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Foxhall et al.

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(54) **GEAR ASSEMBLY FOR A VEHICLE**

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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 26 days.

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(65) **Prior Publication Data**

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Related U.S. Application Data

(62) Division of application No. 17/639,231, filed as application No. PCT/EP2020/074166 on Aug. 28, 2020, now Pat. No. 11,946,530.

(Continued)

(51) **Int. Cl.**
F16H 37/02 (2006.01)

(52) **U.S. Cl.**
CPC ***F16H 37/021*** (2013.01)

(58) **Field of Classification Search**
CPC F16H 3/10; F16H 29/12; F16H 31/004; F16H 31/006; F16H 37/021; F16D 15/00; F16D 41/06
See application file for complete search history.

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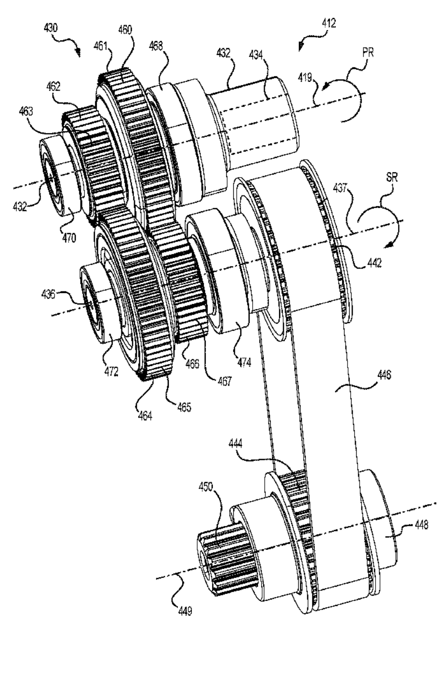
(74) *Attorney, Agent, or Firm* — BCF LLP

(57) **ABSTRACT**

A gearing assembly for a vehicle drivetrain. The assembly includes a first shaft rotating about a first shaft axis; a second shaft with a second shaft axis parallel to the first shaft axis; a first freewheel clutch gear mounted to the first shaft; a second gear mounted to the first shaft; a third freewheel clutch gear mounted to the second shaft and engaged with the second gear; and a fourth gear mounted to the second shaft and engaged with the first gear. When the first shaft rotational speed is greater than the second shaft rotational speed, the first shaft drives the second shaft via the second and third gear, the first gear being overrun; and when the second shaft rotational speed is greater than the first shaft rotational speed, the second shaft drives the first shaft via the fourth and first gear, the third gear being overrun.

10 Claims, 41 Drawing Sheets



Related U.S. Application Data

(60) Provisional application No. 62/893,901, filed on Aug. 30, 2019.

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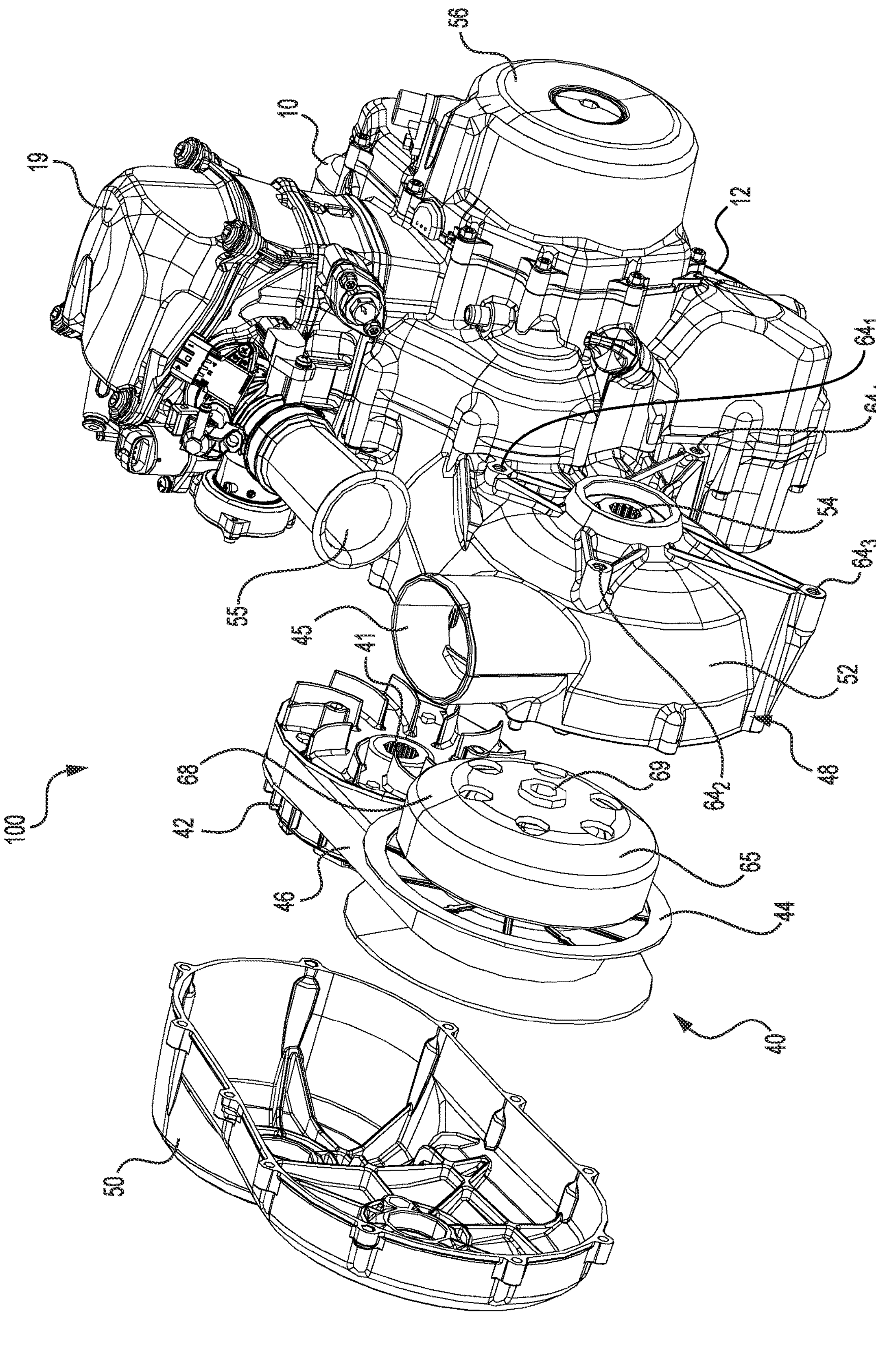
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FIG. 1

