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Gordon

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(54) **TRI-DRIVE TRANSMISSION FOR REAR MID-ENGINE VEHICLE**

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(51) **Int. Cl.**

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B60K 17/04	(2006.01)
F16H 1/24	(2006.01)
F16H 1/22	(2006.01)

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

CPC ***B60K 17/344*** (2013.01); ***B60K 17/043*** (2013.01); ***B60K 17/22*** (2013.01); ***F16H 1/222*** (2013.01); ***F16H 1/24*** (2013.01)

(58) **Field of Classification Search**

CPC B60K 17/344; B60K 17/043; B60K 17/22; F16H 1/222; F16H 1/24; F16H 1/225

See application file for complete search history.

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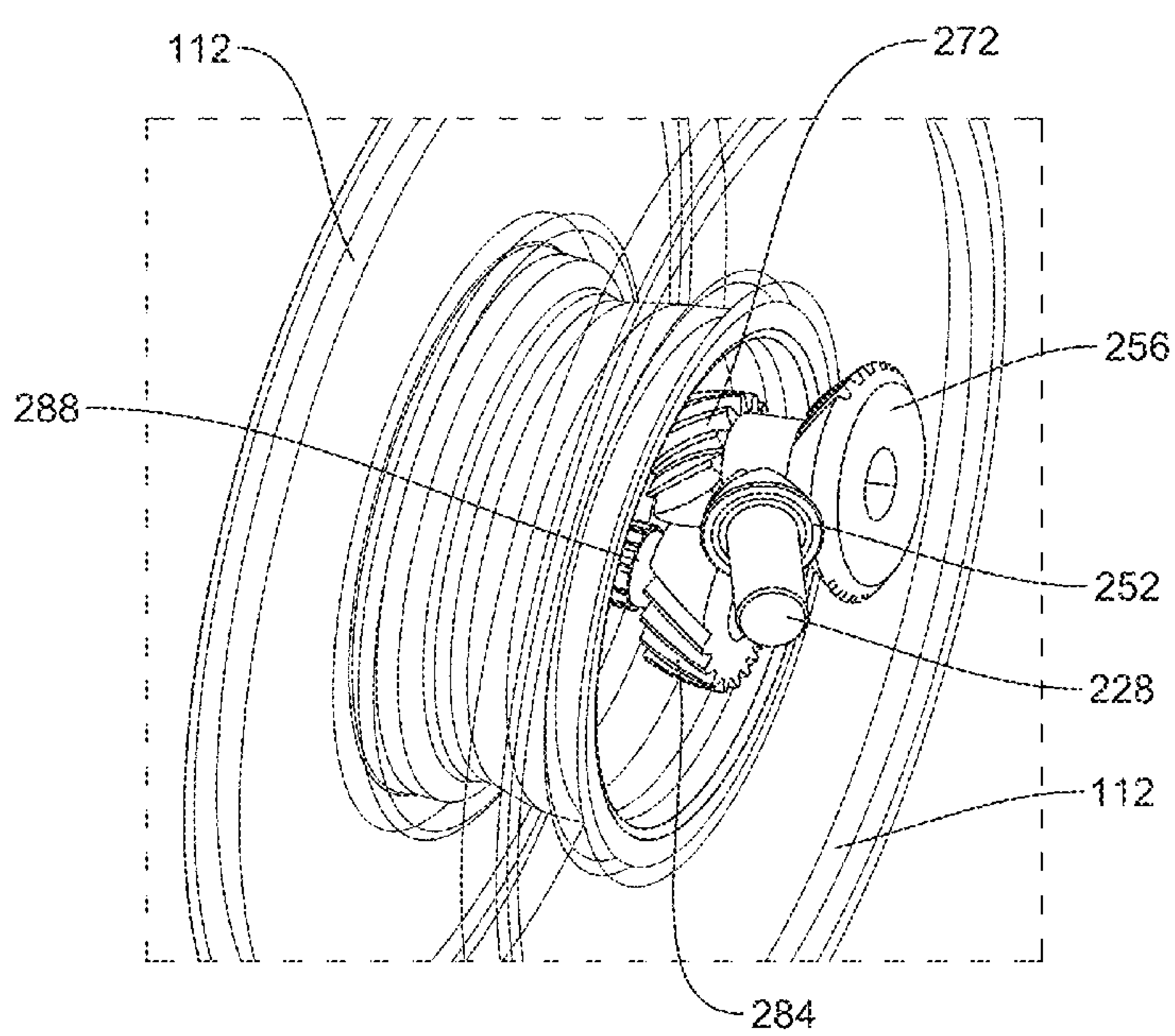
(57) **ABSTRACT**

An apparatus and methods are provided for a transmission for a rear mid-engine vehicle. The transmission comprises a power transfer portion for receiving torque from the engine and a gearbox for providing conversions of rotational speed and torque. First and second side output portions conduct torque from the gearbox to the rear wheels. A forward output portion conducts torque to front wheels of a four-wheel drive vehicle. An air clutch comprising each output portion controls the degree of torque transferred to each wheel. The output portions are each coupled to a rear wheel by a rear axle, bevel gears, and rear portal gears. The rear axles are aligned with, and positioned above, the trailing arms to protect the rear axles from damage due to rocks and debris. The length and alignment of the rear axles cause CV joints to articulate in the same direction as the trailing arms.

