as can be seen from FIG. **3** (and appreciated from FIG. **2**), when fully assembled, the lock assembly **270** is located behind the wheel body **200** (relative to an external viewer looking at the vehicle from a side view of the vehicle). Thus, visibility of the lock assembly **270** is entirely obscured, and a potential thief would not even know that the protective measure exists. Moreover, the lock assembly **270** is also not physically accessible without the key **260**. As such, whereas the lock assembly **270** may be in either a locked state, or an unlocked state, the potential thief can neither observe the current state, nor determine how to transition between states by virtue of the inability to see and interact with the lock assembly **270**.

[0032] As noted above, in a typical situation, the retention nut **244** may secure the wheel hub and bearing assembly **220** and the brake disc **230**, and the wheel body **200** may be secured to the wheel hub and bearing assembly **220** (with the lock assembly **270** between the wheel hub and bearing assembly **220** and the wheel body **200**) via the lug nuts **216**. Whereas the lug nuts **216** can be removed, if the lock assembly **270** is in the locked state, the wheel body **200** may remain secured to the wheel hub and bearing assembly **220** via the lock assembly **270**. In this regard, the lock assembly **270** may include a locking mechanism **300** shown at least in part in FIGS. **4**A, **4**B, **4**C, **5**, **6**A and **6**B, which facilitate transferring the lock assembly **270** between the locked and unlocked states.

[0033] In the locked state, the lock assembly **270** may engage both the wheel hub and bearing assembly **220** and the wheel body **200** to prevent removal of the wheel body **200** from the wheel hub and bearing assembly **220**. In the unlocked state, the lock assembly **270** may release one or both of the wheel hub and bearing assembly **220** and the wheel body **200**. Thus, for example, at least one of the wheel hub and bearing assembly **220** and the wheel body **200** is not engaged by the lock assembly in the unlocked state to enable removal of the wheel body **200** from the wheel hub and bearing assembly **220**. Moreover, the transition between this enablement or disablement for wheel body **200** removal is itself accomplished without removal of the wheel body **200** (to provide visibility and physical access to the lock assembly **270**.

[0034] The lock assembly **270** may be physically structured in various different ways to perform the functions described above. One such example structure is shown in

FIGS. **4**A-**6**B. Referring now to FIGS. **4**A to **6**B, the lock assembly **270** may include the locking mechanism **300** that transfers the lock assembly **270** between the locked and unlocked states. The locking mechanism **300** may be operable via the key **260** passing through keyway **310** formed in the cap **250**. The key **260** (a side view of which is shown in FIG. **5**) may also have an actuating portion **262** that extends substantially perpendicularly away from a shaft portion **264**. The keyway **310** may be shaped to have an opening complementary to the shape of the actuating portion **262** of the key **260**. Thus, a device other than the key **260**, or shaped differently than the key **260**, may not pass through the keyway **310**.

[0035] The actuating portion **262**, when inserted through the keyway **310**, may then pass through a key slot **312** formed in a carrying plate **320** of the lock assembly **270**. After passing through the key slot **312**, the key **260** may engage a rotary lock body **330** disposed in a main body **340** of the lock assembly **270**. The main body **340** may house the rotary lock body **330**, which may rotate responsive to turning the key **260** (based on urging of the actuating portion **262** responsive to twisting or rotating the shaft portion **264**). The rotary lock body **330** may in turn be operably coupled to the carrying plate **320** via protrusions **326** on the carrying plate **320** that interface with the rotary lock body **330**. Thus, when the rotary lock body **330** rotates, the carrying plate **320** also rotates.