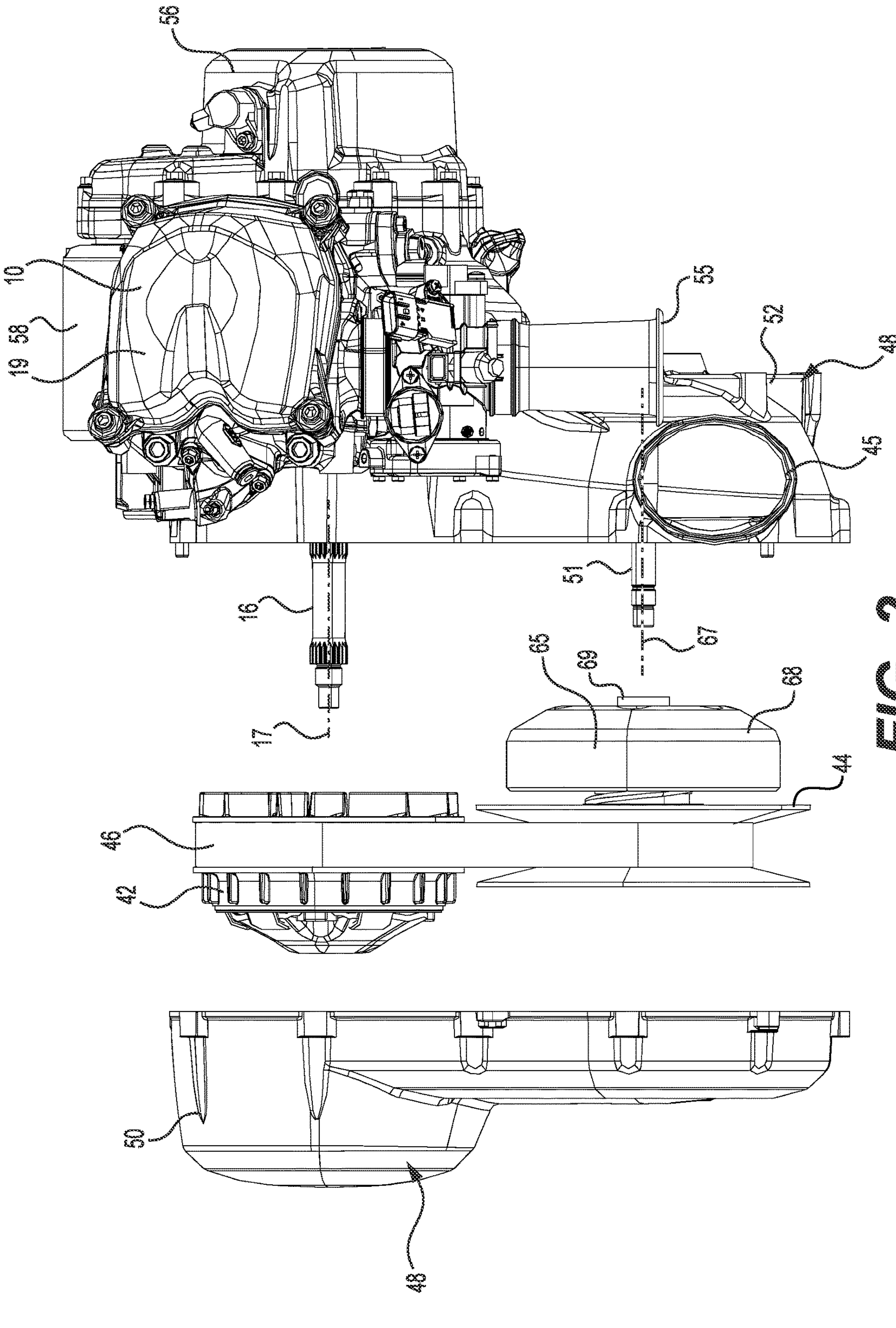


FIG. 2

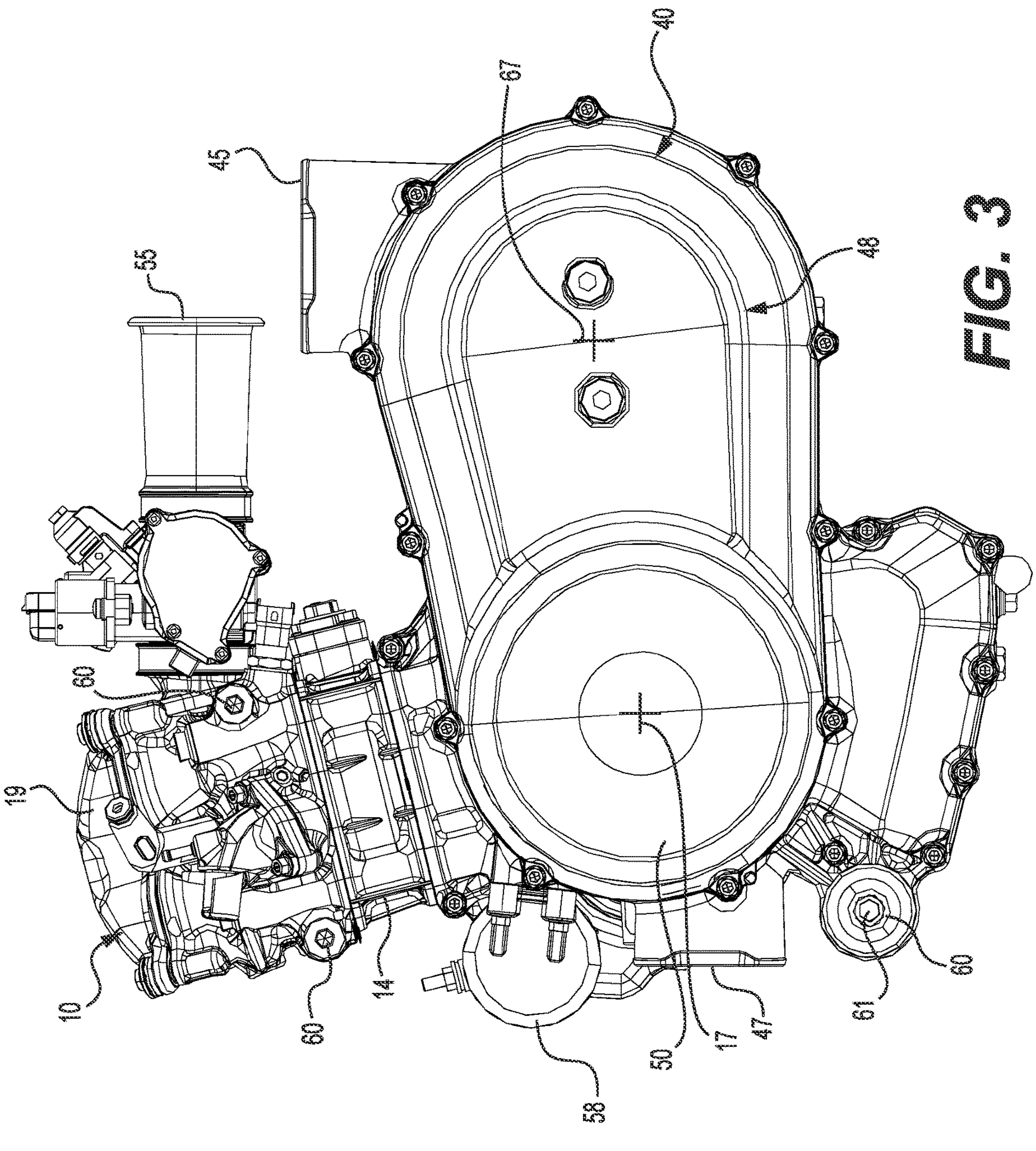
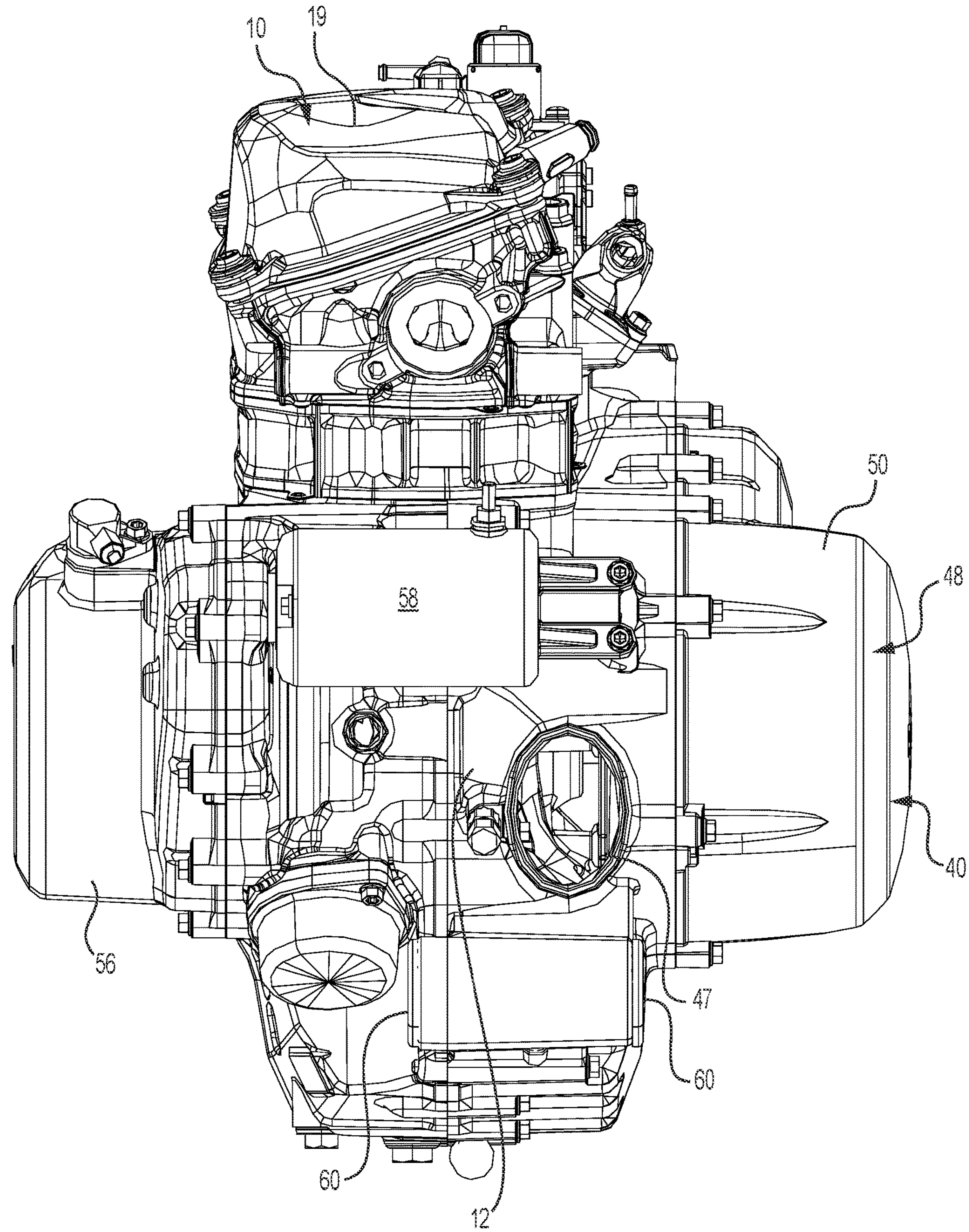


FIG. 3



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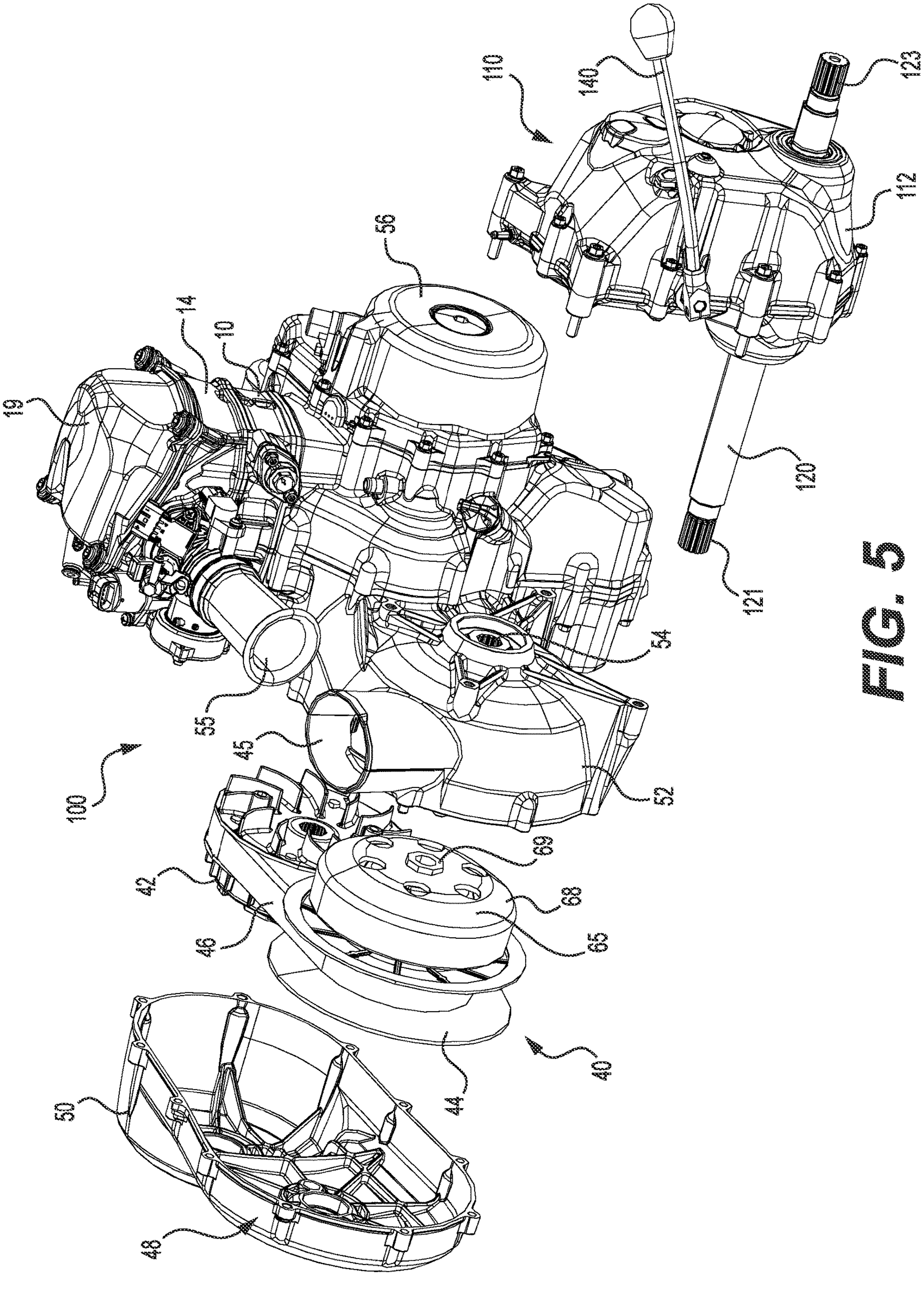
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FIG. 5

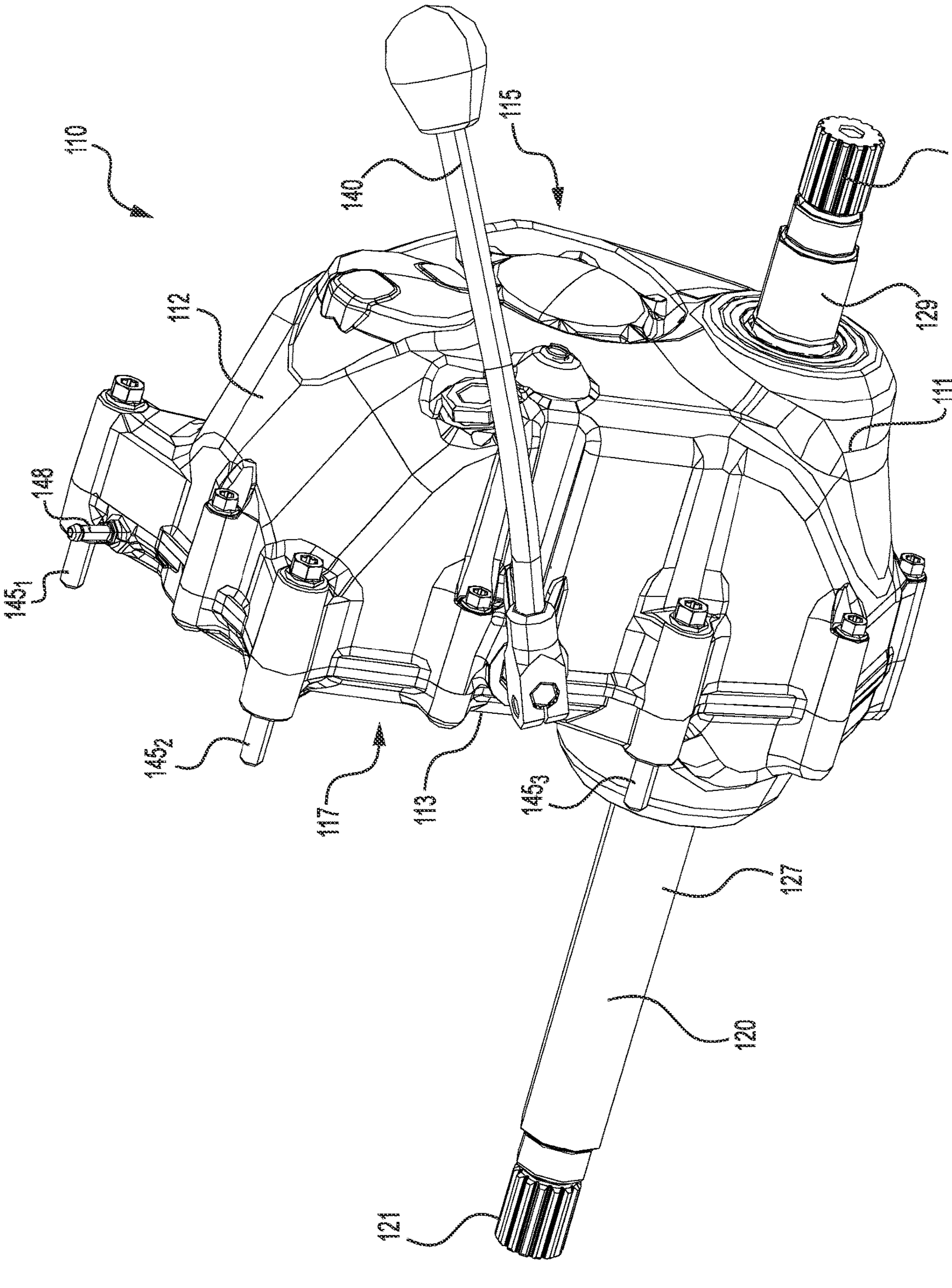
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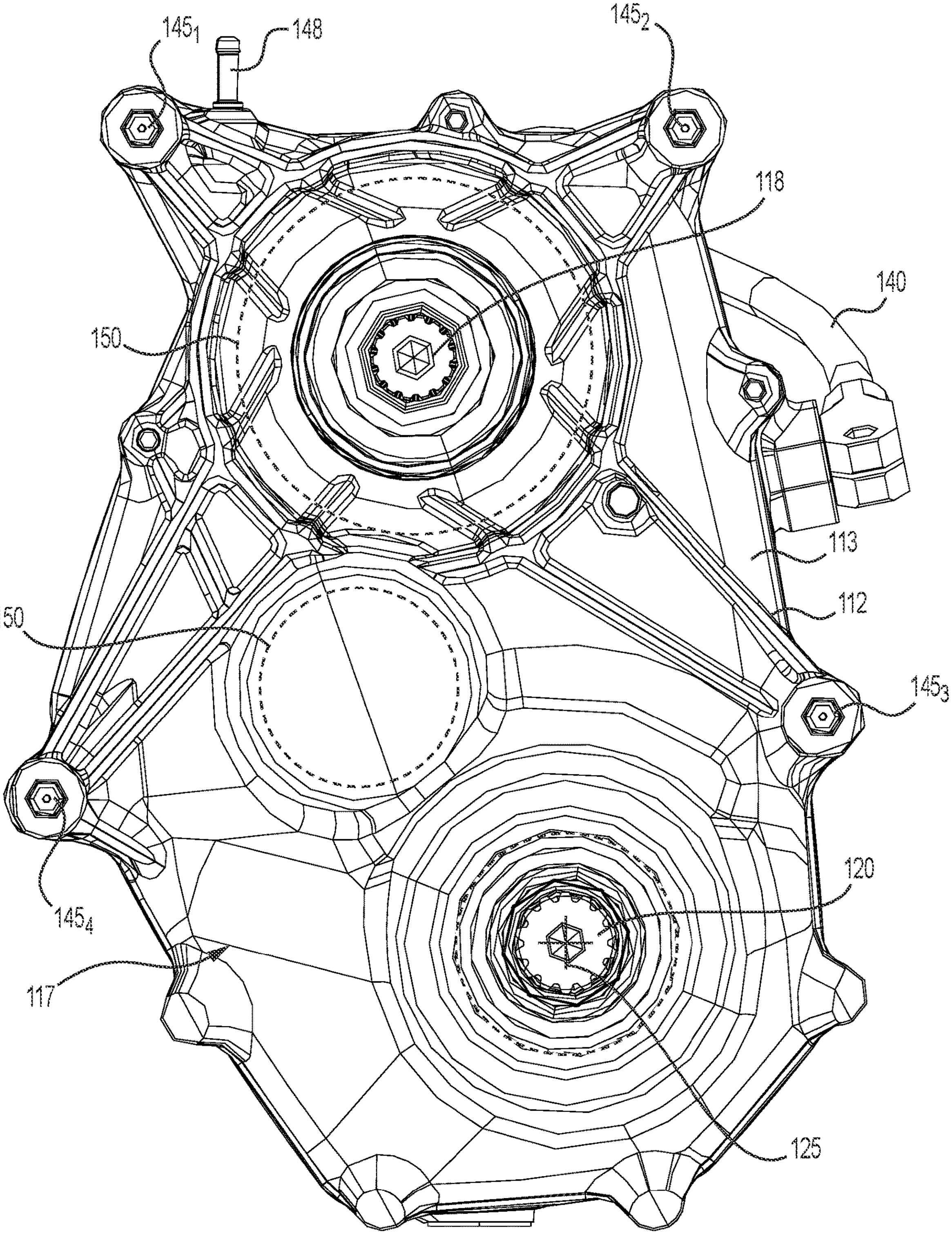
FIG. 6



