

# CLAY FREEMAN

ANCH 309: SENIOR DESIGN

DR. K. BLOEMKER — FALL 2018

PATENT SEARCH HOMEWORK

20 SEPTEMBER, 2018

One of the first questions we had with wheel hub design was how the screws or threaded rods would attach to the plate to provide a secure connection between the hub and the wheel. While many of our benchmarking research had designs for directly mounting the bolt into the hub assembly or welding threaded rods into place, we were concerned with the integrity of this connection if the whole part is to be made from milled aluminum. Patent No. 8,950,824 B2 is a wheel hub nut retainer plate that solves this problem.

This product is marketable to any manufacturer or consumer that is involved in the design of off-road vehicles. This product would be most attractive to hub designers that are pushing the material limits of the part while trying to reduce weight and maintain the structural integrity and safety for the vehicle. The market power for this patent is preventing other designers or manufacturers from using a rigid steel plate for securing the bolts into the wheel hub for added rigidity.

The patent resists invalidation efforts by making claims for the hub to be designed to hold the wheel onto a rotating axis where the axle nuts have a keyed or noncircular shape. The axle nut and receiver with this type of geometry are fixed so they rotate together. Several claims outline the shape and definitions for the nut or keyway receiving portion. This hub plate must be located in the center of the wheel base and the number of arms match the number of bolts or lugs for the wheel. The holes in each hub arm have a loose fit for the threaded rods that comprise the lugs to attach to the wheel. Another claim on this patent is that the plate hub arms reach radially outward from the central portion where they are attached to the axle. Other claims cover other parts of the wheel assembly, retaining plates and geometries that involve components that are generally purchased from commercial suppliers and other commercial sources.

Many of the claims for this patent cover general specifications that would need to be satisfied for any design of a wheel hub on a vehicle of this type. The most descriptive and unique aspects of this design are the use of keyways or non-circular channels to secure the fasteners in place against the part. After this primary claim, it would be nearly impossible to design a part that does not infringe on some of the lesser claims. This patent is a good source for brainstorming however, and informs some of our design decisions.

This patent has been issued to Brian Eck of Bemidji, MN and Reid Anderson of Thief River Falls, MN. Reid Anderson worked as a manufacturing engineer at Bobcat before moving on to Arctic Cat as a design engineer for their ATV team when the patent was filed. The filing date for this patent was September 4, 2012, so it is potentially valid until 2022. The patent was issued on Feb 10, 2015, and the 3.5 year maintenance fee was paid on August 10, 2018, so this patent is still enforceable.



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**Eck et al.**

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(54) **WHEEL HUB NUT RETAINER PLATE**

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(\*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 261 days.

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**B60B 27/00** (2006.01)  
**B60B 37/04** (2006.01)  
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**F16B 41/00** (2006.01)

(52) **U.S. Cl.**

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(58) **Field of Classification Search**

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USPC ..... 301/35.58, 35.621, 35.624, 35.63, 301/105.1, 111.01, 111.02, 111.03; 411/119, 120, 204

See application file for complete search history.

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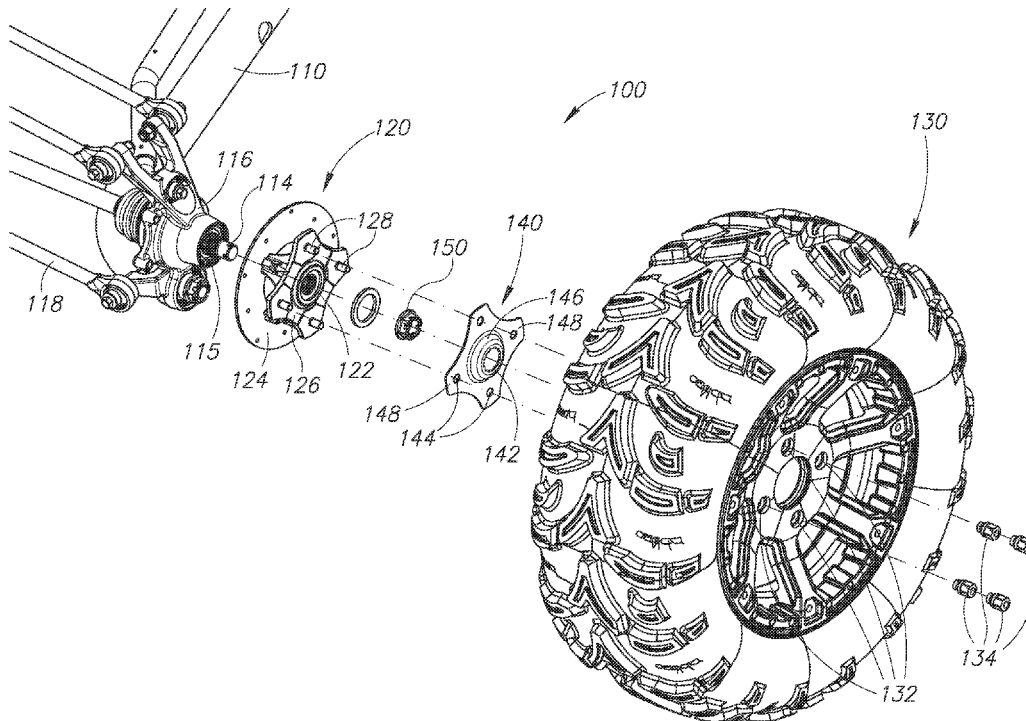
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(57) **ABSTRACT**