[0036] The carrying plate **320** may include legs **322** that extend through respective rotary slots **342** formed in the main body **340** radially outward of the rotary lock body **330**. The legs **322** may engage a cam body **350** disposed on an opposite side of the main body **340** relative to the carrying plate **320**. The cam body **350** may include a first cam body portion **352** and a second cam body portion **354** that are joined together to form the cam body **350**. The first and second cam body portions **352** and **354** may be generally complementary to each other in relation to shapes of their respective peripheral edges. However, each of the first and second cam body portions **352** and **354** may have gaps therebetween at respective camming surfaces **356**. The gaps may form blade sliding slots **358** inside which retention blades **360** may be slidably retained. The retention blades **360** may be fixed in their angular positions relative to a rotational axis of the cam body **350** and the rotary lock body **330**, but may be enabled to slide within the blade sliding slots **358** along the respective camming surfaces **356** to either extend the retention blades **360** radially outward (as shown by arrow **362** in FIG. **6**A) or withdraw the retention blades **360** radially inward (as shown by arrow **364** in FIG. **6**B) depending on which way the rotary lock body **330** and the carrying plate **320** rotate. In an example embodiment, the rotary lock body **330** may be rotated in a first direction shown by arrow **366** to transition from the unlocked state of FIG. **6**B to the locked state of FIG. **6**A. Conversely, the rotary lock body **330** may rotate in a second direction shown by arrow **368** to transition from the locked state of FIG. **6**A to the unlocked state of FIG. **6**B.

[0037] Notably, although the rotary lock body **330** may rotate responsive to turning of the key **260** as described above, an automated or wirelessly actuated operation of the locking mechanism **300** may also or alternatively be provided. In this regard, for example, the main body **340** of some example embodiments may further house a battery **370** (or other local power source), a wireless communication module **372**, and an electric motor **374** (e.g., a servo motor). The wireless communication module **372** and the electric motor **374** may each be powered by the battery **370**. Moreover, the wireless communication module **372** may be configured to receive a wireless trigger signal communicated external to the lock assembly **270** and/or locking mechanism **300**, and actuate the electric motor **374**. The electric motor **374** may turn and, via a gear assembly interface with the carrying plate **320**, cause the carrying plate **320** to also turn. In some cases (as shown in FIG. **11**), an external periphery of a portion of the electric motor **374** may include a lead gear **376** that interfaces with a corresponding spur gear **378** formed at a peripheral edge of the carrying plate **320**. Turning of the electric motor **374** may then turn the lead gear **376**, which turns the spur gear **378** and rotates the carrying plate **320**.

[0038] In an example embodiment, each individual one of the retention blades **360** may be aligned with a respective corresponding one of a set of first retention blade slots **400** formed in a portion of the wheel hub and bearing assembly **220**. In this regard, for example, the lock assembly **270** may be shaped to fit or nest within a cup portion **410** of the wheel hub and bearing assembly **220**. In an example embodiment, three separate instances of the retention blades **360** may be provided as part of the lock assembly **270**, and the retention blades **360** may be separated from each other angularly by 120 degrees. The first retention slots **400** may be separated from each other also by 120 degrees to permit alignment with the retention blades **360**. Moreover, a portion of the main body **340** (e.g., a hub contact plate **333**) may include a locating protrusion **420** that may be aligned with a locating slot **430** formed at a distal end of the cup portion **410** of the wheel hub and bearing assembly **220**. When the locating protrusion **420** is received in the locating slot **430**, the retention blades **360** may be aligned with (and in some cases inserted into) the first retention blade slots **400**.

[0039] Rotation of the cam body **350** (responsive to rotation of the carrying plate **320** either via the key **260** or wireless triggering and operation of the electric motor **374**) in one direction may drive the retention blades **360** outward via the camming surface **356** pushing the retention blades **360** outward through the first retention blade slots **400** and into a corresponding set of second retention blade slots **450** formed at a portion of the wheel body **200** as shown in FIGS. **7**A and **7**B to transition the lock assembly **270** to the locked state. Rotation in the opposite direction, withdraws the retention blades **360** to transition the lock assembly **270** to the unlocked state. FIG. **7**B shows the wheel body **200** in cross section along a plane passing through the axis of rotation of the wheel body **200**. A center portion **500** of the wheel body **200** is highlighted by a circle in FIG. **7**A, and shown in greater detail in FIG. **7**B.