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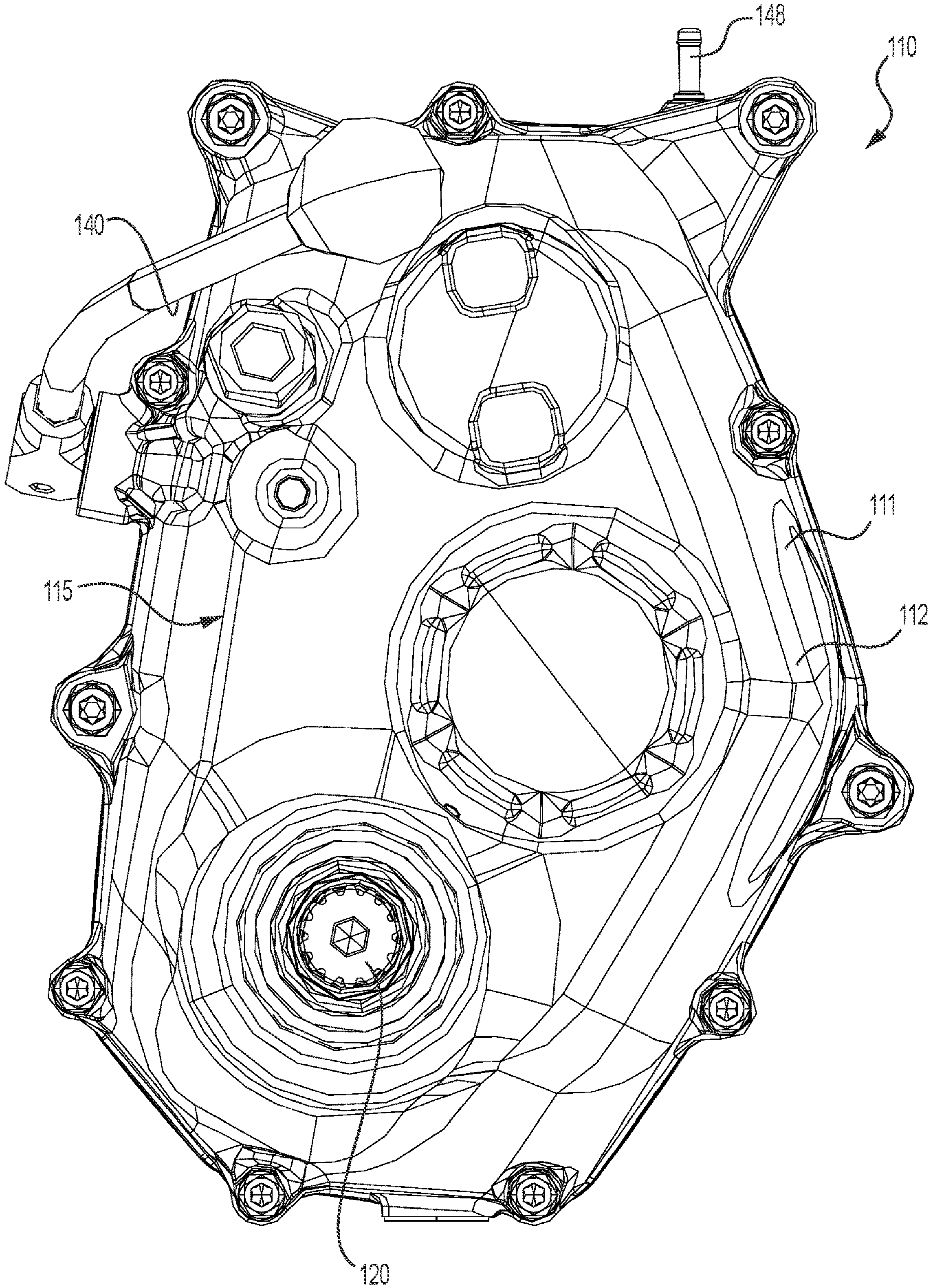

FIG. 8

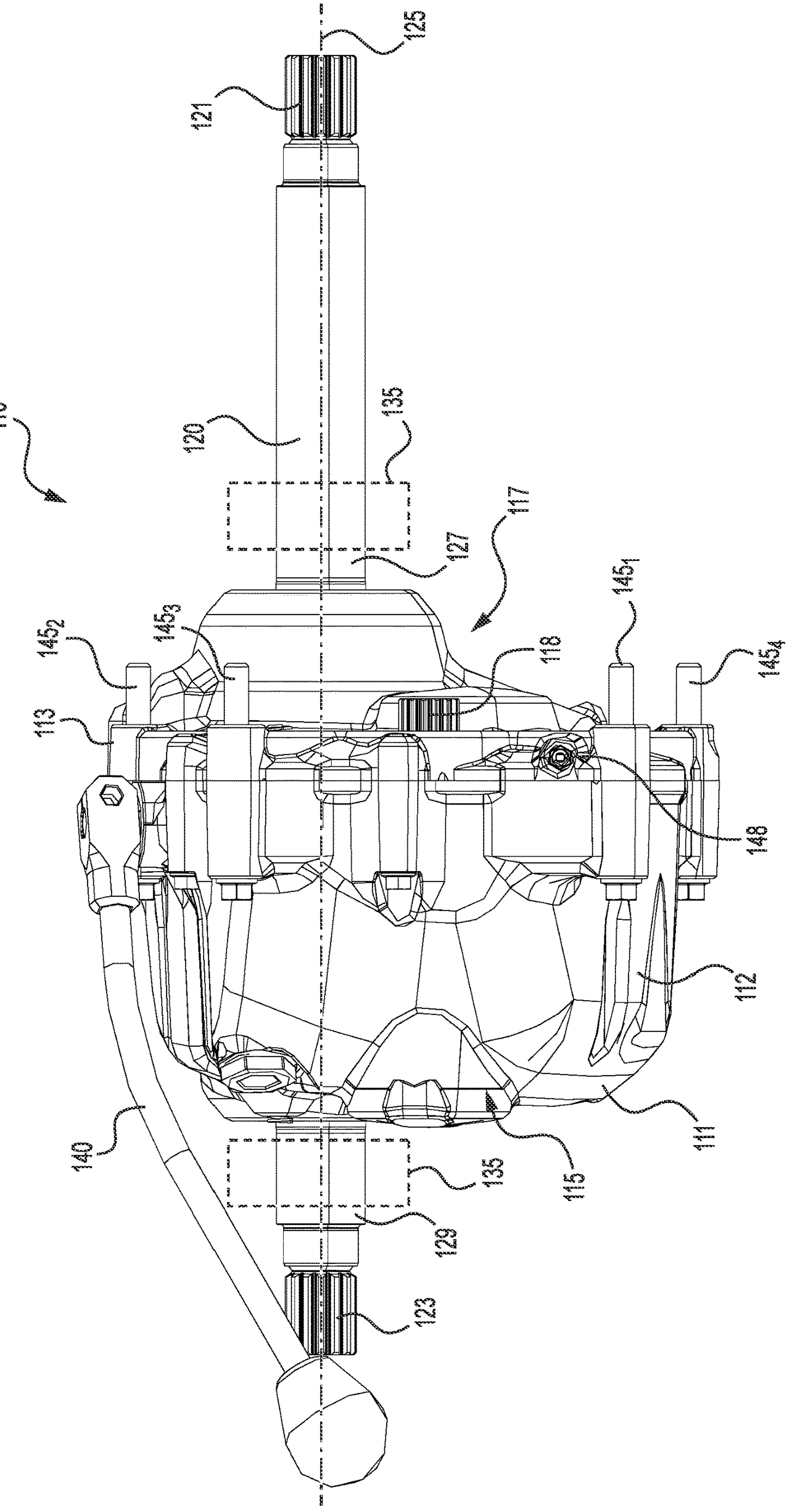
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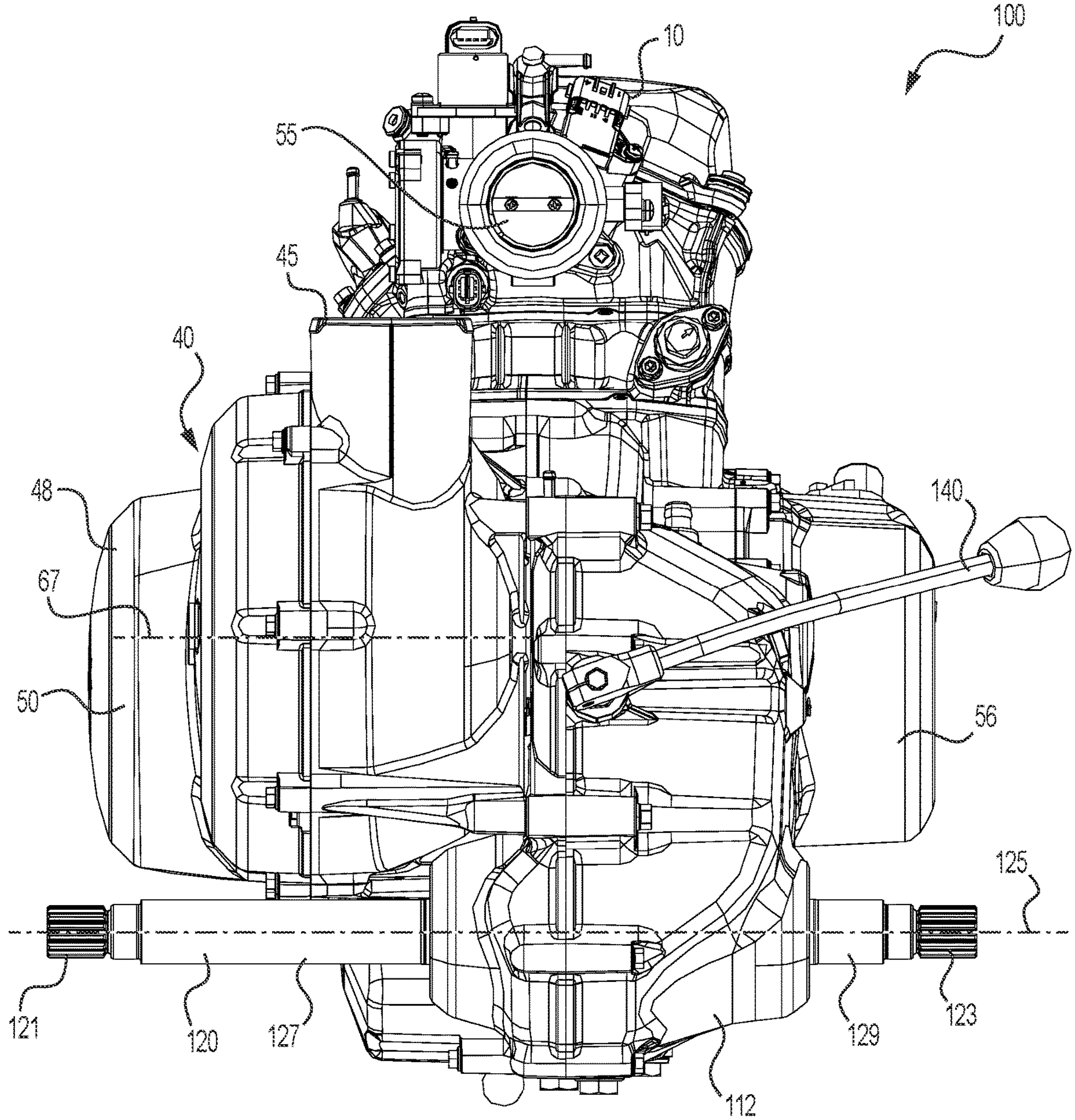
FIG. 9