A retainer plate for preventing or at least mitigating loosening of an axle nut of a vehicle. The retainer plate comprises a generally flat section of rigid material that couples to an axle nut in a non-rotatable fashion and to a portion of the wheel to maintain the axle nut in tight threaded engagement with the axle. The retainer plate can have a central bore that non-rotatably engages the axle nut and a radially outward feature that engages the wheel to prevent the axle nut from loosening.

**22 Claims, 3 Drawing Sheets**



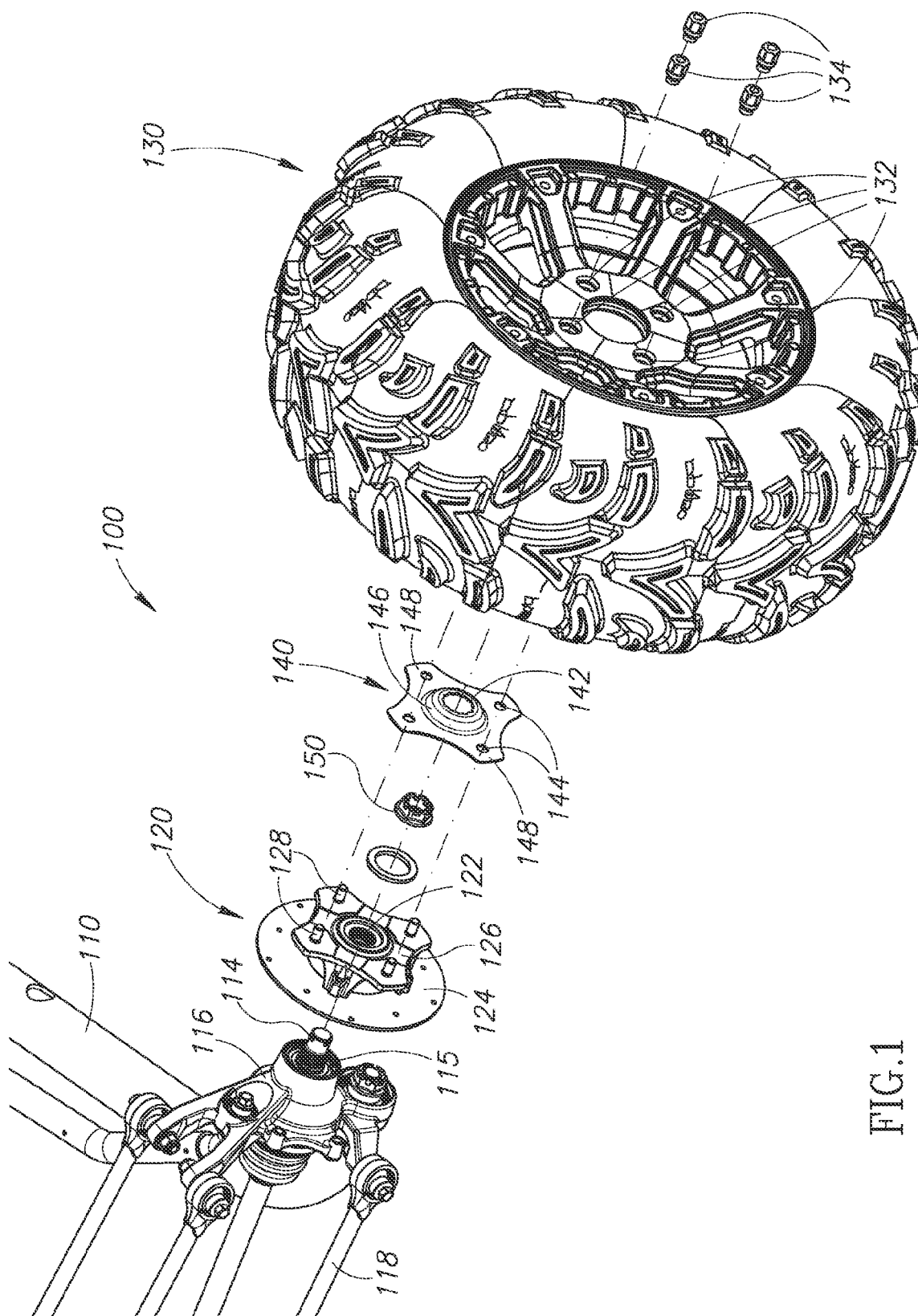
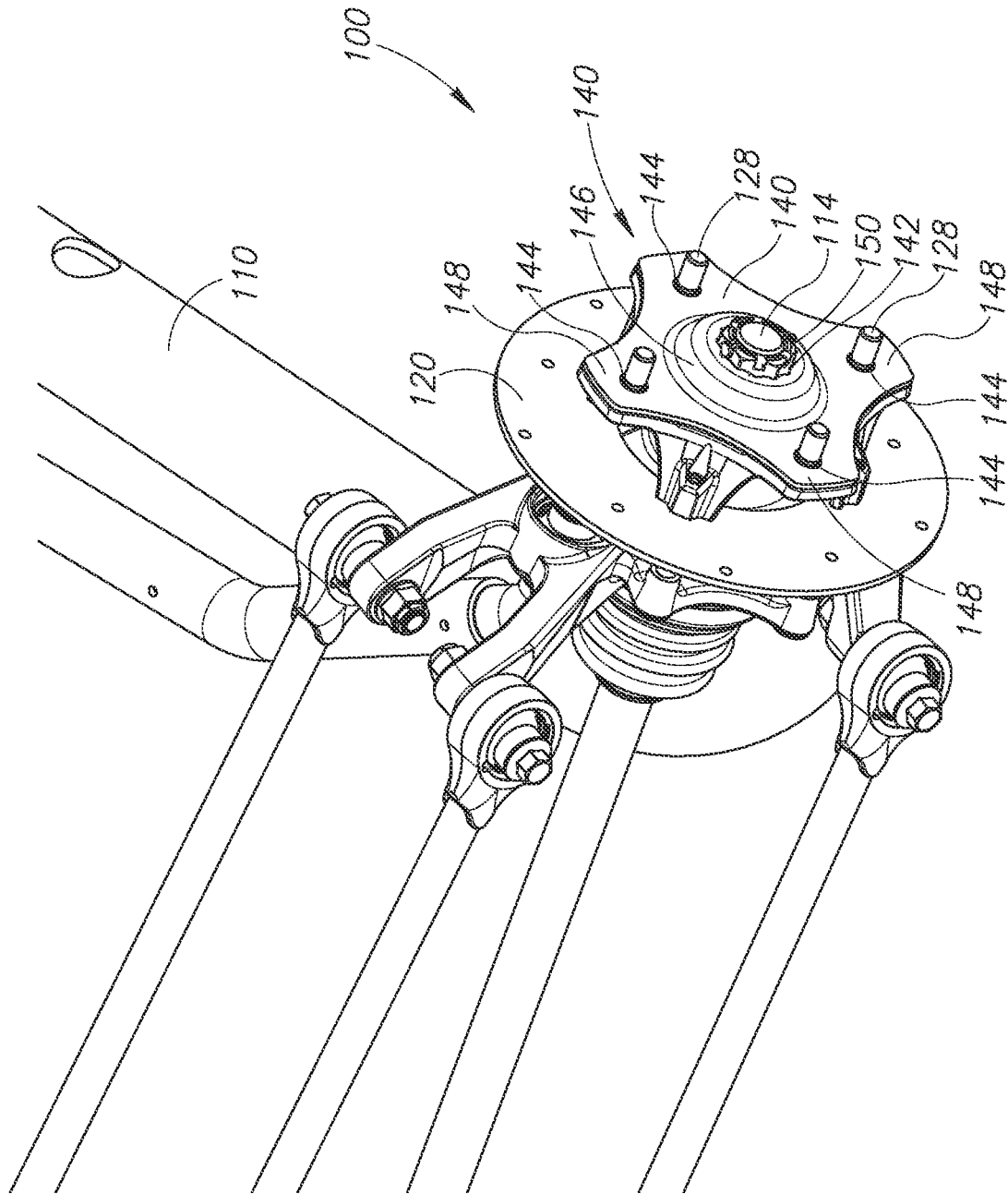