[0040] An axial passage **510** may extend axially through the wheel body **200**, and may include a cap retention slot **520** at an exterior side **522** of the wheel body **200** annularly extending around the axial passage **510**. The cap **250** may be received and retained in the cap retention slot **520**. The axial passage **510** may be further bounded by additional reinforcing material (e.g., metal) to form a solid core or hub for the wheel body **200**. As this additional reinforcing material extends inwardly away from the exterior side **522** of the wheel body **200** it may reach a distal end **530**. Proximate to the distal end **530**, the second retention blade slots **450** may be formed in the wheel body **200** in alignment with the first

retention blade slots **400**. However, it should be noted that the second retention blade slots **450** may, in some cases, be formed as a single continuous slot that extends entirely around the wheel body **200** instead of being discretely located proximate to the first retention blade slots **400**. FIG. **8** shows a side view of the wheel hub and bearing assembly **220** with lugs **214** removed, to particularly show the location of one instance of the first retention blade slots **400** in the cup portion **410**.

[0041] Turning now to FIGS. **9**A and **9**B, cross section views of the entire system in an assembled condition are shown in both the unlocked state (FIG. **9**A) and the locked state (FIG. **9**B). In this regard, in FIG. **9**A, the cam body **350** can be seen with one instance of the retention blades **360** riding in its corresponding instance of the blade sliding slots **358** along the camming surface **356**. In the unlocked state, the retention blade **360** is actually neither inside the first retention blade slot **400** formed in the cup portion **410** of the wheel hub and bearing assembly **220**, nor inside the second retention blade slot **450** formed proximate the distal end **530** of the wheel body **200**. However, when the locking mechanism **300** is operated to transition the lock assembly **270** to the locked state, then the cam body **350** is rotated to the position of FIG. **9**B, and the retention blade **360** rides in the blade sliding slot **358** along the camming surface **356** to extend the retention blade **360** into both the first retention blade slot **400** formed in the cup portion **410** of the wheel hub and bearing assembly **220**, and the second retention blade slot **450** formed proximate the distal end **530** of the wheel body **200** as shown in FIG. **9**B.

[0042] A lock assembly for providing an anti-theft function for a wheel assembly of a vehicle that includes a wheel body having a rim portion on which a tire is mountable and a rotational axis and a wheel hub operably coupled to a shaft or axle of the vehicle and to which the wheel body is mountable may therefore be provided. The lock assembly includes a locking mechanism operable to transition the lock assembly between a locked state in which the lock assembly engages both the wheel hub and the wheel body to prevent removal of the wheel body from the wheel hub and an unlocked state in which at least one of the wheel hub or the wheel body is not engaged by the lock assembly to enable removal of the wheel bod from the wheel hub without removal of the wheel body. The lock assembly also includes a hub contact plate that interfaces with the wheel hub, and a carrying plate that interfaces with the locking mechanism to rotate and carry a portion of the lock assembly between the locked and unlocked states responsive to operation of the locking mechanism.

[0043] The lock assembly (or an anti-theft system including the same) of some embodiments may include additional features, modifications, augmentations and/or the like to achieve further objectives or enhance performance of the device. The additional features, modifications, augmentations and/or the like may be added in any combination with each other. Below is a list of various additional features, modifications, and augmentations that can each be added individually or in any combination with each other. For example, the lock assembly may be disposed between the wheel hub and the wheel body and blocked from view by the wheel body. In an example embodiment, the locking mechanism may be operable via a remote trigger signal actuating the locking mechanism. Alternatively or additionally, the locking mechanism may be operable via a key passing through a keyway formed in a cap disposed at the rotational axis of the wheel body. In some cases, the lock assembly may further include a cam body operably coupled to the carrying plate to move responsive to movement of the carrying plate and one or more instances of a retention blade. The retention blade may extend radially outwardly from the rotational axis responsive to the carrying plate rotating cam body in a first direction to transition to the locked state. The retention blade may also withdraw radially inwardly with respect to the rotational axis responsive to rotation of the cam body in a second direction to transition to the unlocked state. In an example embodiment, the wheel hub may include a first retention blade slot, and the wheel body may include a second retention blade slot aligned with the first retention blade slot to receive the retention blade in both the first and second retention blade slots when the lock assembly is in the locked state. In some cases, the lock assembly may include a locating protrusion and the wheel hub comprises a locating slot disposed at a distal end of a cup portion of the wheel hub, and the lock assembly may be nested inside the cup portion with the locating protrusion received in the locating slot to align the retention blade with both the first and second retention blade slots. In an example embodiment, the cam body may include a blade sliding slot formed in a peripheral portion of a camming surface, and the retention blade may slide through the blade sliding slot along the camming surface to transition into and out of engagement with the wheel hub and the wheel body responsive to rotation of the cam body in the first and second directions, respectively. In some cases, the one or more instances of the retention blade may include a set of three retention blades, and the set of three retention blades may be separated from each other by about 120 degrees around a periphery of the cam body. In an example embodiment, the locking mechanism may be operable via a remote trigger signal to rotate the cam body via an electric motor, and, responsive to a loss of power to the electric motor, or inoperability of the electric motor, an operator of the vehicle may be notified to operate the locking mechanism via a key passing through a keyway formed in a cap disposed at the rotational axis of the wheel body.