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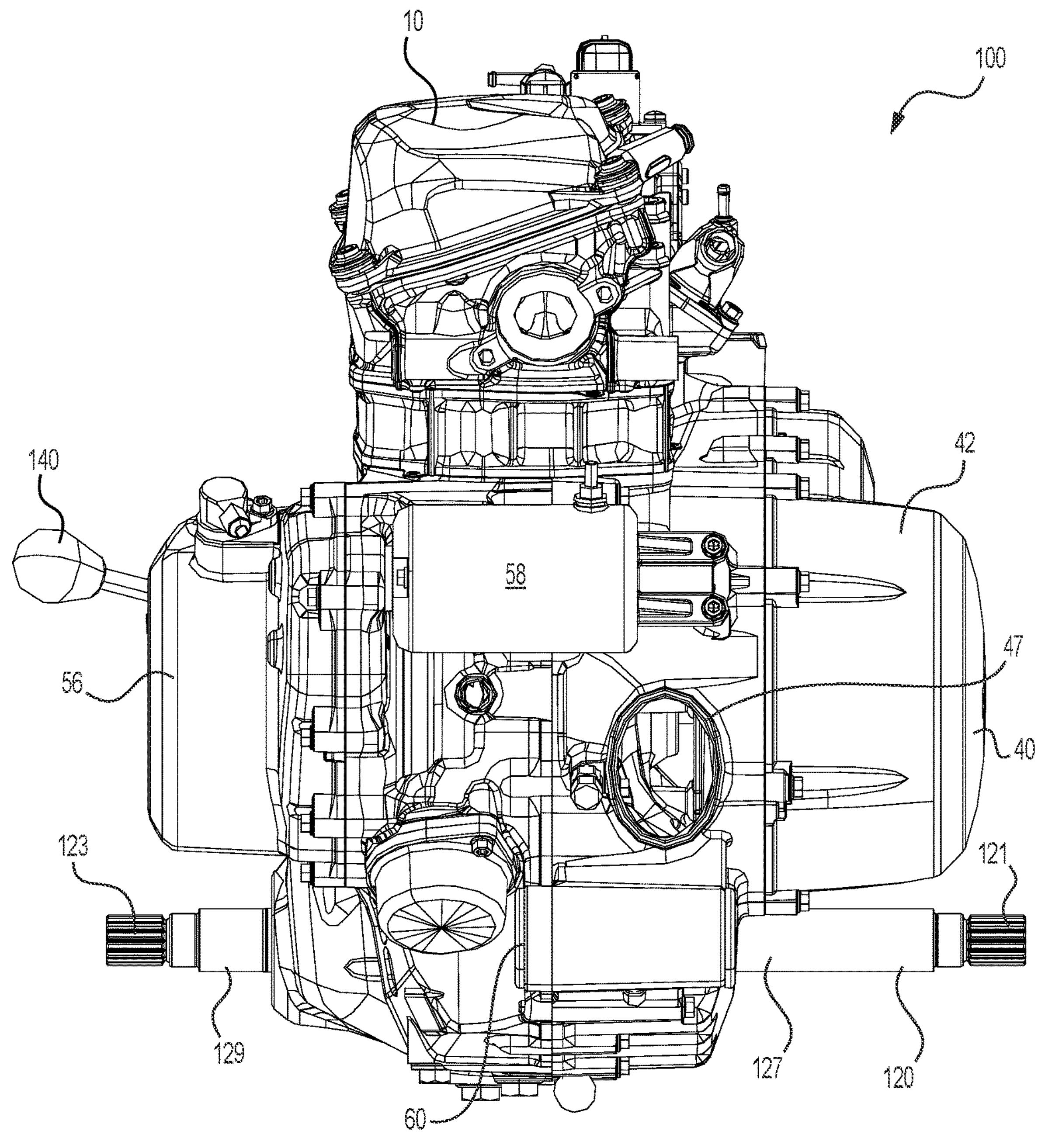

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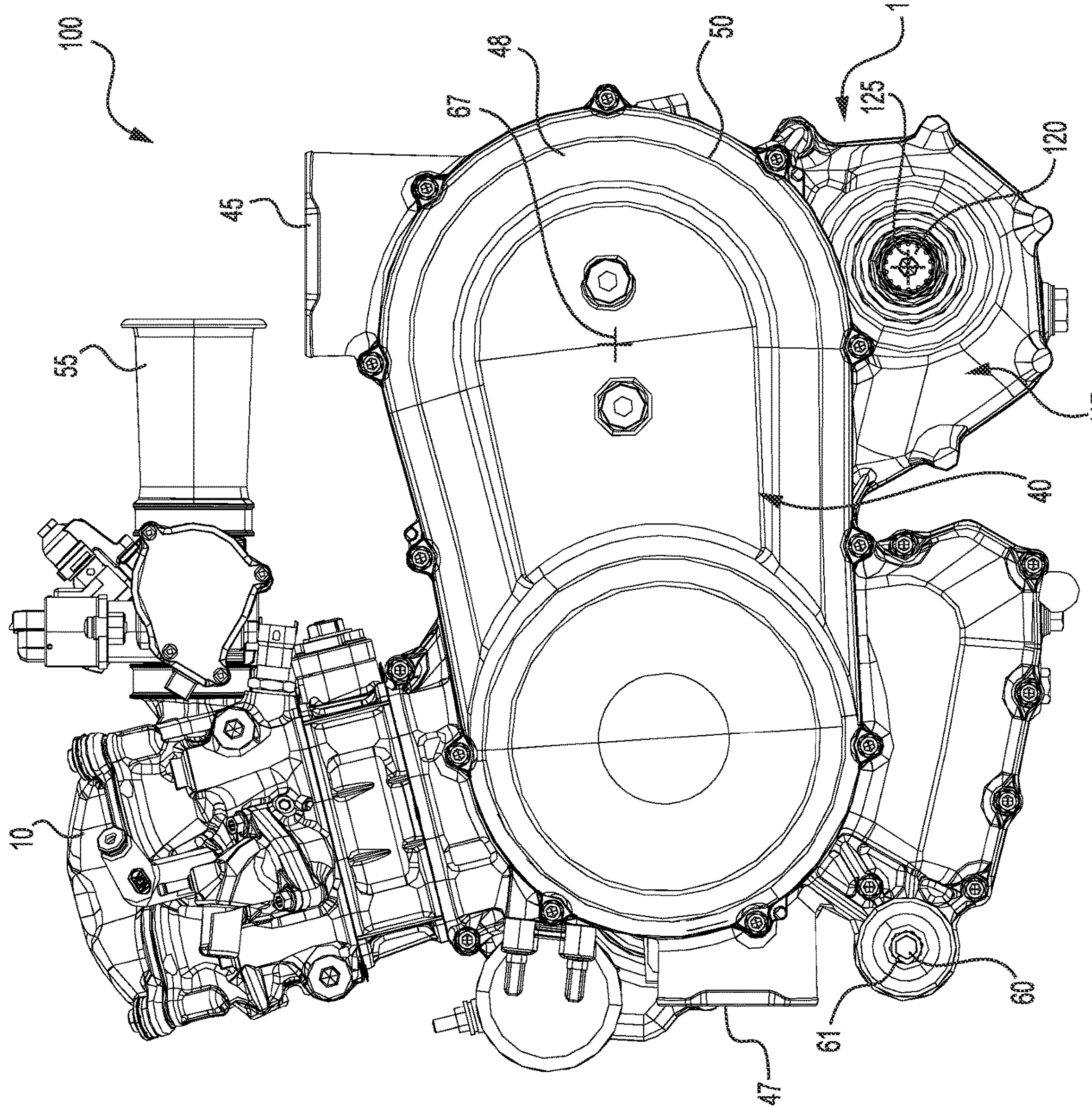
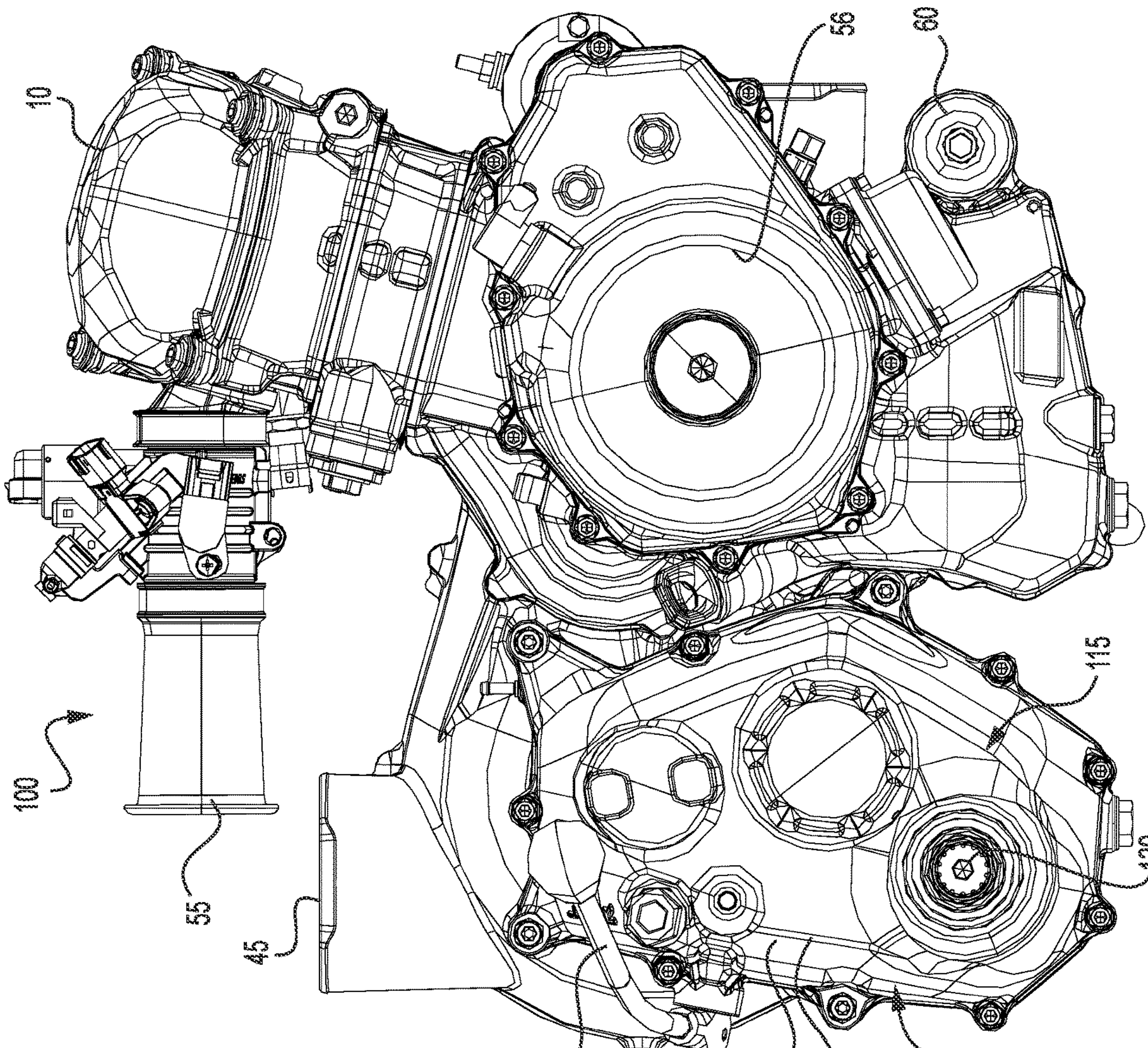
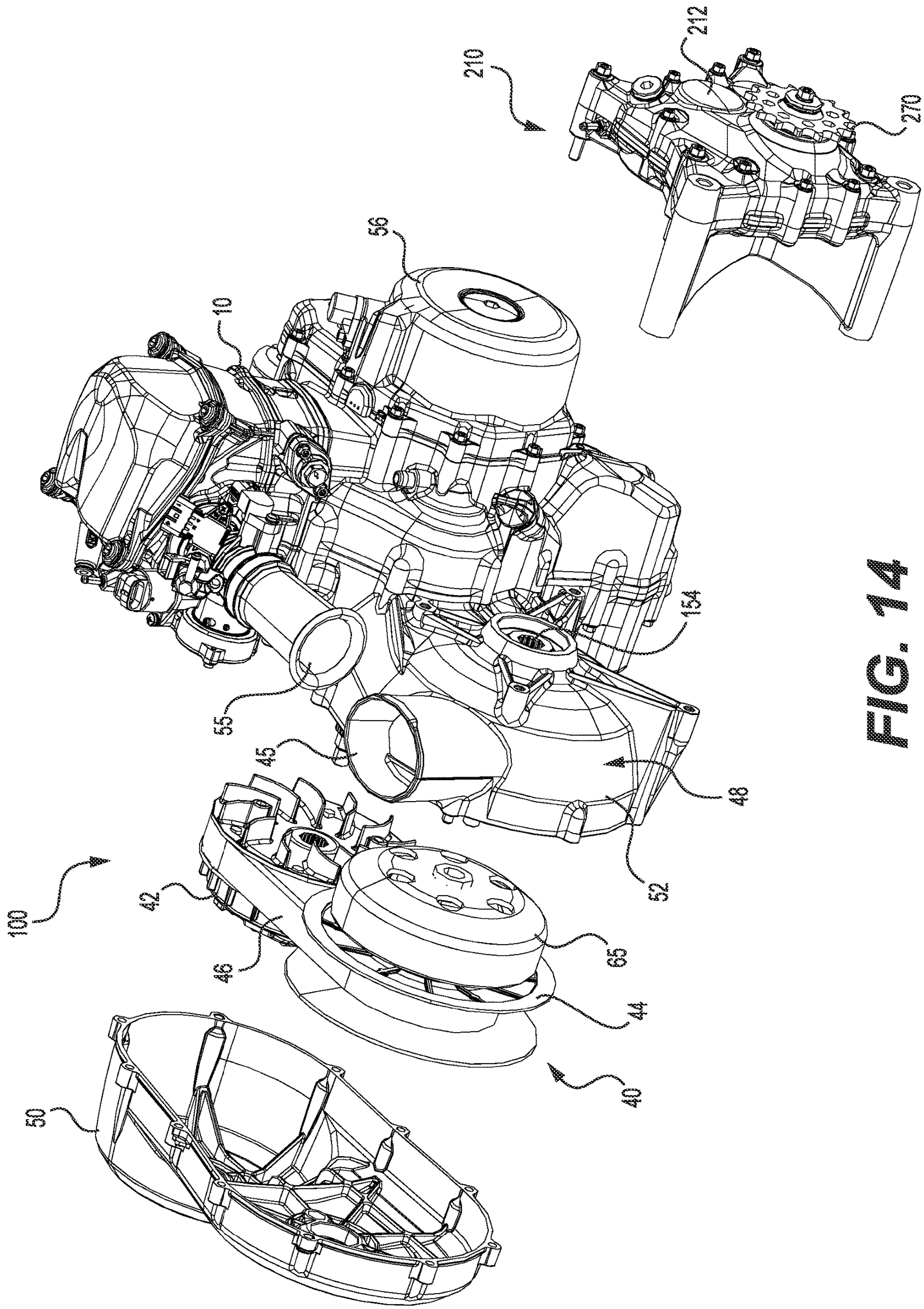