18 Claims, 5 Drawing Sheets



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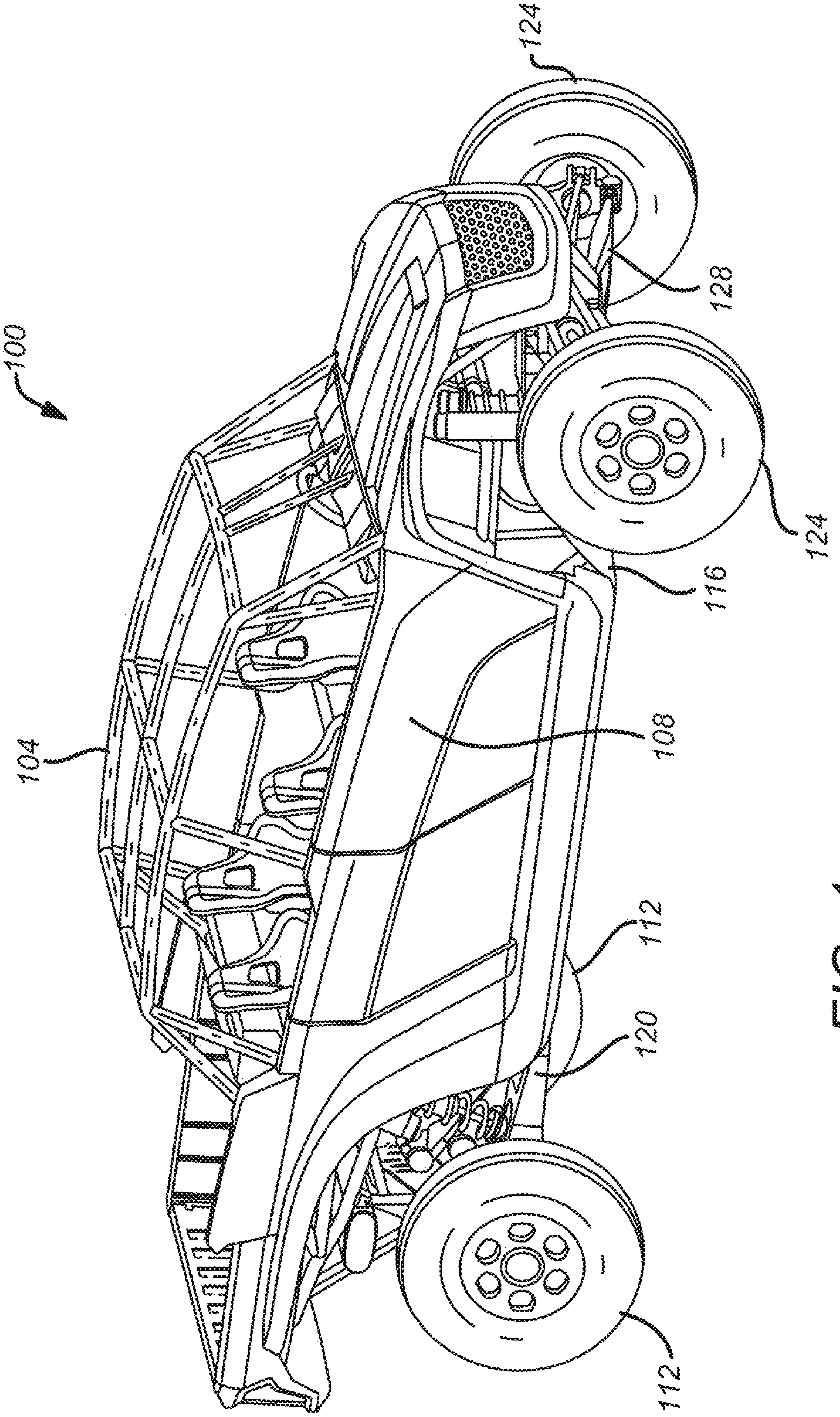
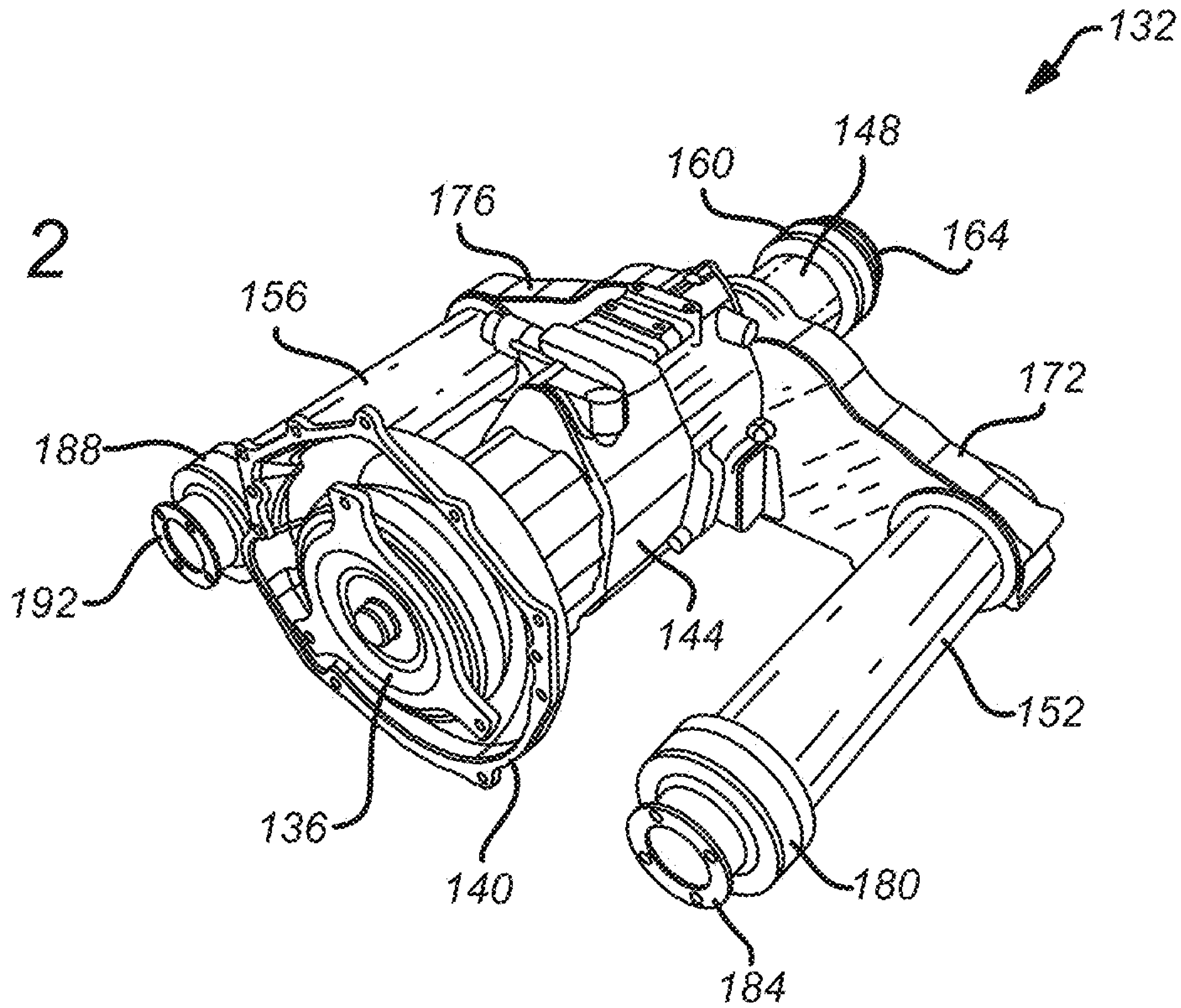


FIG. 1

FIG. 2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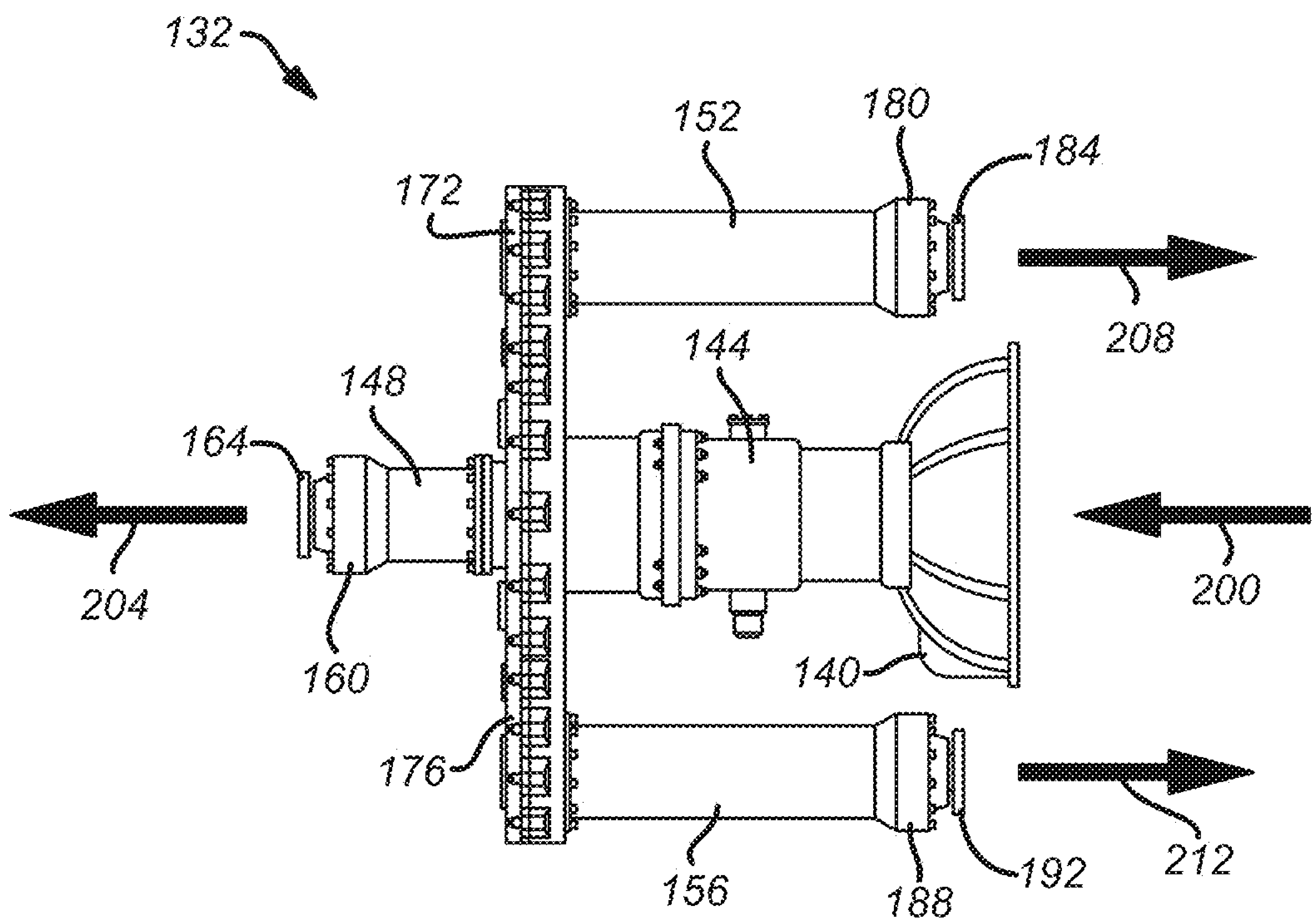
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FIG. 3