[0044] Many modifications and other embodiments of the inventions set forth herein will come to mind to one skilled in the art to which these inventions pertain having the benefit of the teachings presented in the foregoing descriptions and the associated drawings. Therefore, it is to be understood that the inventions are not to be limited to the specific embodiments disclosed and that modifications and other embodiments are intended to be included within the scope of the appended claims. Moreover, although the foregoing descriptions and the associated drawings describe exemplary embodiments in the context of certain exemplary combinations of elements and/or functions, it should be appreciated that different combinations of elements and/or functions may be provided by alternative embodiments without departing from the scope of the appended claims. In this regard, for example, different combinations of elements and/or functions than those explicitly described above are also contemplated as may be set forth in some of the appended claims. In cases where advantages, benefits or solutions to problems are described herein, it should be appreciated that such advantages, benefits and/or solutions may be applicable to some example embodiments, but not necessarily all example embodiments. Thus, any advan-

tages, benefits or solutions described herein should not be thought of as being critical, required or essential to all embodiments or to that which is claimed herein. Although specific terms are employed herein, they are used in a generic and descriptive sense only and not for purposes of limitation.

What is claimed:

1. An anti-theft system for a wheel assembly, the system comprising:

a wheel body having a rim portion on which a tire is mountable and a rotational axis;

a wheel hub operably coupled to a shaft or axle of the vehicle and to which the wheel body is mountable; and

a lock assembly having a locked state in which the lock assembly engages both the wheel hub and the wheel body to prevent removal of the wheel body from the wheel hub, and having an unlocked state in which at least one of the wheel hub or the wheel body is not engaged by the lock assembly to enable removal of the wheel body from the wheel hub,

wherein the lock assembly is disposed between the wheel hub and the wheel body and blocked from view by the wheel body.

2. The system of claim **1**, wherein the lock assembly comprises a locking mechanism operable to transition the lock assembly between the locked state and the unlocked state without removal of the wheel body.

3. The system of claim **2**, wherein the locking mechanism is operable via a remote trigger signal actuating the locking mechanism.

4. The system of claim **2**, wherein the locking mechanism is operable via a key passing through a keyway formed in a cap disposed at the rotational axis of the wheel body.

5. The system of claim **2**, wherein the lock assembly comprises a cam body and one or more instances of a retention blade,

wherein the retention blade extends radially outwardly from the rotational axis responsive to rotation of the cam body in a first direction to transition to the locked state, and

wherein the retention blade withdraws radially inwardly with respect to the rotational axis responsive to rotation of the cam body in a second direction to transition to the unlocked state.

6. The system of claim **5**, wherein the wheel hub comprises a first retention blade slot, and the wheel body comprises a second retention blade slot aligned with the first retention blade slot to receive the retention blade in both the first and second retention blade slots when the lock assembly is in the locked state.

7. The system of claim **6**, wherein the lock assembly comprises a locating protrusion and the wheel hub comprises a locating slot disposed at a distal end of a cup portion of the wheel hub, and

wherein the lock assembly is nested inside the cup portion with the locating protrusion received in the locating slot to align the retention blade with both the first and second retention blade slots.