FIG. 12

FIG. 13





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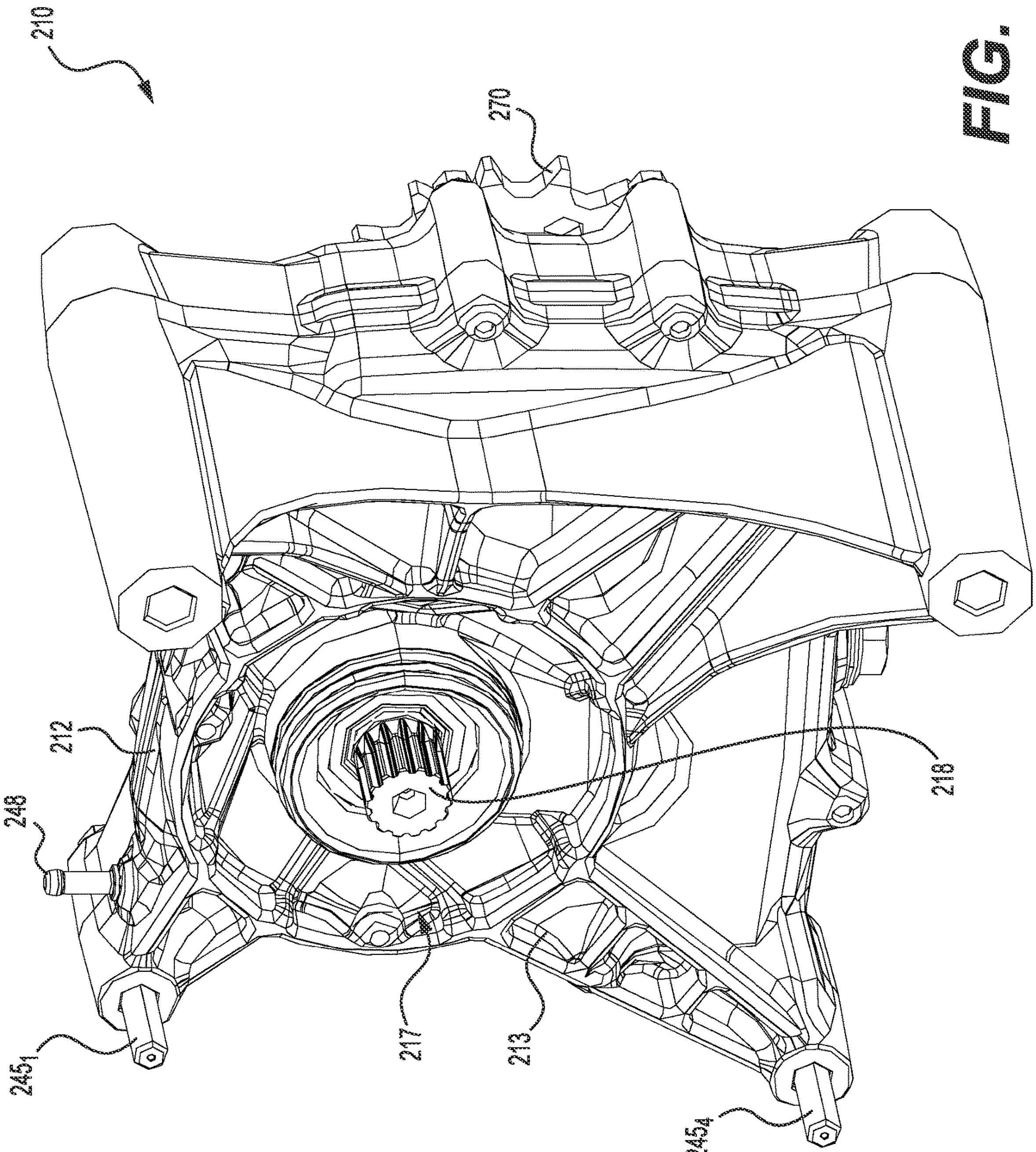

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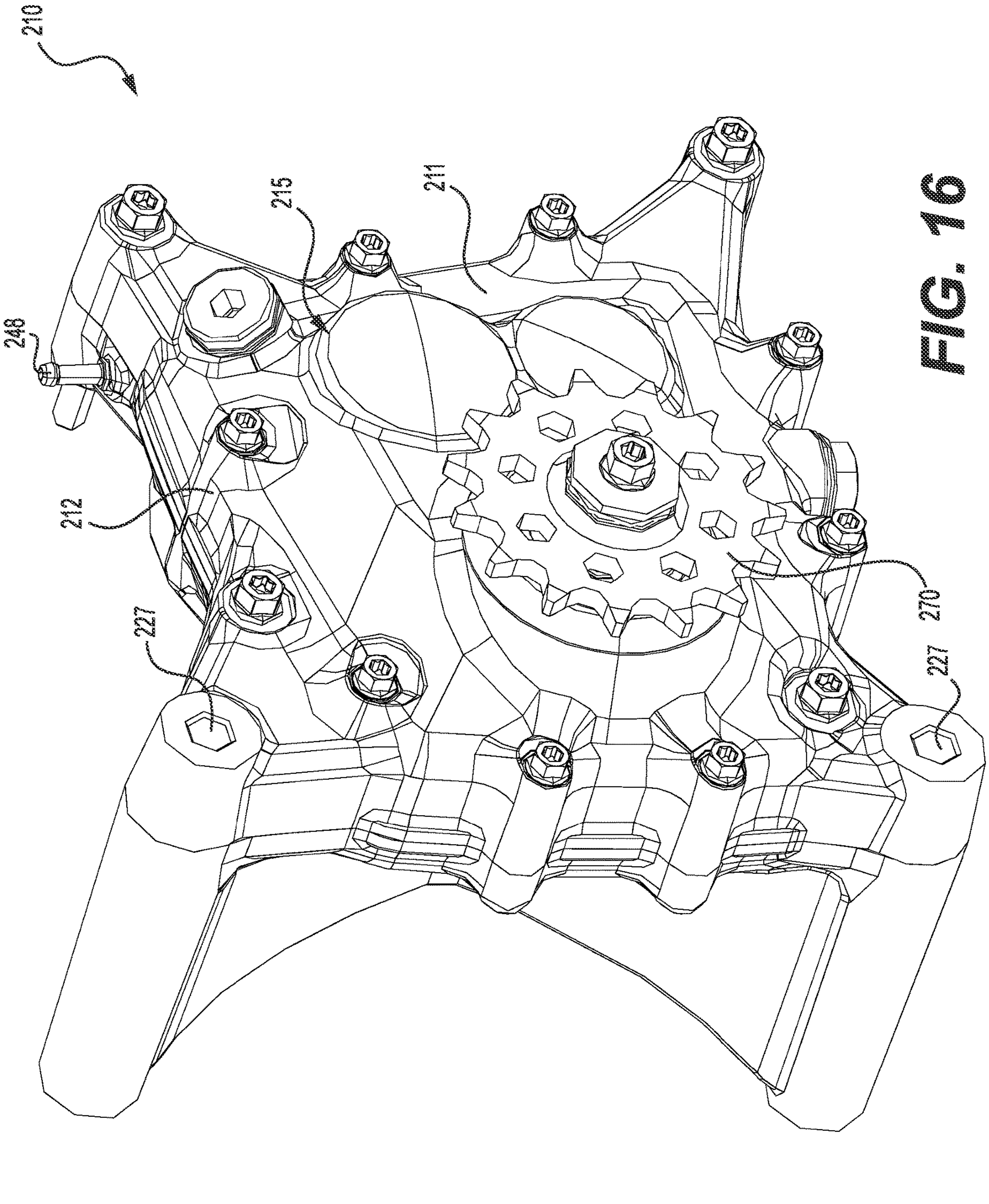

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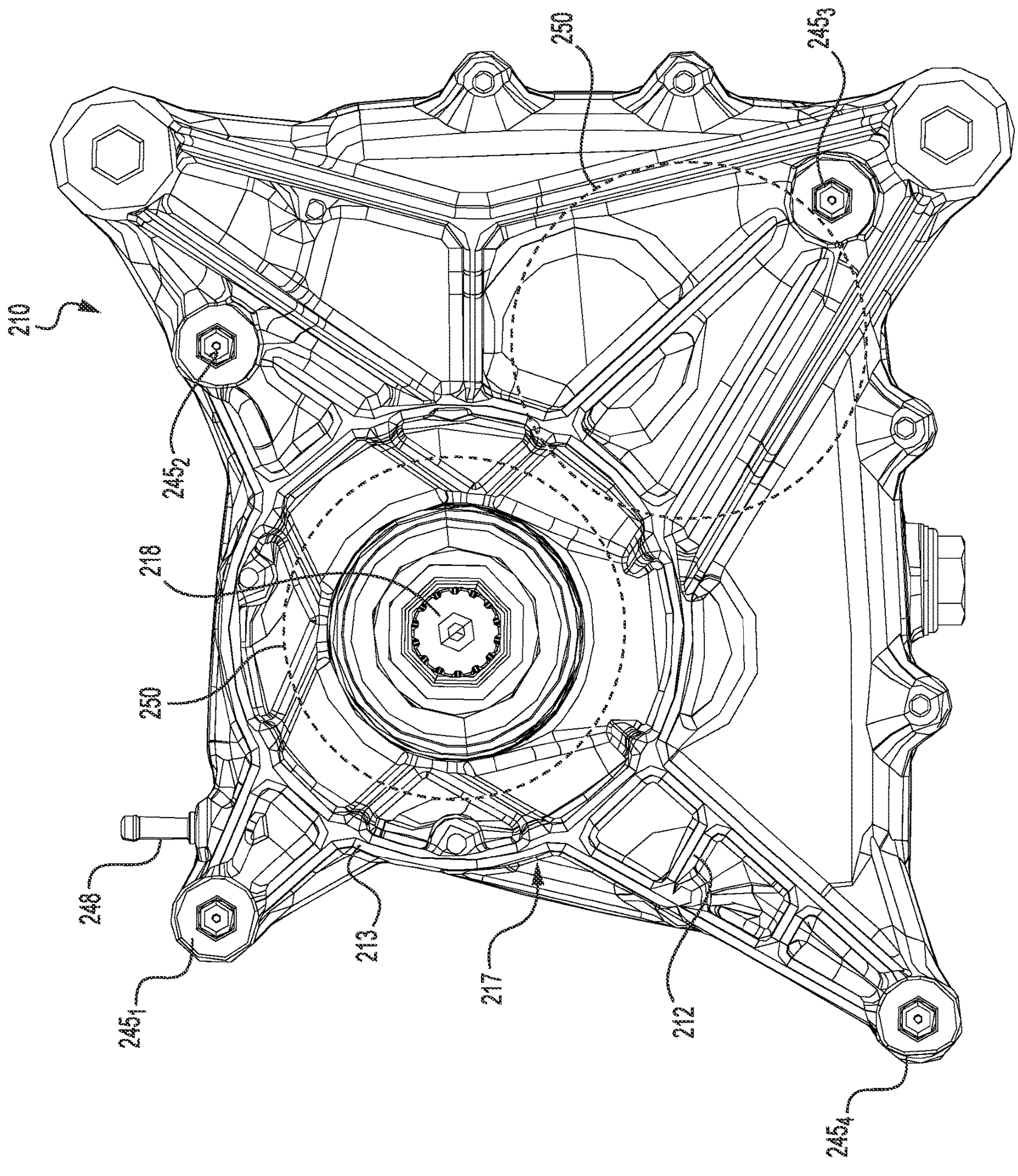