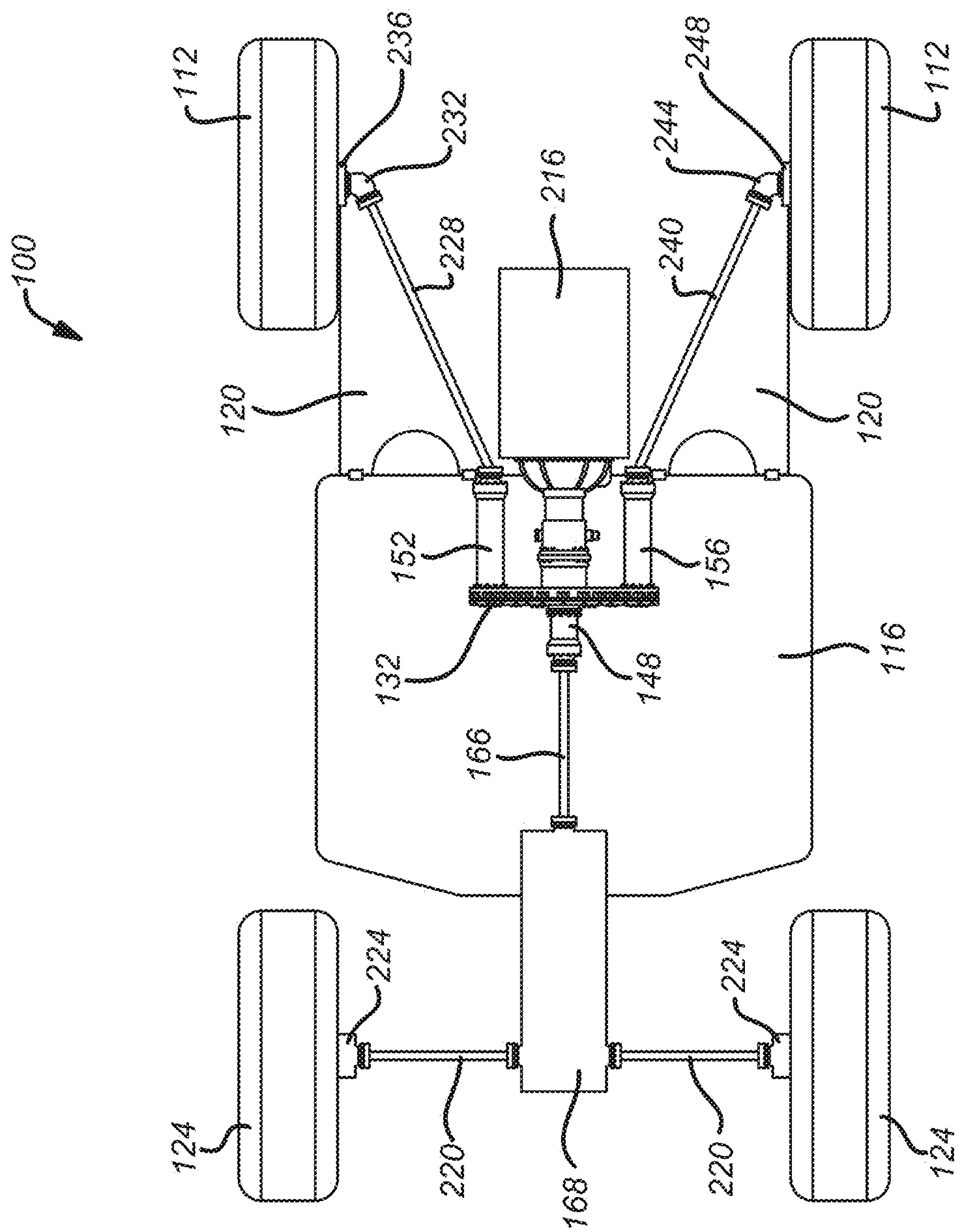
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FIG. 4