FIG.1



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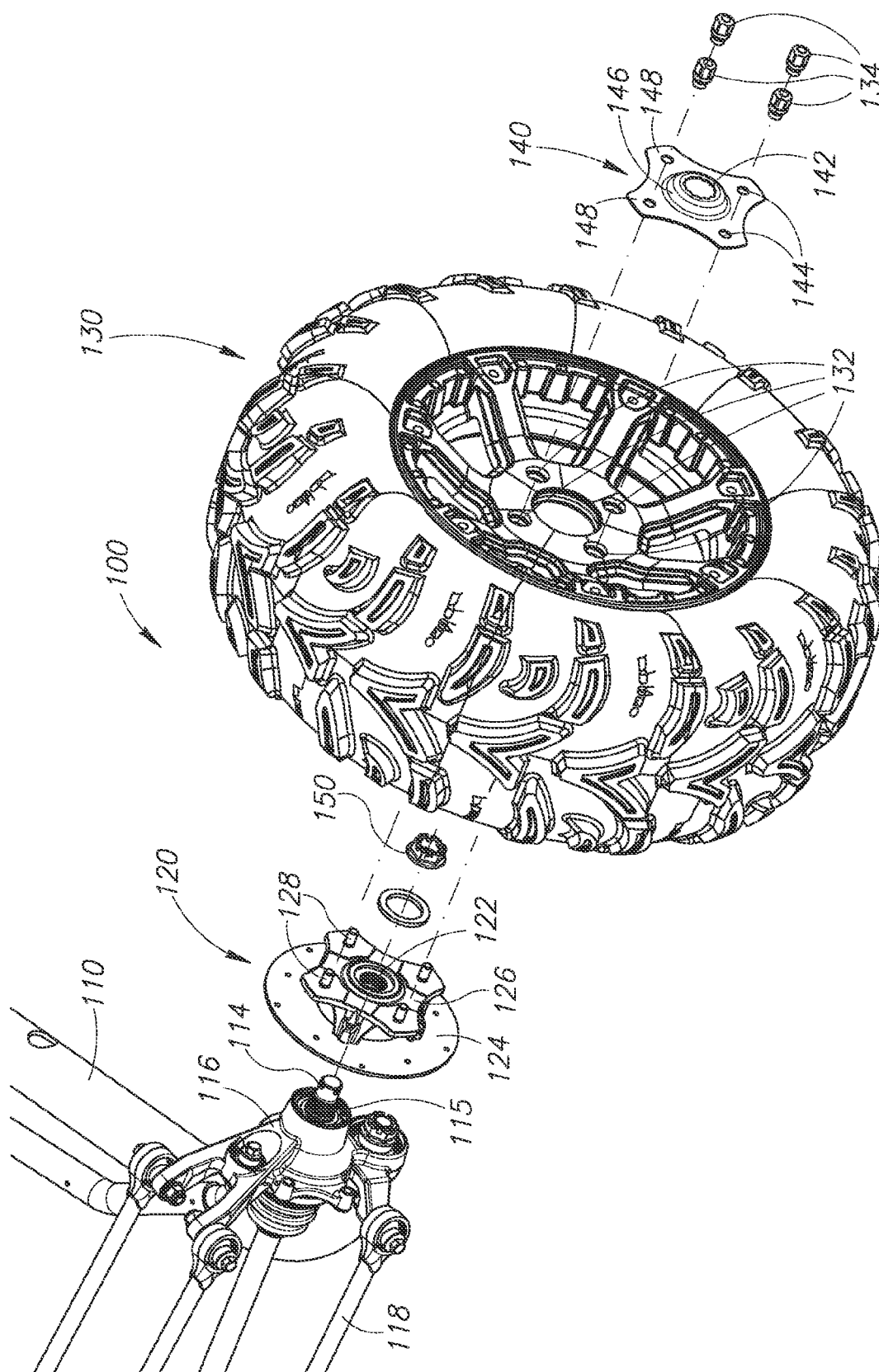


FIG. 3

1

**WHEEL HUB NUT RETAINER PLATE****FIELD OF INVENTION**

This invention relates generally to a plate for a vehicle that couples to wheel mounting studs and to an axle nut to prevent the axle nut from loosening from the axle.