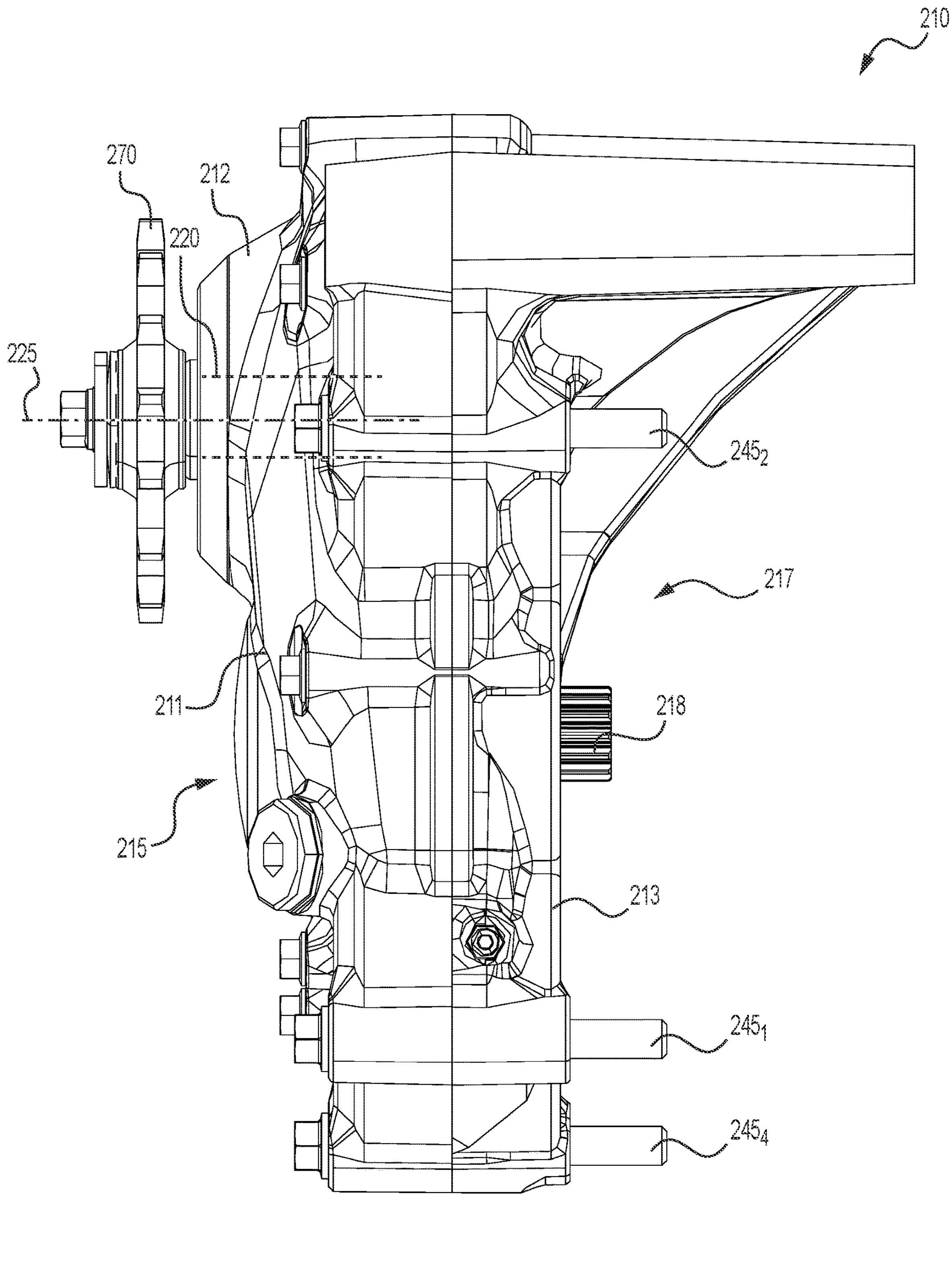

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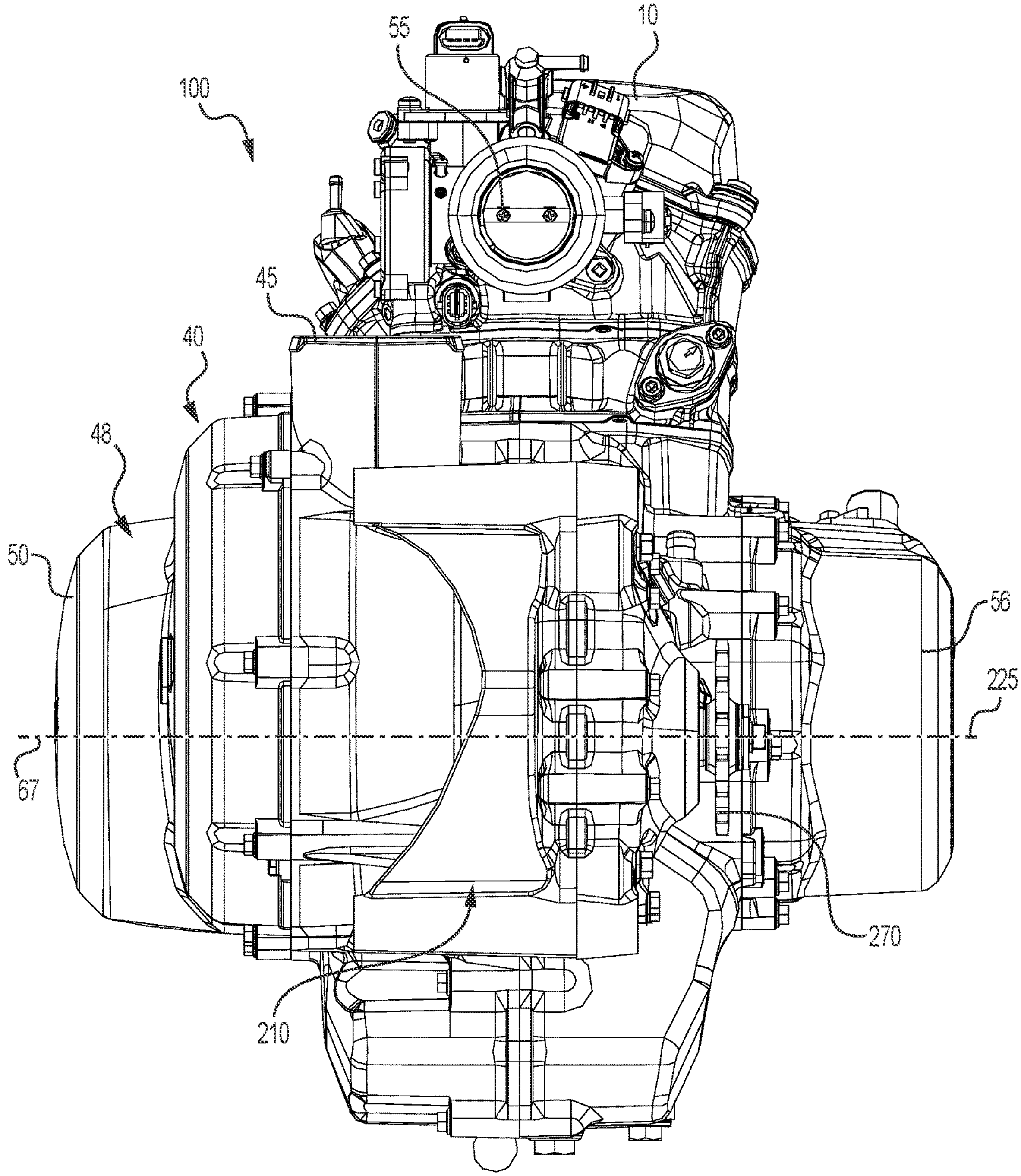

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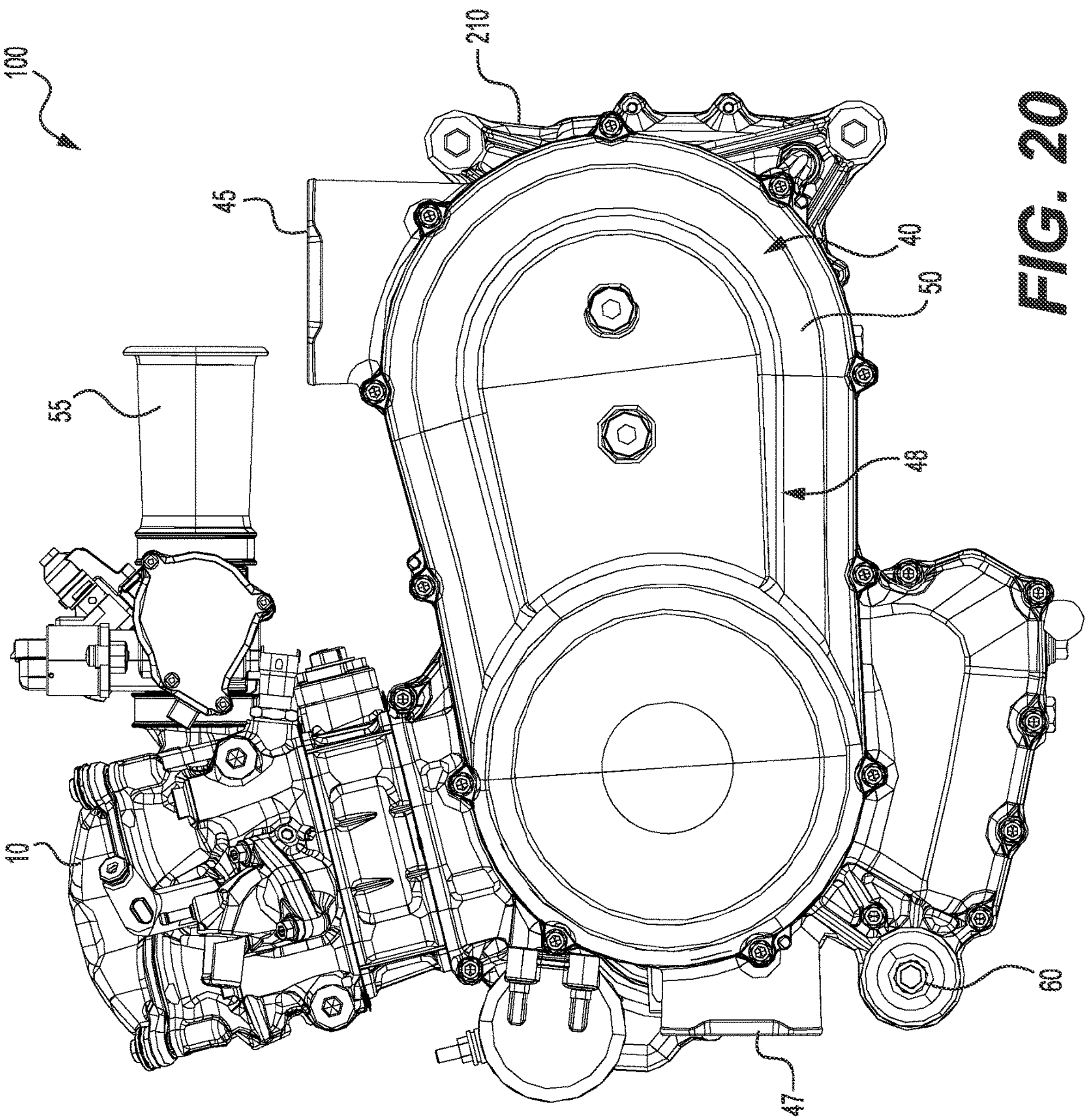

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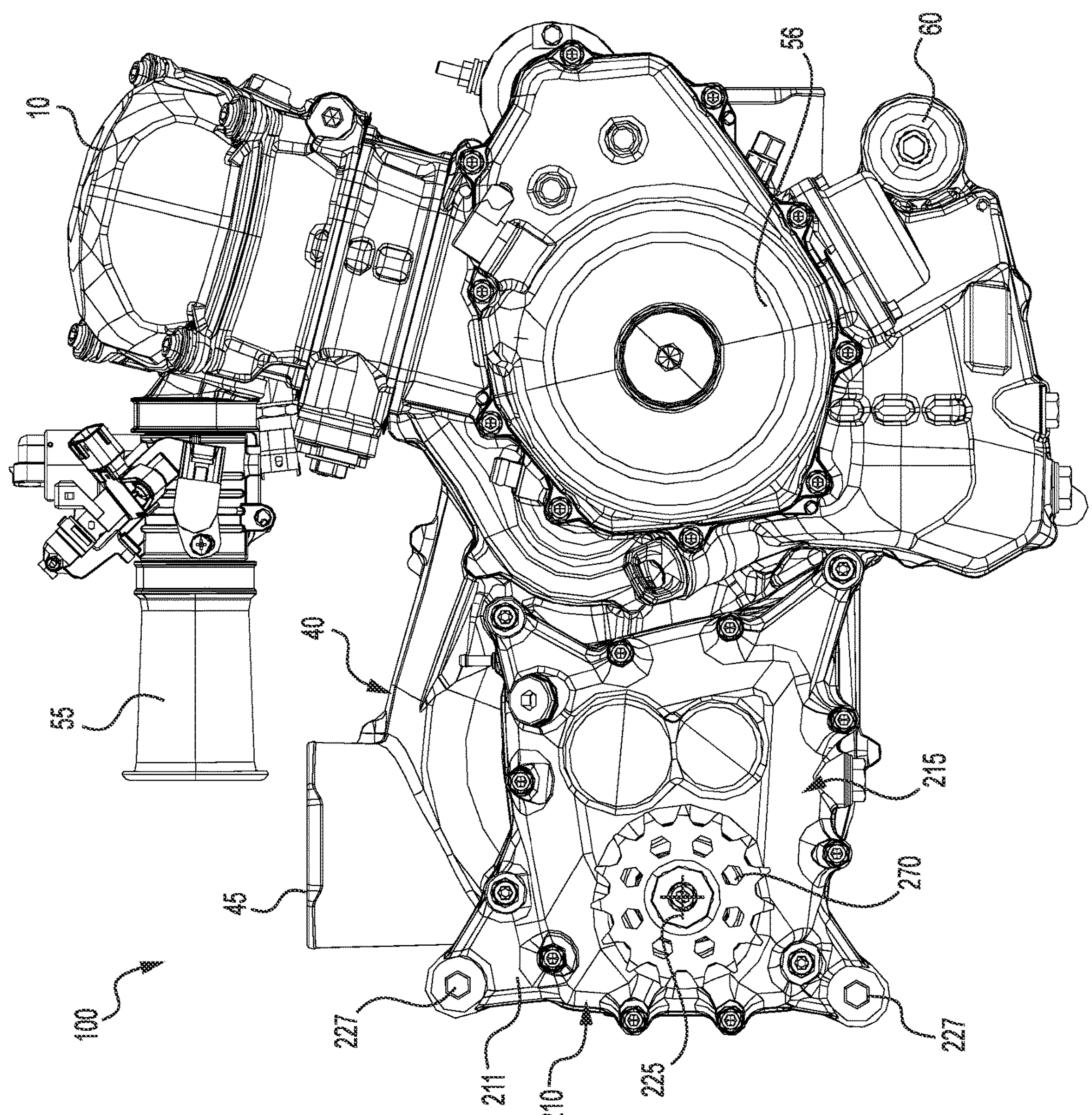