FIG. 5

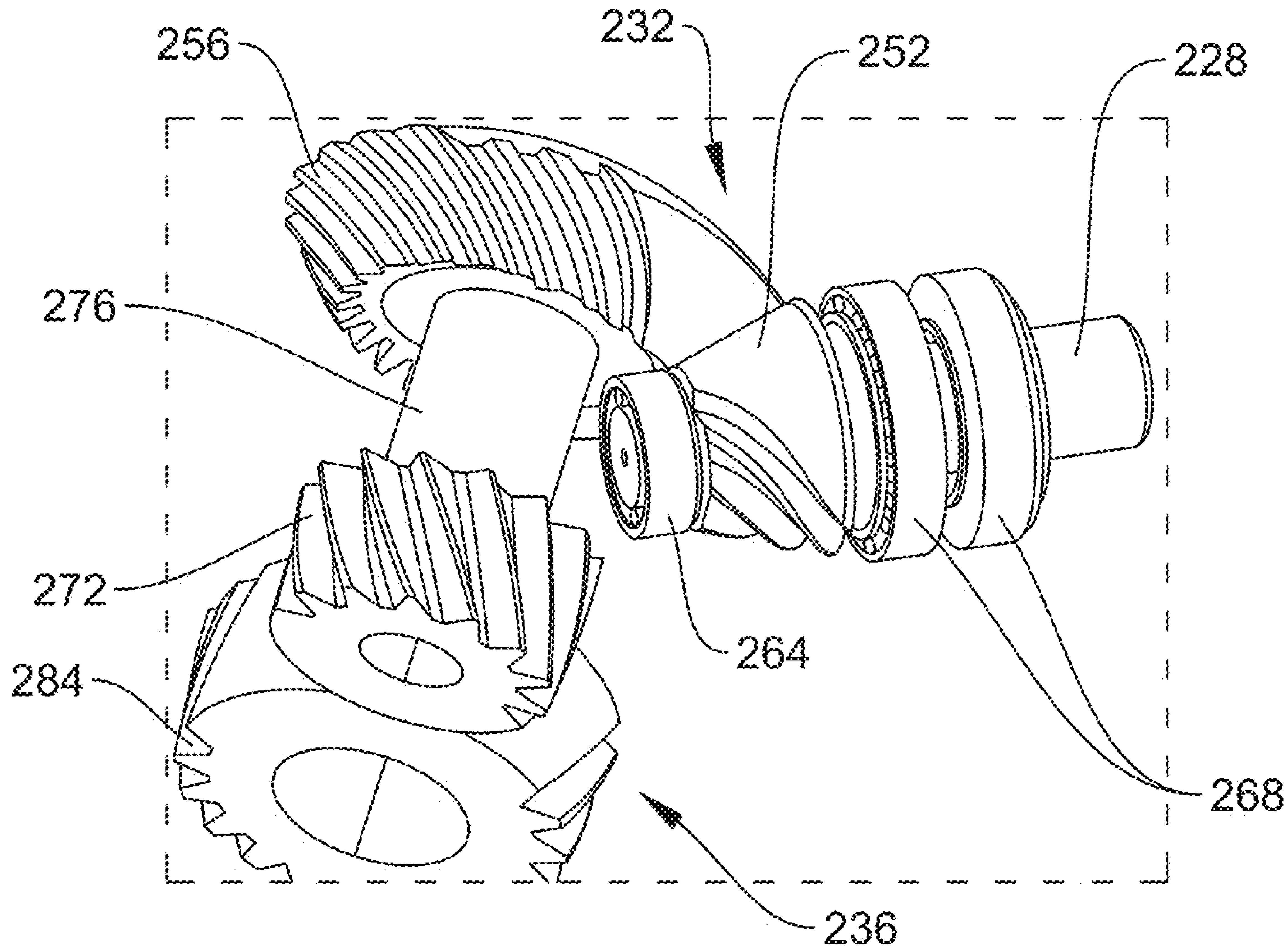
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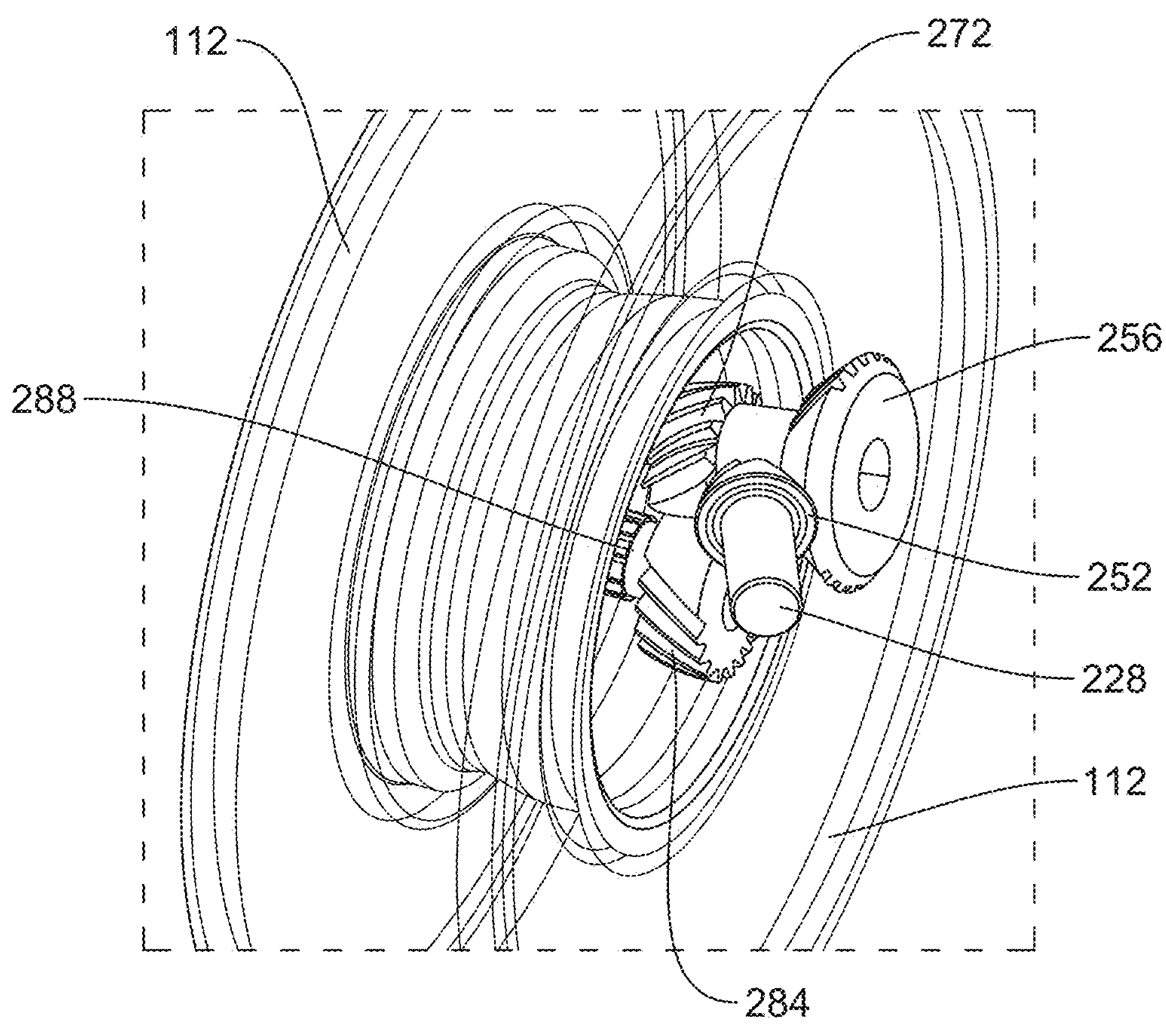
FIG. 6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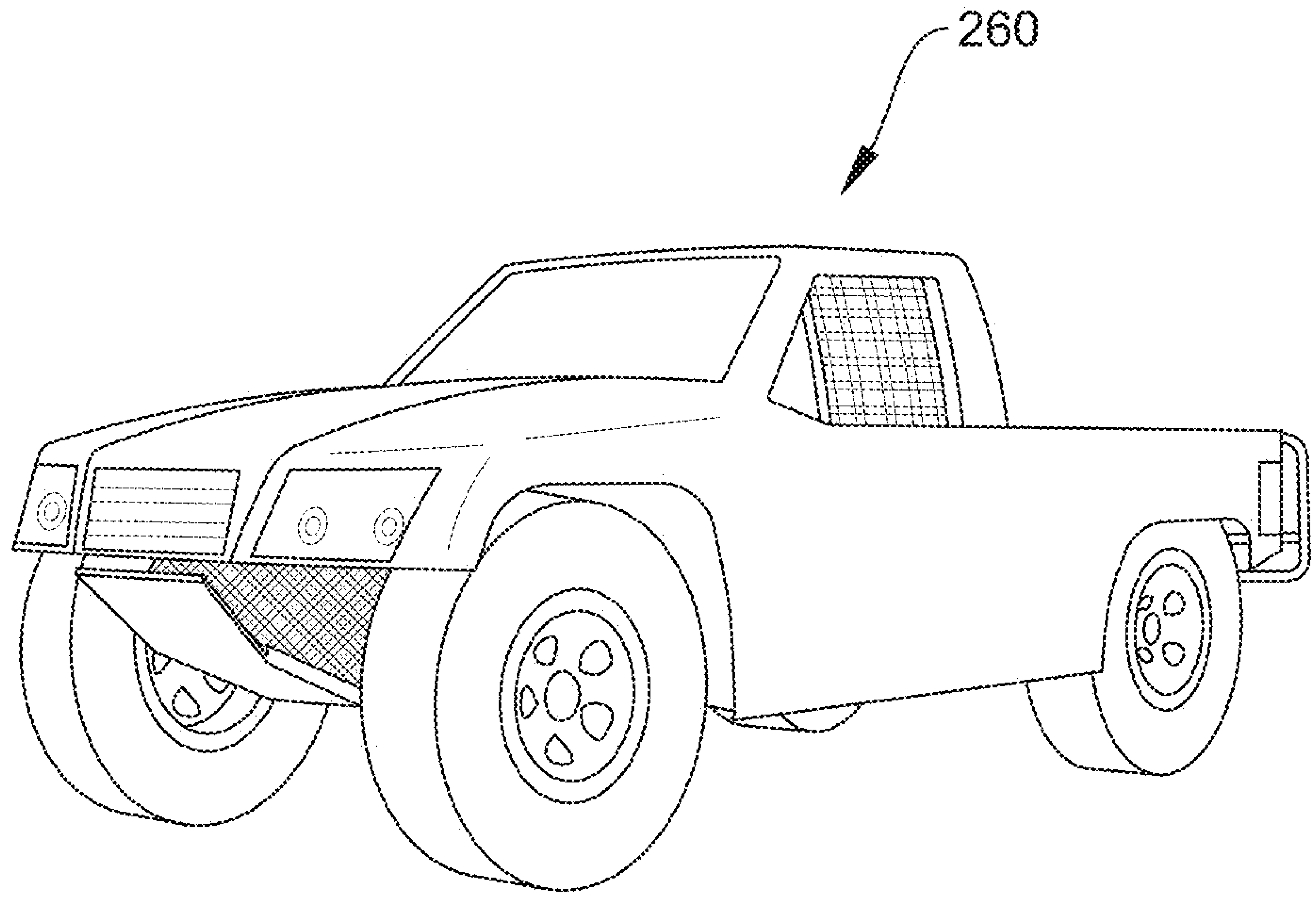