**BACKGROUND OF THE INVENTION**

Fundamental to any wheeled vehicle, such as all-terrain vehicles ("ATVs") and recreational off-road vehicles ("ROVs") are wheels carried by axles. Live axles are driven by the vehicle's engine, and the turning axle causes the wheels to rotate. The coupling between the axle and the wheel ensures that energy provided by the engine can translate into movement of the wheel and ultimately propelling the vehicle. The axle has an axle nut at the end of the axle to hold the wheel and perhaps a hub assembly to the axle. Occasionally, the axle nut can work loose or even fall off the axle. Previous attempts at solving this problem, such as a simple cotter pin passing through the axle nut, are often inadequate. In some cases, the cotter pin shears off under high impact loads. These attempts provide no effective impediment to the axle nut loosening—merely an indication that the axle nut has rotated some unknown degree. There is a need for a lightweight and economical device to ensure that the axle nut does not rotate relative to the axle and loosen.

**SUMMARY OF THE INVENTION**

The present invention is directed to an axle nut retainer for a vehicle having an axle with a rotational axis and a wheel. The retainer plate interfaces with an axle nut. The axle nut is configured to fasten to an axle of a vehicle, the axle nut having a keyed shape, such as a hexagonal outer shape or other non-circular shape. The plate also has a corresponding keyed axle nut-receiving portion and a lug-receiving portion. The "keyed" axle nut-receiving portion is preferably keyed to at least a portion of the keyed shape of the axle nut, but may not be keyed to the complete outer shape of the axle nut. The axle nut-receiving portion is spaced apart from the lug-receiving portion in a direction perpendicular from the rotational axis of the axle. The lug-receiving portion is coupled to a hub lug. (i.e., the lug bolt or wheel stud of the wheel) The axle nut is positioned within the keyed nut-receiving portion. The axle nut and the keyed axle nut-receiving portion of the plate are non-rotatably coupled together to inhibit rotation of the axle nut relative to the axle. In at least one embodiment, the plate comprises an elongated member extending from the axle nut-receiving portion to the radially outward portion.

In other embodiments, the present invention is directed to a wheel assembly including a hub and a plurality of lugs. The hub is coupled to an axle of a vehicle, the axle having an axis of rotation. The plurality of lugs extend from the hub in a direction generally parallel with the axis of rotation and spaced apart from the axle in a direction generally perpendicular to the axis of rotation. The wheel assembly further includes a nut coupled to the axle and configured to hold the hub to the axle, and a retaining plate non-rotatably coupled to the nut and coupled to one or more of the lugs. The wheel assembly can further include a wheel coupled to the lugs with the retaining plate between the hub and the wheel, wherein the retaining plate prevents the nut from rotating relative to the axle.

In still further embodiments, the present invention includes a retaining plate for a wheeled vehicle having an axle, an axle

2

nut, and a wheel. The retaining plate includes a generally flat region extending in a direction perpendicular to the axle, and a first engagement portion being non-rotatably coupled to the axle nut. The retaining plate also includes a second engagement portion coupled to a portion of the wheel that rotates as the wheel rotates. The portion of the wheel is spaced apart from the axle, and the retaining plate resists rotation of the axle nut relative to the axle by virtue of a moment arm formed by the portion of the retaining plate spanning the distance between the first and second engagement portions.

**BRIEF DESCRIPTION OF THE DRAWINGS**

Preferred and alternative embodiments of the present invention are described in detail below with reference to the following drawings.

FIG. 1 is an exploded view of a wheel assembly, a hub assembly, and a retaining plate according to embodiments of the present invention. FIG. 3 shows a similar exploded view to that of FIG. 1, however the retaining plate is positioned outboard of the wheel.

FIG. 2 is an assembled view of the wheel assembly of FIG. 1 according to embodiments of the present invention.

**DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS**

FIG. 1 is an exploded view of a wheel assembly **100** according to embodiments of the present invention. The wheel assembly **100** can be used with a vehicle **110**, such as a recreational off-road vehicle ("ROV") or an all-terrain vehicle ("ATV") or any other suitable wheeled vehicle. The vehicle **110** has an axle **114** supported by a knuckle assembly **116** and a rear suspension **118**. The axle **114** includes an axle nut **150** that threadably engages the end of the axle **114**. The wheel assembly **100** includes a hub assembly **120** that is non-rotatably coupled to the axle **114** and rotates with the axle **114**. The nut **150** secures the hub assembly **120** to the vehicle **110**. The hub assembly **120** has non-circular features, such as teeth **122** that mesh with corresponding teeth **115** on the axle **114** to ensure that rotation of the axle **114** is transmitted to rotation of the hub **120**. The hub assembly **120** also includes a disc **124** for braking purposes, a base **126**, and lugs **128** extending from the base **126**. The wheel assembly **100** also includes a wheel **130** having lug holes **132** that engage the lugs **128** to secure the wheel **130** to the hub assembly **120**. The wheel **130** is secured to the hub assembly **120** by lug nuts **134**.

The wheel assembly **100** also includes a retaining plate **140**, which can be positioned between the hub assembly **120** and the wheel **130** (as shown in FIG. 1). The retaining plate **140** can alternatively be positioned outboard of the wheel **130**. With the retaining plate **140** positioned between the hub assembly **120** and wheel **130** and with the hub assembly **120** and wheel **130** clamped against the retaining plate **140**, the friction between the components is sufficient to prevent the axle nut **150** from loosening. The plate **140** includes a radially outward portion **148** spaced apart radially from the center of the plate **140**, defining a moment arm between the center of the plate **140** and the radially outward portion **148**. The retaining plate can have a first aperture **142** and at least one second aperture **144** on the radially outward portion **148** spaced apart from the first aperture **142**. Preferably, plate **140** includes second apertures **144** for each lug **128** with an appropriate clearance between the lugs **128** and the second apertures **144**. For example, an appropriate clearance is one that enables installation but prevents excessive rotation of the plate **140**. In the illustrated embodiment the first aperture **142** is positioned

3

centrally on the plate 140 and the second apertures 144 are positioned around a periphery of the plate 140, and there are four second apertures 144 corresponding to the four lugs 128. The axle 114 protrudes through the hub assembly 120 and is engaged with the nut 150, which is engaged non-rotatably with the retaining plate 140. The nut 150 can be a hexagonal nut or other keyed shape to facilitate the non-rotational coupling with a tightening tool (not shown). The first aperture 142 of the retaining plate 140 has a corresponding keyed shape that engages the nut 150 such that the plate 140 prevents the nut 150 from loosening or rotating relative to the axle 114. In the preferred embodiment, the plate 140 includes twelve evenly spaced recesses to engage the hexagonal nut 150 at multiple rotational placements. The second apertures 144 engage the lugs 128. The distance between the first aperture 142 and the second apertures 144 serves as a moment arm by which the retaining plate resists rotation of the nut 150 relative to the axle 114 to prevent loosening of the axle nut 150. In some embodiments the primary retaining force is the friction between the retaining plate 140, the wheel 130, and the hub assembly 120. The lugs 128 and second apertures 144 can be a secondary retaining force. For example, if the wheel 130 and hub assembly 120 loosen and friction lessens, the lugs 128 engage the retaining plate 140 to resist loosening of the nut 150. In other embodiments the engagement between the lugs 128 and the second apertures 144 is itself the primary resisting force.

In other embodiments the apertures 142, 144 can be any suitable engagement feature, such as a C-shaped recess or clip or bolt that secures to the nut 150 and lug 128, respectively. In other embodiments, the retaining plate 140 can engage with a portion of the wheel 130 other than the lugs 128, such as a protrusion and or recess feature of the hub 120 and or wheel or the spokes of the wheel 130. The retaining plate 140 can engage with any feature that, during operation of the vehicle 110, rotates with the nut 150 so that the retaining plate 140 can prevent or at least substantially mitigate loosening of the nut 150. In other embodiments the retaining plate 140 is not a plate at all; rather, the plate 140 can be a single member extending from the nut 150 and one of the lugs 128, somewhat resembling a crescent wrench, but still having non-rotating engagement features 142, 144 to prevent loosening of the axle nut 150. In some embodiments, two or more of these members can be used one for each lug 128. With more members engaging more lugs 128, the loosening resistance is increased. In some cases where loosening is particularly prevalent and potentially harmful, a retaining plate engaging many lugs 128 can be used. In other circumstances where the loosening phenomenon is less prevalent or less severe, fewer engagement apertures 144 can be used at the discretion of the operator. The preferred plate shown, which engages all four lugs also operates to keep the spacing between the hub and the wheel consistent.