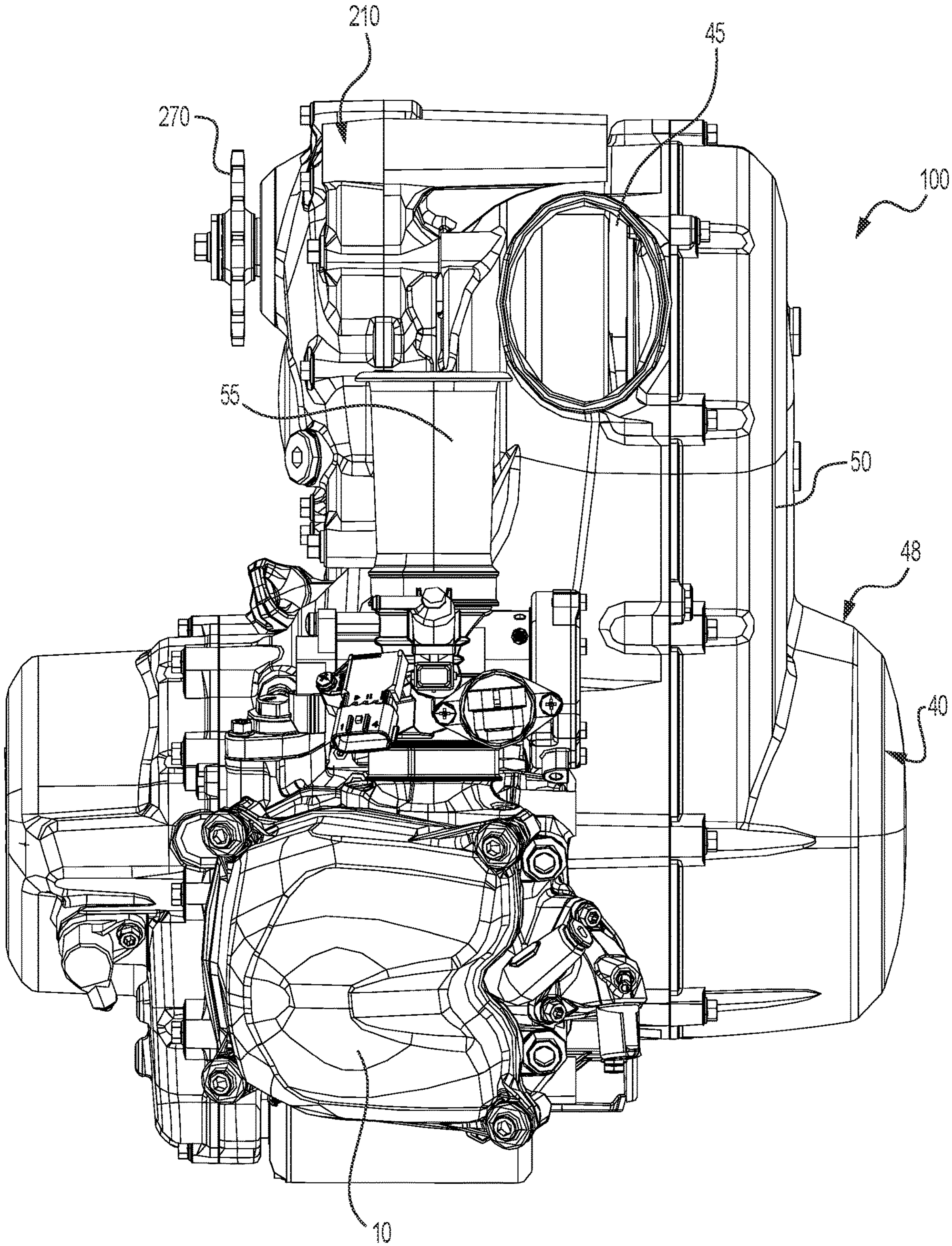

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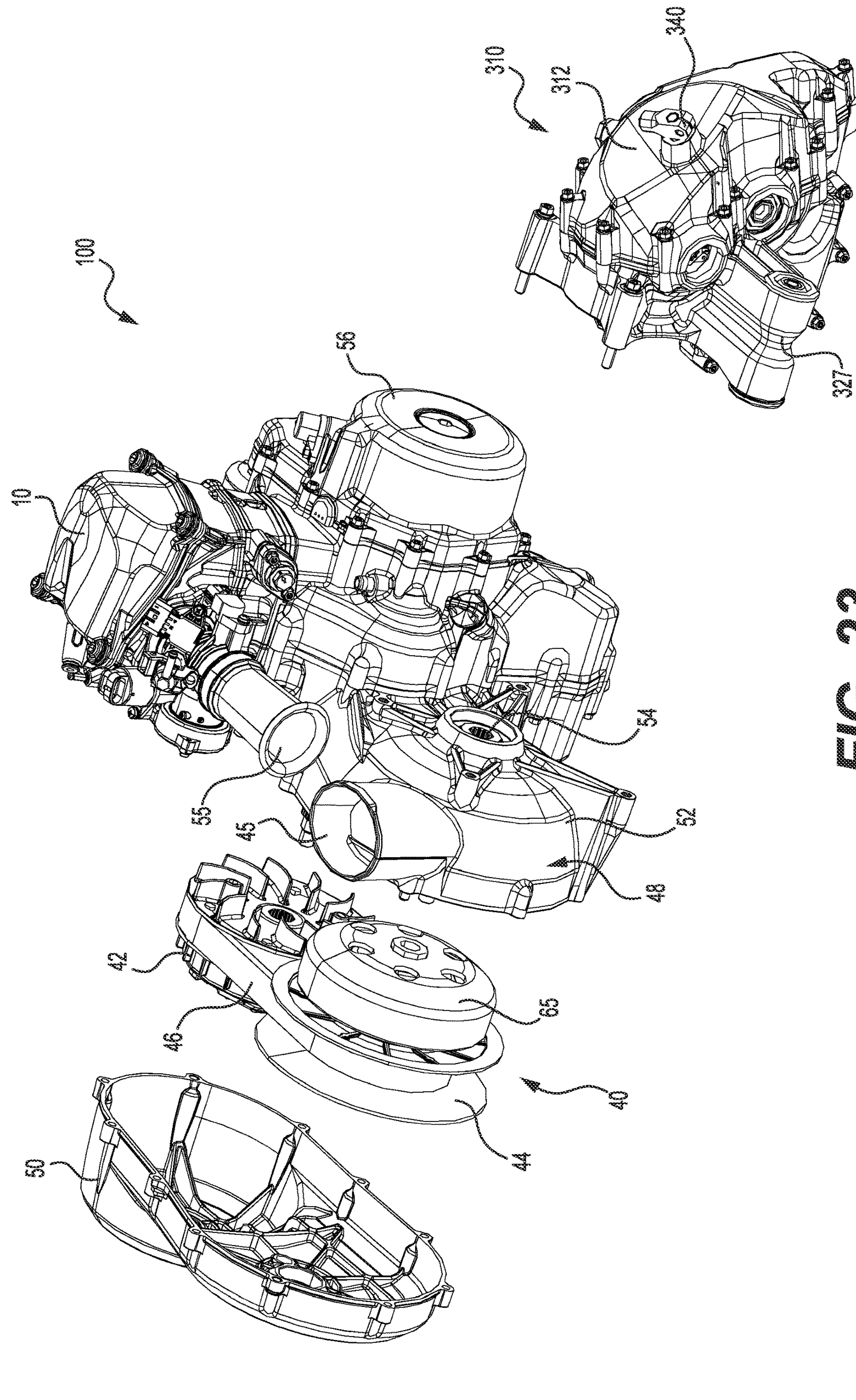

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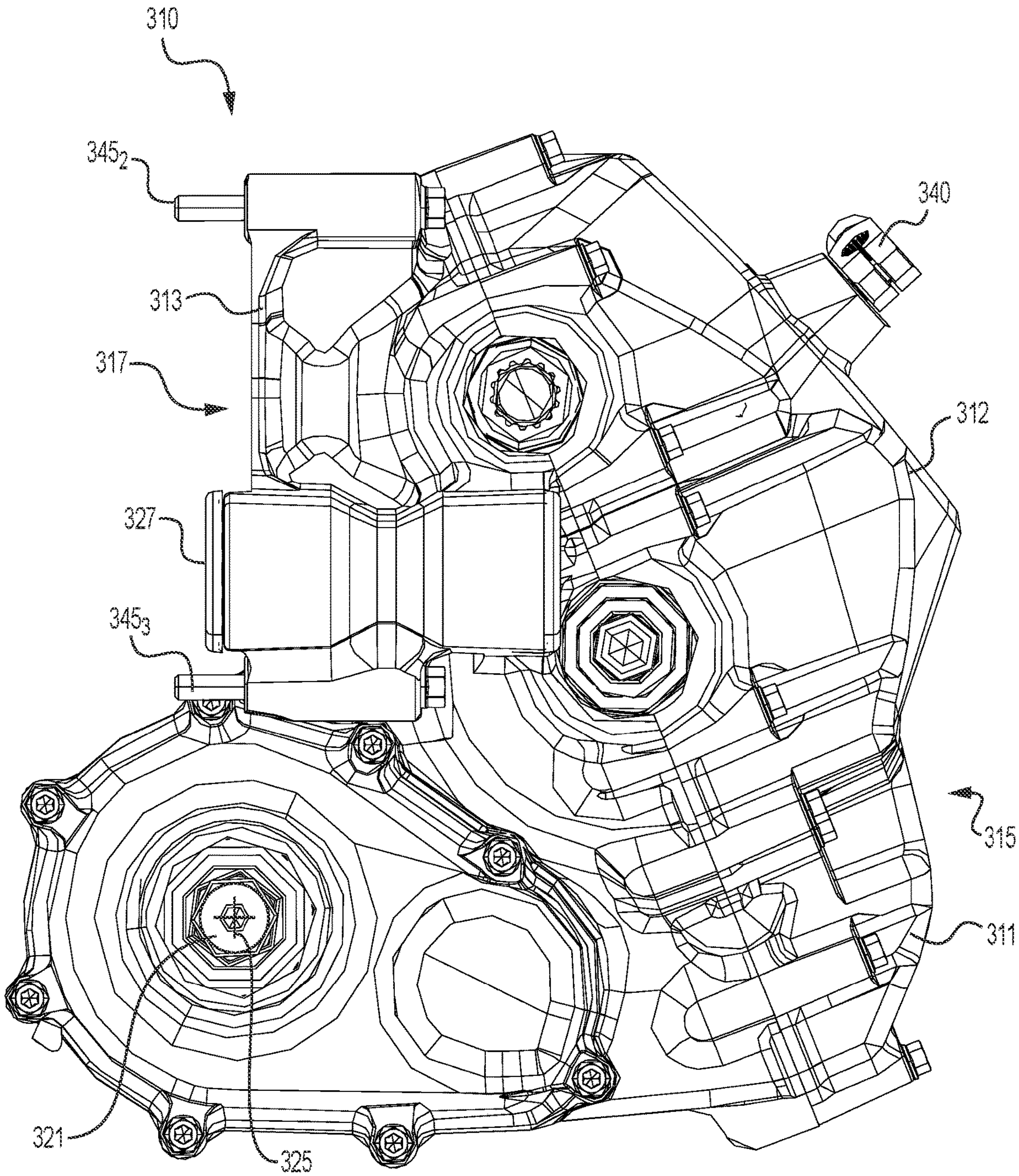