FIG. 7

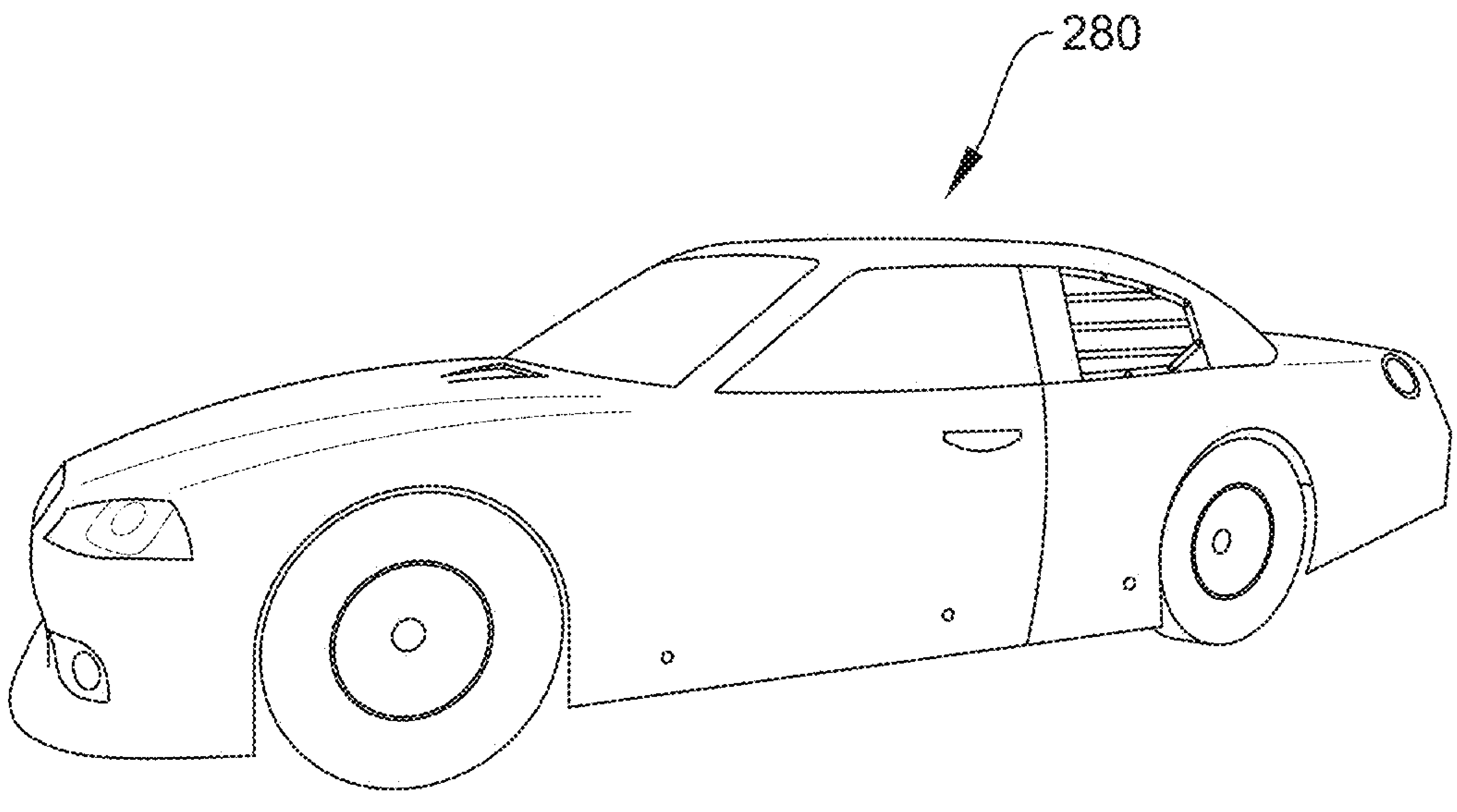

FIG. 8

TRI-DRIVE TRANSMISSION FOR REAR MID-ENGINE VEHICLE

PRIORITY

This application is a continuation-in-part of, and claims the benefit of, U.S. patent application, entitled "Tri-Drive Transmission For Rear Mid-Engine Vehicle," filed on Sep. 1, 2022, and having application Ser. No. 17/901,418, which claims the benefit of and priority to U.S. Provisional Application, entitled "Tri-Drive Transmission For Rear Mid-Engine Vehicle," filed on Sep. 3, 2021 and having application Ser. No. 63/240,793, the entirety of said application being incorporated herein by reference.

FIELD

Embodiments of the present disclosure generally relate to vehicle suspension systems. More specifically, embodiments of the disclosure relate to an apparatus and methods for a tri-drive transmission for a rear mid-engine vehicle and configured for driving front wheels and two rear wheels individually.

BACKGROUND

Off-road vehicles enjoy an enthusiastic following because of their many uses and versatility. As a result, several types of motorsports involve racing of various types of off-road vehicles. For example, competitions exist that are dedicated to various types of terrain, such as rally, desert racing, and rock-crawling. Besides their use in various motorsports, off-road vehicles commonly are used for sight-seeing and traveling to areas that may not be accessed by way of standard, paved roads.

The use of higher clearance, higher traction vehicles enables off-road vehicles to access trails and roads having rough, low traction surfaces that may not be traversed using a standard, on-road vehicle. As such, off-road vehicles typically comprise larger wheels, wider tires, and suspension configurations that are specifically engineered for use in off-road applications. As a consequence of such suspension configurations, as well as the rough terrain typically traversed, driver and passenger safety is a crucial concern. For example, drivers and passengers typically must be wear safety restraints during off-road travel. A wide variety of different types of safety harnesses are available for use with off-road vehicles.

Unlike on-road vehicles, such as passenger cars, off-road vehicles typically are open, often lacking windows, doors, and body panels common to passenger cars. A chassis comprising a structural arrangement of welded tubes typically is configured to support components of the off-road vehicle. For example, a front portion of the chassis is configured to support a front suspension of the off-road vehicle and various components of the off-road vehicle, such as a steering gear, a front differential, and the like. A rear portion of the chassis is configured to support a rear suspension of the off-road vehicle, such as rear trailing arms, as well as support various drivetrain components, such as a transaxle, a rear differential, an engine, and the like. Further, a roll cage or canopy comprising a welded tube structure coupled to the chassis is configured to protect the driver and passengers in the event of a rollover situation.

Trailing arm suspensions are well known and commonly used in off-road vehicles such as four-wheeled buggies. A typical trailing arm suspension comprises a trailing arm having one end pivotally connected to a vehicle frame or chassis through a frame bracket and another end connected to the vehicle frame by a spring or strut. The trailing arm supports an axle to which the vehicle wheels are mounted. Road-induced reaction forces acting on the wheels are controlled by the pivoting of the trailing arm in response to these forces, with the forces being resisted by the spring.

Given that off-road vehicles routinely travel over very rough terrain, such as mountainous regions, and are prone to tipping over, there is a desire to improve the mechanical strength, safety, convenience, and comfort of off-road vehicles, while at the same improving the performance of such vehicles.

SUMMARY

An apparatus and methods are provided for a transmission for a rear mid-engine vehicle. The transmission comprises a power transfer portion for receiving torque from the engine and a gearbox for providing conversions of rotational speed and torque. First and second side output portions conduct torque from the gearbox to the rear wheels. A forward output portion conducts torque to front wheels of a four-wheel drive vehicle. An air clutch comprising each output portion controls the degree of torque transferred to each wheel. The air clutches may be controlled by an artificial intelligence in response to detected road and/or driving conditions. The first and second side output portions are each coupled to a rear wheel by a rear axle, bevel gears, and rear portal gears. The rear axles are aligned with, and positioned above, the trailing arms to protect the rear axles from damage due to rocks and debris. The length and alignment of the rear axles cause CV joints to articulate in the same direction as the trailing arms.

In an exemplary embodiment, an apparatus for transmitting torque received from a rear mounted engine of a vehicle comprises: a power transfer portion for receiving torque from the engine; a gearbox for providing conversions of rotational speed and torque; a first side output portion; and a second side output portion.

In another exemplary embodiment, the apparatus further comprises a forward output portion adapted to conduct torque to front wheels of a four-wheel drive vehicle. In another exemplary embodiment, the forward output portion includes an air clutch configured to facilitate controlling the degree of torque that is transferred to the front wheels.

In another exemplary embodiment, the gearbox is in mechanical communication with the power transfer portion. In another exemplary embodiment, the gearbox includes multiple gears and gear trains arranged to provide block conversions of rotational speed and torque received from the engine by way of the power transfer portion.

In another exemplary embodiment, a first side gear transfer case is disposed between the gearbox and the first side output portion; and wherein a second gear transfer case is disposed between the gearbox and the second side output portion. In another exemplary embodiment, the first side gear transfer case and the second side gear transfer case house components configured to respectively communicate torque to the first side output portion and the second side output portion. In another exemplary embodiment, the components are configured to cause the first side output portion and the second side output portion to rotate in directions that cause rear wheels of the vehicle to rotate in the same direction.

In another exemplary embodiment, the first side output portion includes a first air clutch, and the second side output portion includes a second air clutch. In another exemplary embodiment, the first air clutch and the second air clutch are interconnected with a third air clutch comprising a forward output portion that is adapted to conduct torque to front wheels of a four-wheel drive vehicle. In another exemplary embodiment, the first air clutch, the second air clutch, and the third air clutch are configured to facilitate controlling the degree of torque that is respectively output by way of the first side output portion, the second side output portion, and the forward output portion. In another exemplary embodiment, each of the first air clutch, the second air clutch, and the third air clutch includes a solenoid configured to release air upon activation.

In another exemplary embodiment, air released from and one or more of the first, second, and third air clutch is routed to any other of the one or more of the first, second, and third air clutches. In another exemplary embodiment, the first, second, and third air clutches are controlled by way of an artificial intelligence configured to operate the first, second, and third air clutches in response to detected road and/or driving conditions. In another exemplary embodiment, the artificial intelligence is electrically coupled with various sensors that supply the artificial intelligence with data about the operation of the vehicle. In another exemplary embodiment, the artificial intelligence is configured to operate the first, second, and third air clutches to accommodate road and/or driving conditions without any need for intervention by a driver of the vehicle.

In another exemplary embodiment, the first side output portion is operably coupled to a rear passenger-side wheel by way of a first rear axle, bevel gears, and rear portal gears; and wherein the second side output portion is operably coupled to a rear driver-side wheel by way of a second rear axle, bevel gears, and rear portal gears. In another exemplary embodiment, the first rear axle and the second rear axle are aligned with inboard portions of trailing arms comprising a rear suspension of the vehicle. In another exemplary embodiment, the first rear axle and the second rear axle are disposed above the trailing arms to protect the first rear axle and the second rear axle are protected from potential damage due to impacts by rocks and other debris. In another exemplary embodiment, the first rear axle and the second rear axle each has a length and an alignment with the trailing arms that causes CV joints to articulate in the same direction as the trailing arms.