In general, the greater the distance separating the lugs 128 (or other point at which the retaining plate 140 engages the hub 120 and or wheel 130) and the nut 150 the greater the loosening resistance due to the greater leverage. However, even a small distance between the first aperture 142 and second aperture 144 strongly resists loosening of the nut 150.

The retaining plate 140 can include a shaped portion 146 that protrudes from the body of the plate 140. The shaped portion 146 can allow the plate 140 to conform to the shape of the wheel 130 and more particularly to the hub against which the plate 140 rests. The profile of the retaining plate 140 can vary according to the space in which the plate 140 is disposed. The plate 140 can, in some embodiments, be thin enough to be inserted between wheel components of an existing vehicle

4

that was not specifically designed for use with the retaining plate 140, but that, nevertheless, benefits from the nut loosening prevention that the plate 140 provides. In some embodiments, the plate 140 can be placed outboard of the wheel 130, in which case there is presumably more room in which the plate 140 can operate. In such embodiments, the plate 140 can engage the lug nuts 134, and not the lugs 128 directly. In some embodiments in which the axle nut 150 does not protrude beyond the outer surface of the hub, the retaining plate 140 can include a shaped portion 146 that protrudes inboard from the body of the plate 140 to engage the axle nut 150. The shape of the wheel 130 can determine how the retaining plate 140 will engage the axle nut 150 and lugs 128.

FIG. 2 illustrates a wheel assembly 100 according to the present disclosure in which the retaining plate 140 is positioned on the hub assembly 120. The first aperture 142, or engagement portion, is non-rotatably coupled to the axle nut 150. In this embodiment, the nut 150 is a hexagonal nut, but the nut 150 can have any keyed shape that enables a torque to be applied to the nut. The second apertures 144 of the retaining plate 140 engage with the lugs 128. The retaining plate 140 permits the wheel 130 shown in FIG. 1 to be mounted normally to the lugs 128. The retaining plate 140 prevents, or at least substantially mitigates, loosening of the nut 150.

While the preferred embodiments of the invention have been illustrated and described, as noted above, many changes can be made without departing from the spirit and scope of the invention. Accordingly, the scope of the invention is not limited by the disclosure of the preferred embodiments. For example, the present invention can include other mechanical equivalents that prevent an axle nut from loosening from the axle, including a retaining arm extending from the axle nut to a single lug or to another portion of the wheel. Other embodiments are also possible. Accordingly, the invention should be determined entirely by reference to the claims that follow.

The invention claimed is:

1. A retainer for a vehicle having an axle with a rotational axis, a wheel, and an axle nut configured to fasten to the axle of the vehicle, the axle nut having a keyed shape, the retainer comprising a plate having a keyed axle nut-receiving portion and a radially outward portion spaced apart from the axle nut-receiving portion in a direction perpendicular from the rotation axis of the axle, wherein:

the radially outward portion is non-rotatably coupled to and frictionally engaged with the wheel to prevent the plate from rotating relative to the wheel, the axle nut is positioned within the keyed nut-receiving portion, and wherein the axle nut and the keyed axle nut-receiving portion of the plate are non-rotatably coupled together to inhibit rotation of the axle nut relative to the axle.

2. The retainer of claim 1 wherein the keyed axle nut-receiving portion is configured to receive the axle nut and the axle nut is a hexagonal nut.

3. The retainer of claim 1 wherein the non-circular axle nut-receiving portion has a 24-sided shape.

4. The retainer of claim 1 wherein the non-circular axle nut-receiving portion is centrally located in the plate.

5. The retainer of claim 1 wherein the radially outward portion comprises a plurality of holes configured to engage with lugs of the vehicle.

6. The retainer of claim 5 wherein the radially outward portion comprises a bore that loosely engages the lug to prevent the plate from rotating relative to the wheel.

7. The retainer of claim 1 wherein the plate further comprises a generally flat region extending generally perpendicular



5

lar to the rotational axis of the axle, and a central shaped portion that protrudes from the plate.