8. The system of claim **5**, wherein the cam body includes a blade sliding slot formed in a peripheral portion of a camming surface, and

wherein the retention blade slides through the blade sliding slot along the camming surface to transition into and out of engagement with the wheel hub and the wheel body responsive to rotation of the cam body in the first and second directions, respectively.

9. The system of claim **5**, wherein the one or more instances of the retention blade include a set of three retention blades, and

wherein the set of three retention blades are separated from each other by about 120 degrees around a periphery of the cam body.

10. The system of claim **5**, wherein the locking mechanism is operable via a remote trigger signal to rotate the cam body via an electric motor, and

responsive to a loss of power to the electric motor, or inoperability of the electric motor, an operator of the vehicle is notified to operate the locking mechanism via a key passing through a keyway formed in a cap disposed at the rotational axis of the wheel body.

11. A lock assembly for providing an anti-theft function for a wheel assembly of a vehicle comprising a wheel body having a rim portion on which a tire is mountable and a rotational axis and a wheel hub operably coupled to a shaft or axle of the vehicle and to which the wheel body is mountable, the lock assembly comprising:

a locking mechanism operable to transition the lock assembly between a locked state in which the lock assembly engages both the wheel hub and the wheel body to prevent removal of the wheel body from the wheel hub and an unlocked state in which at least one of the wheel hub or the wheel body is not engaged by the lock assembly to enable removal of the wheel body from the wheel hub;

a hub contact plate that interfaces with the wheel hub; and

a carrying plate that interfaces with the locking mechanism to rotate and carry a portion of the lock assembly between the locked and unlocked states responsive to operation of the locking mechanism.

12. The lock assembly of claim **11**, wherein the lock assembly is disposed between the wheel hub and the wheel body and blocked from view by the wheel body.

13. The lock assembly of claim **11**, wherein the locking mechanism is operable via a remote trigger signal actuating the locking mechanism.

14. The lock assembly of claim **11**, wherein the locking mechanism is operable via a key passing through a keyway formed in a cap disposed at the rotational axis of the wheel body.

15. The lock assembly of claim **11**, further comprising a cam body operably coupled to the carrying plate to move responsive to movement of the carrying plate and one or more instances of a retention blade,

wherein the retention blade extends radially outwardly from the rotational axis responsive to the carrying plate rotating cam body in a first direction to transition to the locked state, and

wherein the retention blade withdraws radially inwardly with respect to the rotational axis responsive to rotation of the cam body in a second direction to transition to the unlocked state.

16. The lock assembly of claim **15**, wherein the wheel hub comprises a first retention blade slot, and the wheel body comprises a second retention blade slot aligned with the first retention blade slot to receive the retention blade in both the first and second retention blade slots when the lock assembly is in the locked state.

17. The lock assembly of claim **16**, wherein the lock assembly comprises a locating protrusion formed on the hub contact plate and the wheel hub comprises a locating slot disposed at a distal end of a cup portion of the wheel hub, and

wherein the lock assembly is nested inside the cup portion with the locating protrusion received in the locating slot to align the retention blade with both the first and second retention blade slots.

18. The lock assembly of claim **15**, wherein the cam body includes a blade sliding slot formed in a peripheral portion of a camming surface, and

wherein the retention blade slides through the blade sliding slot along the camming surface to transition into and out of engagement with the wheel hub and the wheel body responsive to rotation of the cam body in the first and second directions, respectively.

19. The lock assembly of claim **15**, wherein the one or more instances of the retention blade include a set of three retention blades, and

wherein the set of three retention blades are separated from each other by about 120 degrees around a periphery of the cam body. **20** The lock assembly of claim **15**, wherein the locking mechanism is operable via a remote trigger signal to rotate the cam body via an electric motor, and

responsive to a loss of power to the electric motor, or inoperability of the electric motor, an operator of the vehicle is notified to operate the locking mechanism via a key passing through a keyway formed in a cap disposed at the rotational axis of the wheel body.

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