In an exemplary embodiment, an assembly for communicating torque from a rear mounted engine to rear wheels of a vehicle comprises: a transmission coupled with the rear mounted engine; a first side output portion and a second side output portion comprising the transmission; an axle coupled with each of the first side output portion and the second side output portion; a bevel gear assembly operationally disposed between each axle and a rear portal gear assembly; and a spindle coupling each rear portal gear assembly with a rear wheel.

In another exemplary embodiment, the bevel gear assembly is configured to overcome an acute angle between the axle and the rear portal gear assembly so as to put the axle into rotational communication with the rear wheel. In another exemplary embodiment, the bevel gear assembly and the rear portal gear assembly are configured to communicate torque from the axle to the rear wheel. In another exemplary embodiment, the bevel gear assembly comprises a pinion gear that is coupled with the axle and meshed with an output gear. In another exemplary embodiment, the output gear is coupled with a pinion gear comprising the rear portal gear assembly by way of a shaft. In another exemplary embodiment, the pinion gear comprising the rear portal gear assembly is meshed with an output gear comprising the rear portal gear assembly. In another exemplary embodiment, the output gear comprising the rear portal gear assembly is configured to communicate torque to the rear wheel by way of the spindle.

In an exemplary embodiment, an assembly for communicating torque from an axle to a rear wheel of a vehicle comprises: a bevel gear assembly for overcoming an acute angle between the axle and the rear wheel; a rear portal gear assembly operatively coupled with the bevel gear assembly; and a spindle for communicating torque from the rear portal gear assembly to the rear wheel.

In another exemplary embodiment, the bevel gear assembly comprises a pinion gear that is coupled with the axle and meshed with an output gear. In another exemplary embodiment, the output gear is coupled with a pinion gear comprising the rear portal gear assembly by way of a shaft. In another exemplary embodiment, the pinion gear comprising the rear portal gear assembly is meshed with an output gear comprising the rear portal gear assembly. In another exemplary embodiment, the output gear comprising the rear portal gear assembly is configured to communicate torque to the rear wheel by way of the spindle.

In an exemplary embodiment, a method for an assembly to communicate torque from a rear mounted engine to rear wheels of a vehicle comprises: configuring a first side output portion and a second side output portion comprising the transmission; coupling the transmission with the rear mounted engine; coupling an axle with each of the first side output portion and the second side output portion; operationally disposing a bevel gear assembly between each axle and a rear portal gear assembly; and configuring the rear portal gear assembly to communicate torque from the bevel gear assembly to the rear wheel.

In another exemplary embodiment, operationally disposing includes configuring the bevel gear assembly to overcome an acute angle between the axle and the rear portal gear assembly so as to put the axle into rotational communication with the rear wheel. In another exemplary embodiment, operationally disposing includes configuring the bevel gear assembly and the rear portal gear assembly to communicate torque from the axle to the rear wheel. In another exemplary embodiment, operationally disposing the bevel gear assembly includes coupling a pinion gear with the axle and meshing the pinion gear with an output gear. In another exemplary embodiment, operationally disposing includes coupling the output gear with a pinion gear comprising the rear portal gear assembly by way of a shaft.

In another exemplary embodiment, configuring the rear portal gear assembly includes meshing the pinion gear comprising the rear portal gear assembly with an output gear comprising the rear portal gear assembly. In another exemplary embodiment, configuring the rear portal gear assembly includes coupling each rear portal gear assembly with a rear wheel by way of a spindle. In another exemplary embodiment, coupling each rear portal gear assembly includes configuring the output gear comprising the rear portal gear assembly to communicate torque to the rear wheel by way of the spindle.

These and other features of the concepts provided herein may be better understood with reference to the drawings, description, and appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

The drawings refer to embodiments of the present disclosure in which:

FIG. **1** illustrates an exemplary embodiment of an off-road vehicle that is configured to seat up to four occupants and is suitable for a rear mid-engine and a tri-drive transmission in accordance with the present disclosure;

FIG. **2** illustrates a perspective view of an exemplary embodiment of tri-drive transmission suitable for a rear mid-engine vehicle according to the present disclosure;

FIG. **3** is a diagram showing a power input and multiple power outputs of an exemplary embodiment of a tri-drive transmission in accordance with the present disclosure;

FIG. **4** is a diagram that shows a top view of a powertrain comprising an exemplary embodiment of a four-wheel drive (4WD) vehicle that includes a tri-drive transmission in accordance with the present disclosure;

FIG. **5** illustrates an isometric view of an exemplary embodiment of bevel gears and rear portal gears that may be used in concert with a tri-drive transmission according to the present disclosure;

FIG. **6** illustrates a ghost-view of the bevel gears and rear portal gears of FIG. **5** coupled with a wheel according to the present disclosure;

FIG. **7** illustrates an exemplary embodiment of a performance vehicle that is suitable for a tri-drive transmission in accordance with the present disclosure; and

FIG. **8** illustrates an exemplary embodiment of a performance vehicle that is suitable for a tri-drive transmission in accordance with the present disclosure.

While the present disclosure is subject to various modifications and alternative forms, specific embodiments thereof have been shown by way of example in the drawings and will herein be described in detail. The present disclosure should be understood to not be limited to the particular forms disclosed, but on the contrary, the intention is to cover all modifications, equivalents, and alternatives falling within the spirit and scope of the present disclosure.

DETAILED DESCRIPTION

In the following description, numerous specific details are set forth in order to provide a thorough understanding of the present disclosure. It will be apparent, however, to one of ordinary skill in the art that the apparatus and methods disclosed herein may be practiced without these specific details. In other instances, specific numeric references such as "first gear," may be made. However, the specific numeric reference should not be interpreted as a literal sequential order but rather interpreted that the "first gear" is different than a "second gear." Thus, the specific details set forth are merely exemplary. The specific details may be varied from and still be contemplated to be within the spirit and scope of the present disclosure. The term "coupled" is defined as meaning connected either directly to the component or indirectly to the component through another component. Further, as used herein, the terms "about," "approximately," or "substantially" for any numerical values or ranges indicate a suitable dimensional tolerance that allows the part or collection of components to function for its intended purpose as described herein.

Trailing arm suspensions are well known and commonly used in off-road vehicles such as four-wheeled buggies. A typical trailing arm suspension comprises a trailing arm having one end pivotally connected to a vehicle frame or chassis through a frame bracket and another end connected to the vehicle frame by a spring or strut. The trailing arm supports an axle to which the vehicle wheels are mounted. Road-induced reaction forces acting on the wheels are controlled by the pivoting of the trailing arm in response to these forces, with the forces being resisted by the spring. Given that off-road vehicles routinely travel over very rough terrain, such as mountainous regions, and are prone to tipping over, there is a desire to improve the mechanical strength, safety, convenience, and comfort of off-road vehicles, while at the same improving the performance of such vehicles. Embodiments disclosed herein provide an apparatus and methods for a tri-drive transmission for a rear mid-engine vehicle and configured for driving front wheels and two rear wheels individually.

FIG. **1** illustrates an exemplary embodiment of an off-road vehicle **100** that is particularly suitable for implementation of a tri-drive transmission in accordance with the present disclosure. As disclosed hereinabove, the off-road vehicle **100** generally is of a Utility Task Vehicle (UTV) variety that seats up to four occupants, includes a roll-over protection system **104**, and may have a cab enclosure **108**. As shown in FIG. **1**, rear wheels **112** of the off-road vehicle **100** are operably coupled with a chassis **116** by way of rear suspension trailing arms **120**. Front wheels **124** are operably coupled with the chassis **116** by way of a front suspension system **128**. It should be understood, however, that the rear suspension trailing arms **120** disclosed herein are not to be limited to the specific off-road vehicle **100** shown in FIG. **1**, but rather the rear suspension trailing arms **120** may be incorporated into a wide variety of vehicles, other than the off-road vehicle **100** of FIG. **1**, without limitation.

As will be recognized by those skilled in the art, the rear wheel **112** generally is fastened to the rear suspension trailing arm **120** by way of a wheel hub (not shown). Preferably, the wheel hub is rotatably attached to the rear suspension trailing arm **120** by way of one or more suitably sized roller bearings. As will be further recognized, the rear wheel **112** and wheel hub generally are driven by way of a constant velocity (CV) joint configured to convey torque from an engine of the vehicle.

Moreover, although the rear suspension trailing arm **120** illustrated and described herein is best suited for use in a rear suspension of a vehicle, it is contemplated that the trailing arm **120** is not to be limited to rear suspensions, but rather in some embodiments, the trailing arm **120** may be configured for use in a front suspension of a vehicle, without limitation, and without deviating beyond the spirit and scope of the present disclosure. For the sake of brevity, however, the trailing arm **120** is hereinafter discussed in connection with a rear suspension of a vehicle. As such, terms conveying a relative positioning of components or portions comprising the trailing arm **120**, such as "forward," "rearward," "back," "front," "proximal," and "distal," should not be construed as limiting in nature, but rather such terms should be understood merely as tools used to convey the details of the invention to those of ordinary skill in the art.