8. The retainer of claim 7 wherein the central shaped portion is shaped to allow the keyed axle nut-receiving portion to engage the axle nut.

9. The retainer of claim 1 wherein the plate comprises an elongated member extending from the axle nut-receiving portion to the radially outward portion.

10. A wheel assembly, comprising:

a hub coupled to an axle of a vehicle, the axle having an axis of rotation;

a nut coupled to the axle and configured to hold the hub to the axle;

a retaining plate non-rotatably coupled to the nut and non-rotatably coupled to the hub;

a plurality of lugs extending from the hub in a direction generally parallel with the axis of rotation and spaced apart from the axle in a direction generally perpendicular to the axis of rotation, wherein the retaining plate is coupled to one or more of the plurality of lugs to prevent rotation of the plate relative to the hub; and

a wheel coupled to at least one of the plurality of lugs with the retaining plate between the hub and the wheel, wherein the retaining plate prevents the nut from rotating relative to the axle.

11. The wheel assembly of claim 10 wherein the nut comprises a hexagonal nut.

12. The wheel assembly of claim 10 wherein the plate has a keyed aperture configured to receive the nut.

13. The wheel assembly of claim 12 wherein the keyed aperture comprises an internal surface having multiple flat surfaces that engage with corresponding surfaces on the nut.

14. A retaining plate for a wheeled vehicle having an axle, an axle nut, and a wheel, the retaining plate comprising:

a generally flat region extending in a direction perpendicular to the axle, wherein at least a portion of the flat region is frictionally engaged with the wheel;

a first engagement portion being non-rotatably coupled to the axle nut;

a second engagement portion coupled to a portion of at least one of the wheel or a hub that rotates as the axle

6

rotates, wherein the portion of at least one of the wheel or the hub is spaced apart from the axle, wherein the retaining plate resists rotation of the axle nut relative to the axle by virtue of a moment arm formed by the portion of the retaining plate spanning the distance between the first and second engagement portions.

15. The retaining plate of claim 14 wherein the wheeled vehicle comprises a recreational off-road vehicle or an all-terrain vehicle.

16. The retaining plate of claim 14 wherein the engagement portions comprise apertures.

17. The retaining plate of claim 14 wherein the retaining plate is positioned between the wheel and the vehicle.

18. The retaining plate of claim 14 wherein the retaining plate is positioned outboard of the wheel.

19. The retaining plate of claim 14 wherein the portion of the wheel comprises at least one of spokes, lugs, or lug nuts of the wheel.

20. The retaining plate of claim 14 wherein the retaining plate is configured and arranged to engage with a protrusion of the hub.

21. A retainer for a vehicle having an axle with a rotational axis, a wheel, and an axle nut configured to fasten to the axle of the vehicle, the axle nut having a keyed shape, the retainer comprising a plate having a keyed axle nut-receiving portion and a radially outward portion spaced apart from the axle nut-receiving portion in a direction perpendicular from the rotation axis of the axle, wherein:

the radially outward portion comprises a plurality of holes configured to engage with lugs of the vehicle and is non-rotatably coupled to the wheel to prevent the plate from rotating relative to the wheel,

the axle nut is positioned within the keyed nut-receiving portion, and wherein

the axle nut and the keyed axle nut-receiving portion of the plate are non-rotatably coupled together to inhibit rotation of the axle nut relative to the axle.

22. The retainer of claim 21, wherein the radially outward portion comprises a bore that loosely engages the lug to prevent the plate from rotating relative to the wheel.

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Invention

## WHEEL HUB NUT RETAINER PLATE

PATENT #	APPLICATION #	FILING DATE	ISSUE DATE
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## Payment Details

PAYMENT DATE	DATE POSTED	TRANSACTION ID	ATTORNEY DOCKET #	TOTAL PAYMENT
08/10/2018	08/10/2018	081018INTMTFEE00009812032641	T13 D.2B.113-US01	\$1,600.00

Fee Code	Description	Sale ID	Fee Amount
1551	MAINTENANCE FEE DUE AT 3.5 YEARS	081018INTMTFEE00009812	\$1,600.00

According to the records of the United States Patent and Trademark Office (USPTO), the maintenance fee and any necessary surcharge have been timely paid for the patent listed above. The payment shown above is subject to actual collection. If the payment is refused or charged back by a financial institution, the payment will be void and the maintenance fee and any necessary surcharge unpaid.