Turning, now, to FIG. **2**, a perspective view of an exemplary embodiment of tri-drive transmission **132** (hereinafter, "transmission **132**") is shown according to the present disclosure. The transmission **132** is suitable for a rear mid-engine 4WD vehicle, such as the off-road vehicle **100** shown in FIG. **1**. However, it is to be understood that the transmission **132** is not limited to off-road vehicles, but rather the transmission **132** may be implemented in a wide variety of different vehicles, without limitation. For example, FIG. **7** illustrates an exemplary embodiment of a Stadium Truck **260** that is suitable for the transmission **132** in accordance with the present disclosure. Further, FIG. **8** illustrates an exemplary embodiment of racing car **280** that is suitable for the transmission **132** in accordance with the present disclosure. It is contemplated that the transmission **132** may be incorporated into any of UTVs, Super Cars, Super Trucks and other racing vehicles, on-road automobiles, trucks, recreational vehicles, buses, boats and ships, earthmoving equipment, farming vehicles and tractors, various cargo moving vehicles, and the like, without limitation.

In general, the transmission **132** shown in FIG. **2** is adapted to receive power input, or torque, by way of a rear mounted engine of the vehicle and transmit the torque as power output to the front wheels **124** and the rear wheels **112** individually. The transmission **132** includes a power transfer portion **136**, such as a clutch or a torque converter, suitable for being coupled with the engine. A bell housing **140** comprising the transmission **132** is configured to be fastened to the engine. The transmission **132** includes a gearbox **144** that is in mechanical communication with the power transfer portion **136**. As will be appreciated, the gearbox **144** may include multiple gears and gear trains arranged to provide block conversions of rotational speed and torque received from the engine by way of the power transfer portion **136**. In some embodiments, the gearbox **144** may include a differential, as needed, and without limitation.

As shown in FIGS. **2-3**, the gearbox **144** is configured to conduct torque from the engine to a forward output portion **148** as well as to flanking side output portions **152**, **156**. The forward output portion **148** is adapted to conduct torque to the front wheels **124** (see FIG. **1**) and may include an air clutch **160** and a hub **164**. The air clutch **160** is configured to facilitate controlling the degree of torque that is transferred to the front wheels **124**. The air clutch **160** may be of a variety of air clutch that becomes engaged upon receiving compressed air and disengages when the air is released or vented. It is contemplated that the degree of torque transferred by air clutch **160** may be adjusted between about 0% and about 100% of the torque provided by way of the gearbox **144**.

The hub **164** is configured to place the forward output portion **148** into mechanical communication with the front wheels **124** by way of a drive shaft **166** and a front transaxle **168** (see FIG. **4**). In some embodiments, one or more a constant velocity (CV) joint, or other suitable joints, may be used to connect the drive shaft **166** between the hub **164** and the front transaxle. In some embodiments, the front transaxle **168** may comprise a portion of a front structural bulkhead comprising the vehicle **100**. Details pertaining to incorporating front transaxles into front structural bulkheads are discussed in greater detail in U.S. Provisional Patent Application, entitled "Front Structural Bulkhead For Vehicle Chassis," filed on Mar. 22, 2021, and having application Ser. No. 63/164,079, the entirety of said application being incorporated herein by reference.

In some embodiments, the forward output portion **148** may be omitted and thus the transmission **132** may comprise a "twin-drive" that includes only the side outputs **152**, **156**. It is contemplated that such a twin-drive will be particularly advantageous for various types of boats, such as, by way of example, UTV boats, mini jet boats, speedboats, catamarans, and the like, without limitation.

With continuing reference to FIGS. **2-3**, a passenger-side gear transfer case **172** is disposed between the gearbox **144** and the side output portion **152** while a driver-side gear transfer case **176** is disposed between the gearbox **144** and the side output portion **156**. The gear transfer cases **172**, **176** house components configured to communicate torque to the side output portions **152**, **156**. In some embodiments, either or both of the gear transfer cases **172**, **176** include gear trains that are configured to respectively communicate torque from the gearbox **144** to the side output portions **152**, **156**. In some embodiments, either or both of the gear transfer cases **172**, **176** may include either a chain or a belt drive configured to conduct torque to the side output portions **152**, **156**. As described herein, the gear transfer cases **172**, **176** generally are configured to cause the side output portions **152**, **156** to rotate in directions that cause the rear wheels **112** to rotate in the same direction.

With continuing reference to FIGS. **2-3**, the side output portions **152**, **156** are configured to transmit torque to the rear wheels **112** (see FIG. **1**) by of rear axles, as described herein. To this end, the side output portion **152** includes an air clutch **180** and a hub **184** while the side output portion **156** includes an air clutch **188** and a hub **192**. It is contemplated that either or both of the air clutches **180**, **188** are substantially identical to the air clutch **160**. As such, the air clutch **180** facilitates controlling the degree of torque that is transferred to the rear passenger-side wheel **112** while the air clutch **188** facilitates controlling the degree of torque that is transferred to the rear driver-side wheel **112**. The hubs **184**, **192** are configured to place the side output portions **152**, **156** into mechanical communication with the rear wheels **112**, as described herein. As will be appreciated, in some embodiments, the hubs **184**, **192** are configured to receive a CV joint and a drive axle whereby the rear wheels **112** may be put into rotation.

As best shown in FIG. **3**, the transmission **132** generally receives a power input **200** from the engine to the gearbox **144** and distributes that power to the forward output portion **148** and the side portions **152**, **156**, in accordance with the present disclosure. Thus, the transmission **132** effectively directs a portion of the power input **200** as a power output **204** to the front wheels **124** by way of the forward output portion **148**. Further, a power output **208** is directed to the rear passenger-side wheel **112** by way of the side output portion **152** while a power output **212** is directed to the rear driver-side wheel **112** by way of the side output portion **156**.

Moreover, the air clutches **160**, **180**, **188** are configured to facilitate controlling the power outputs **204**, **208**, **212**. For example, any one or more of the air clutches **160**, **180**, **188** may be configured as a "torque limiter" that facilitates controlling the degree of torque that is respectively output by way of the output portions **148**, **152**, **156**. As mentioned hereinabove, the degree of torque transferred by any of the air clutches **160**, **180**, **188** may be adjusted between about 0% and about 100% of the torque provided by way of the gearbox **144**. In some embodiments, the air clutches **160**, **180**, **188** may each include a solenoid and be suitably interconnected, by way of air hoses or other suitable tubing, such that air may be vented from any one or more of the air clutches **160**, **180**, **188** and routed into any other of the one or more of the air clutches **160**, **180**, **188**. Thus, the air clutches **160**, **180**, **188** generally comprise three electronically operable valves that may be controlled by a driver of the vehicle **100** in response to various road and/or driving conditions. For example, upon detecting that a wheel is beginning to slip, the driver may vent air from the appropriate air clutch to decrease the torque applied to the wheel. Further, the vented air may be routed to the remaining air clutches to avoid a loss in total power output due to the decreased torque being applied to the slipping wheel.

In some embodiments, the air clutches **160**, **180**, **188** may be controlled by way of an artificial intelligence configured to operate the air clutches **160**, **180**, **188** in response to detected road and/or driving conditions. For example, the artificial intelligence may comprise a suitably programmed control unit that is electrically coupled with various sensors that supply the control unit with data about the operation of the vehicle **100**. The control unit may operate the air clutches **160**, **180**, **188** based on the data received and thus intelligently control the power outputs **204**, **208**, **212** to accommodate road and/or driving conditions without any need for intervention by the driver.

Turning, now, to FIG. **4**, the transmission **132** is shown incorporated into a powertrain of an exemplary vehicle **100**, in accordance with the present disclosure. As shown in FIG. **4**, the vehicle **100** includes a chassis **116** that supports the transmission **132** and an engine **216**, as well as a front transaxle **168**. Rear wheels **112** of the vehicle **100** are operably coupled with the chassis **116** by way of rear suspension trailing arms **120**. Front wheels **124** are operably coupled with the chassis **116** by way of a front suspension system **128** (see FIG. **1**). As described herein, the engine **216** supplies power input **200** (see FIG. **3**) to the transmission **132**, and the transmission **132** divides the power input **200** among a front output portion **148** and side output portions **152**, **156**. As shown in FIG. **4**, the front output portion **148** is operably coupled to a front transaxle **168** by way of a driveshaft **166**. Further, a front axle **220** is coupled between the front transaxle **168** and front portal gears **224** coupled with each front wheel **124**. Thus, power output from the front output portion **148** is directed to the front wheels **124** by way of the front transaxle **168**, the front axles **220**, and the front portal gears **224**. The front portal gears **224** are discussed in greater detail in U.S. patent application, entitled "Front Portal Spindle Assembly," filed on Aug. 21, 2020, and having application Ser. No. 17/000,075, the entirety of said application being incorporated herein by reference.

With continuing reference to FIG. **4**, the side output portion **152** is operably coupled to a rear passenger-side wheel **112** by way of a rear axle **228**, bevel gears **232**, and rear portal gears **236**. Similarly, the side output portion **156** is operably coupled to a rear driver-side wheel **112** by way of a rear axle **240**, bevel gears **244**, and rear portal gears **248**. In general, CV joints couple the rear axle **228** between the side output portion **152** and the bevel gears **232**. The bevel gears **232** overcome an acute angle between the rear axle **228** and the rear portal gears **236** and thus put the rear axle **228** into rotational communication with the rear passenger-side wheel **112**.

Moreover, CV joints couple the rear axle **240** between the side output portion **156** and the bevel gears **244**. As will be appreciated, the bevel gears **244** couple the rear axle **240** with the rear portal gears **248** and thus put the rear axle **240** into rotational communication with the rear driver-side wheel **112**. The rear portal gears **236**, **248** may be incorporated into the trailing arms **120** or may comprise separate components that are fastened onto the trailing arms **120**, without limitation. Details pertaining to the rear portal gears **236**, **248** may be found in U.S. Provisional Patent Application, entitled "Rear Portal Gear Assembly For Trailing Arms," filed on May 24, 2021, and having application Ser. No. 63/192,202, the entirety of said application being incorporated herein by reference.

As mentioned above, the bevel gears **232** are configured to overcome the acute angle between the rear axle **228** and the rear portal gears **236** and thus put the rear axle **228** into rotational communication with the rear passenger-side wheel **112**. As best shown in FIGS. **5-6**, the bevel gears **232** comprise a pinion gear **252** that is coupled with the rear axle **228** and meshed with an output gear **256**. As shown in FIG. **5**, a distal bearing **264** and proximal bearings **268** can be used to support the pinion gear **252** within a housing (not shown). Further, the output gear **256** is coupled with a pinion gear **272** comprising the rear portal gears **236** by way of a shaft **276**. The pinion gear **272** is meshed with an output gear **284** that is engaged with the rear wheel by way of a spindle **288** (see FIG. **6**). As such, torque applied to the bevel gears **232** by the rear axle **228** is ultimately communicated to the rear wheel **112** by way of bevel gears **252**, **256**, the shaft **276**, portal gears **272**, **284**, and the spindle **288**.

It should be understood that although the bevel gears **232** have been discussed specifically in connection with the passenger-side of the vehicle **100**, the bevel gears **244** coupled with the driver-side wheel **112** are substantially identical to the bevel gears **232**, with the exception that the bevel gears **244** are configured specifically to operate with the rear driver-side wheel **112** of the vehicle **100**. As will be appreciated, therefore, the passenger-side and driver-side bevel gears **232**, **244** may be configured as reflections of one another across a longitudinal midline of the vehicle **100**.

As shown in FIG. **4**, the rear axles **228**, **240** are aligned with inboard portions of the trailing arms **120** unlike conventional drivetrains wherein the rear axles generally are perpendicular to the trailing arms. Further, the rear axles **228**, **240** are relatively longer than conventional rear axles and are disposed above the trailing arms **120**. Experimentation has demonstrated that positioning the rear axles **228**, **240** above the trailing arms **120** protects the rear axles **228**, **240** from potential damage due to impacts by rocks and other debris. Further, the length of the rear axles **228**, **240** and their alignment with the trailing arms **120** cause the CV joints to articulate in the same direction as the trailing arms **120**, resulting in less articulation angle, less plunging, and thus an increased vertical travel of the rear wheels **112**. Observations have shown that the rear axles **228**, **240**, illustrated in FIG. **4**, generally result in better handing of the vehicle **100** as compared to vehicles that include conventional rear axle arrangements.

While the tri-drive transmission and methods have been described in terms of particular variations and illustrative figures, those of ordinary skill in the art will recognize that the tri-drive transmission is not limited to the variations or figures described. In addition, where methods and steps described above indicate certain events occurring in certain order, those of ordinary skill in the art will recognize that the ordering of certain steps may be modified and that such modifications are in accordance with the variations of the tri-drive transmission. Additionally, certain of the steps may be performed concurrently in a parallel process when possible, as well as performed sequentially as described above. To the extent there are variations of the tri-drive transmission, which are within the spirit of the disclosure or equivalent to the tri-drive transmission found in the claims, it is the intent that this patent will cover those variations as well. Therefore, the present disclosure is to be understood as not limited by the specific embodiments described herein, but only by scope of the appended claims.

What is claimed is:

1. An assembly for communicating torque from a rear mounted engine to rear wheels of a vehicle, the assembly comprising:
  - a transmission coupled with the rear mounted engine;
  - a first side output portion and a second side output portion comprising the transmission;
  - an axle coupled with each of the first side output portion and the second side output portion;

a bevel gear assembly operationally disposed between each axle and a rear portal gear assembly; and

a spindle coupling each rear portal gear assembly with a rear wheel,

wherein the bevel gear assembly is configured to overcome an acute angle between the axle and the rear portal gear assembly so as to put the axle into rotational communication with the rear wheel.

2. The assembly of claim **1**, wherein the bevel gear assembly and the rear portal gear assembly are configured to communicate torque from the axle to the rear wheel.

3. The assembly of claim **1**, wherein the bevel gear assembly comprises a pinion gear that is coupled with the axle and meshed with an output gear.

4. The assembly of claim **3**, wherein the output gear is coupled with a pinion gear comprising the rear portal gear assembly by way of a shaft.

5. The assembly of claim **4**, wherein the pinion gear comprising the rear portal gear assembly is meshed with an output gear comprising the rear portal gear assembly.

6. The assembly of claim **5**, wherein the output gear comprising the rear portal gear assembly is configured to communicate torque to the rear wheel by way of the spindle.

7. An assembly for communicating torque from an axle to a rear wheel of a vehicle, the assembly comprising:

a bevel gear assembly for overcoming an acute angle between the axle and the rear wheel;

a rear portal gear assembly operatively coupled with the bevel gear assembly; and

a spindle for communicating torque from the rear portal gear assembly to the rear wheel.

8. The assembly of claim **7**, wherein the bevel gear assembly comprises a pinion gear that is coupled with the axle and meshed with an output gear.

9. The assembly of claim **8**, wherein the output gear is coupled with a pinion gear comprising the rear portal gear assembly by way of a shaft.

10. The assembly of claim **9**, wherein the pinion gear comprising the rear portal gear assembly is meshed with an output gear comprising the rear portal gear assembly.

11. The assembly of claim **10**, wherein the output gear comprising the rear portal gear assembly is configured to communicate torque to the rear wheel by way of the spindle.

12. A method for an assembly to communicate torque from a rear mounted engine to rear wheels of a vehicle, comprising:

configuring a first side output portion and a second side output portion comprising the transmission;

coupling the transmission with the rear mounted engine;

coupling an axle with each of the first side output portion and the second side output portion;

operationally disposing a bevel gear assembly between each axle and a rear portal gear assembly; and

configuring the rear portal gear assembly to communicate torque from the bevel gear assembly to the rear wheel,

wherein, operationally disposing includes configuring the bevel gear assembly to overcome an acute angle between the axle and the rear portal gear assembly so as to put the axle into rotational communication with the rear wheel.

13. The method of claim **12**, wherein operationally disposing includes configuring the bevel gear assembly and the rear portal gear assembly to communicate torque from the axle to the rear wheel.

14. The method of claim **12**, wherein operationally disposing the bevel gear assembly includes coupling a pinion gear with the axle and meshing the pinion gear with an output gear.

15. The method of claim **14**, wherein operationally disposing includes coupling the output gear with a pinion gear comprising the rear portal gear assembly by way of a shaft.

16. The method of claim **15**, wherein configuring the rear portal gear assembly includes meshing the pinion gear comprising the rear portal gear assembly with an output gear comprising the rear portal gear assembly.

17. The method of claim **16**, wherein configuring the rear portal gear assembly includes coupling each rear portal gear assembly with a rear wheel by way of a spindle.

18. The method of claim **17**, wherein coupling each rear portal gear assembly includes configuring the output gear comprising the rear portal gear assembly to communicate torque to the rear wheel by way of the spindle.

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