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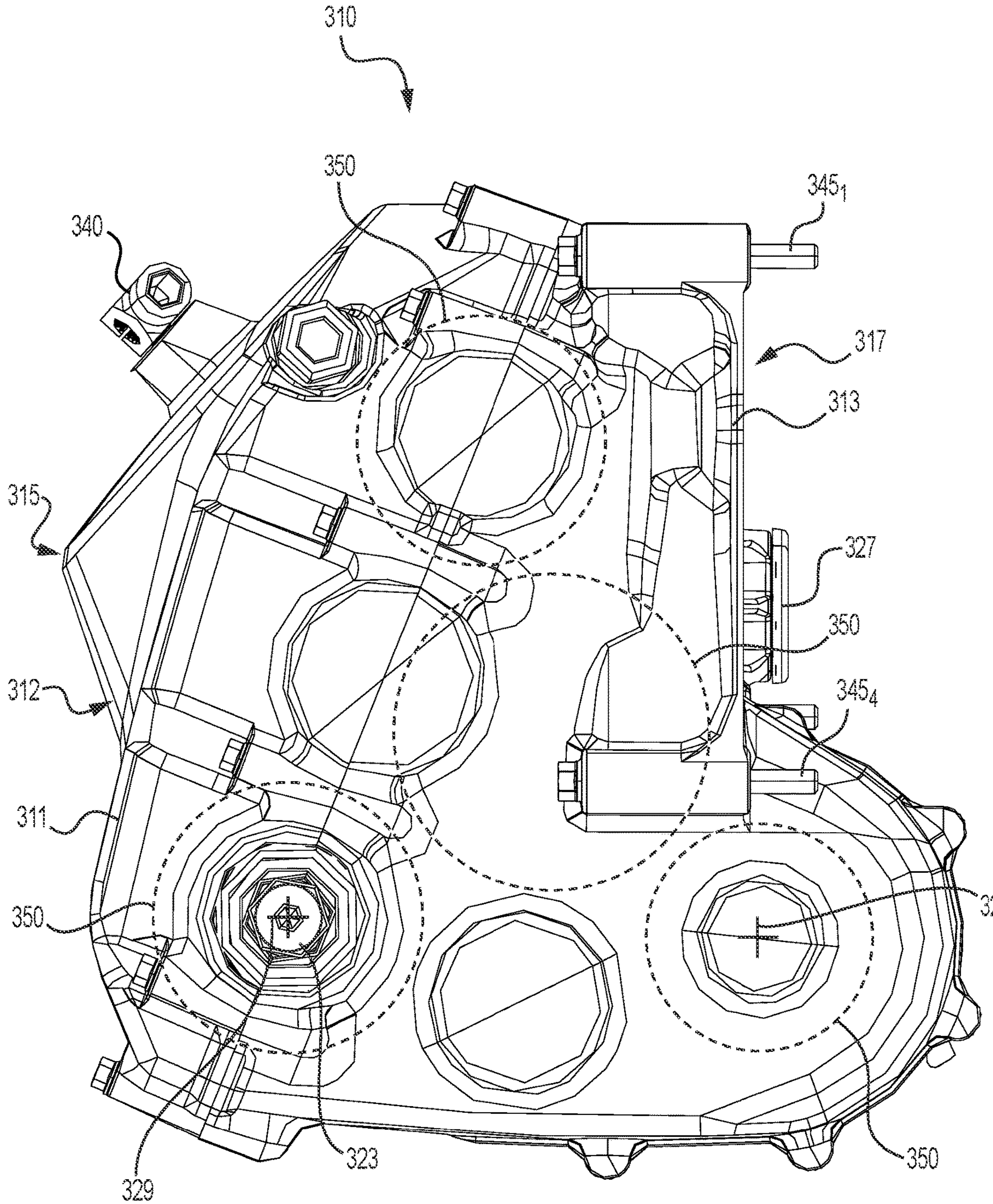
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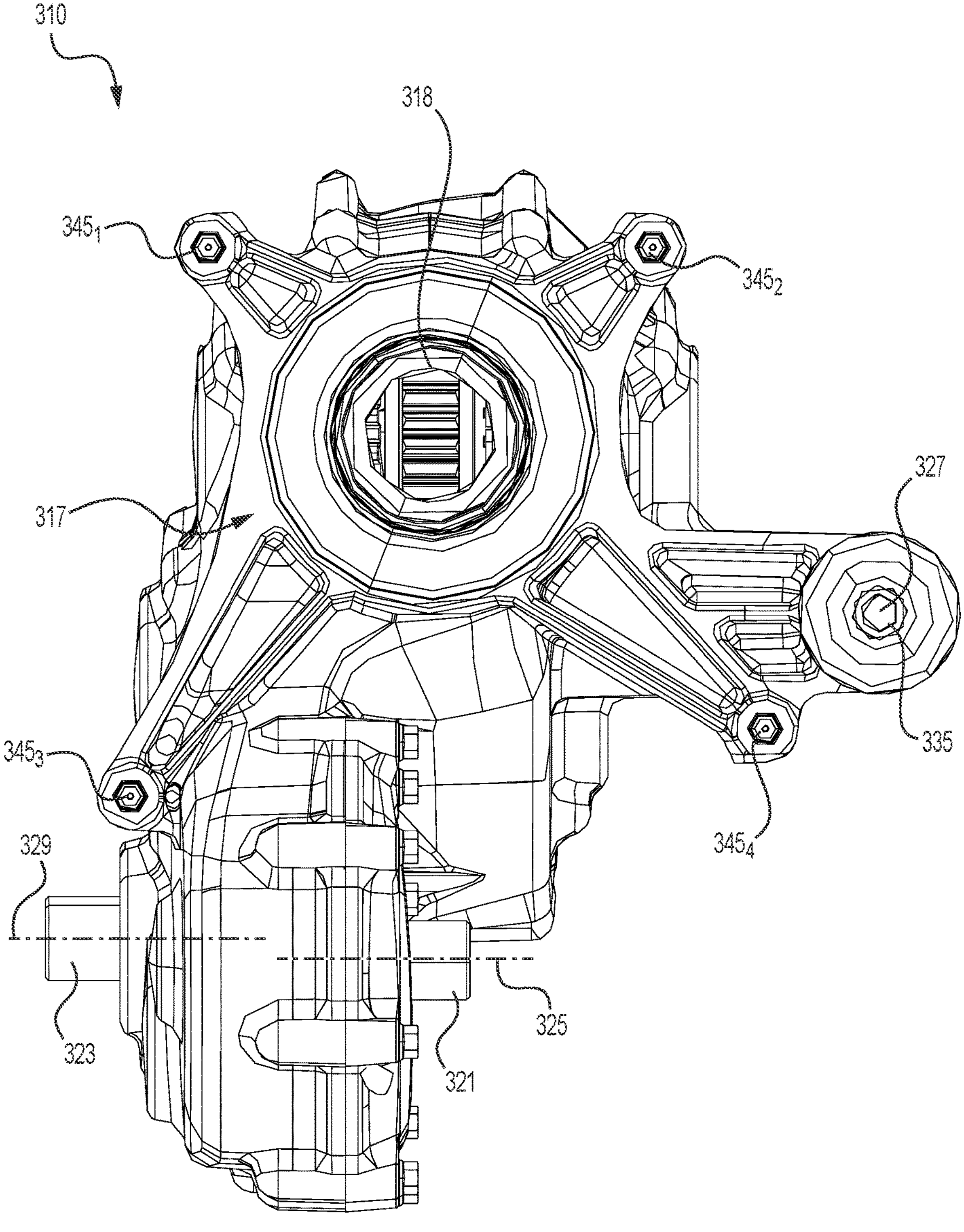
FIG. 25



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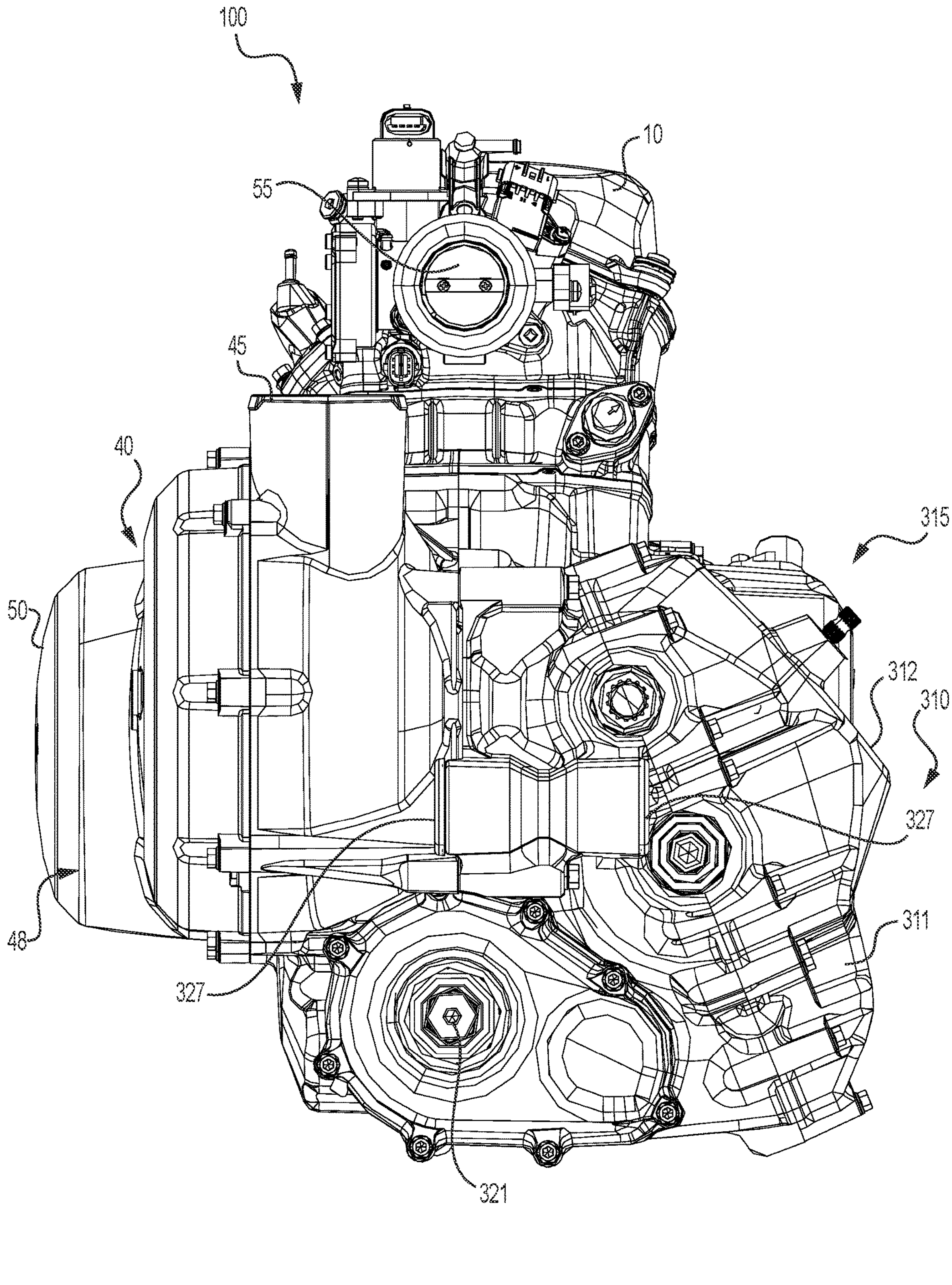

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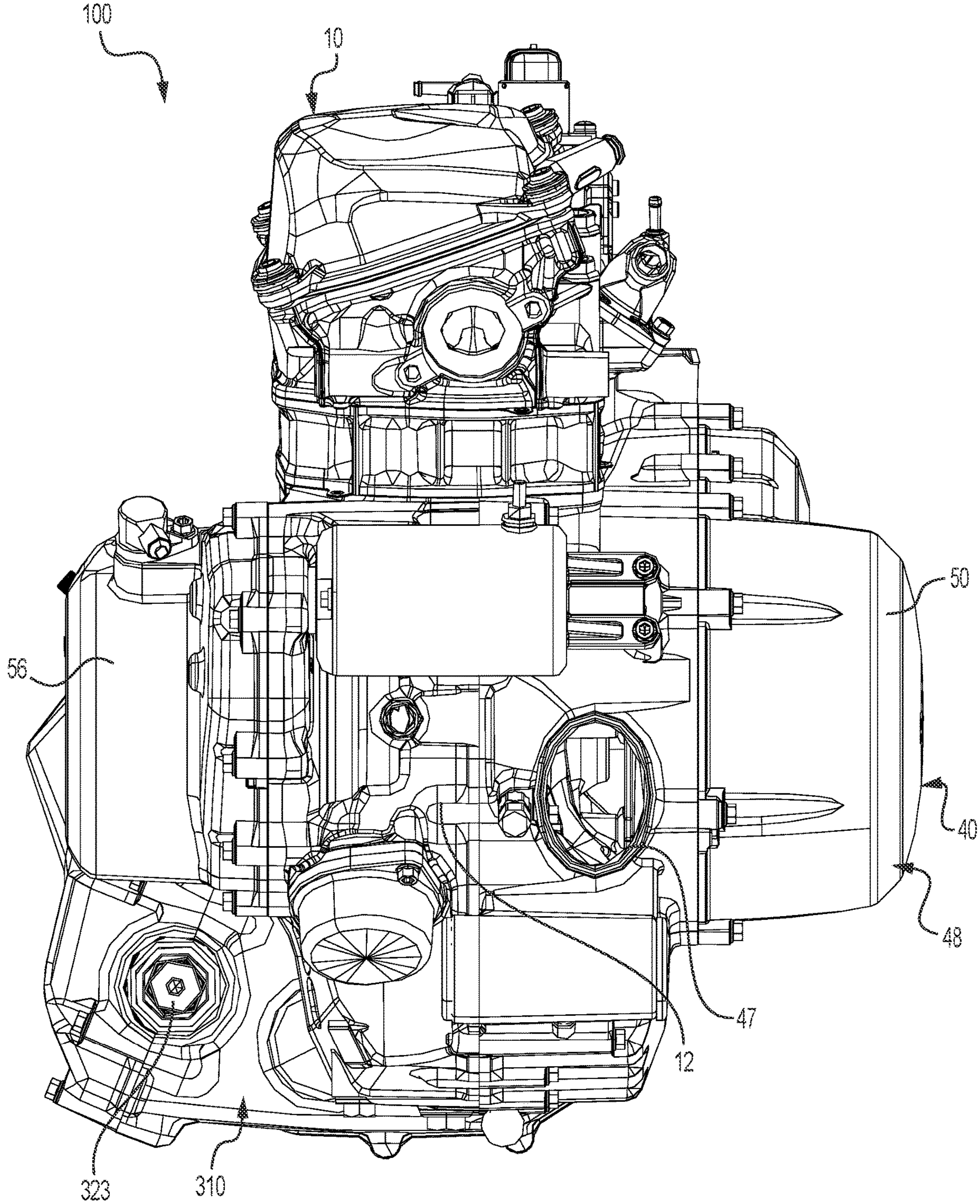

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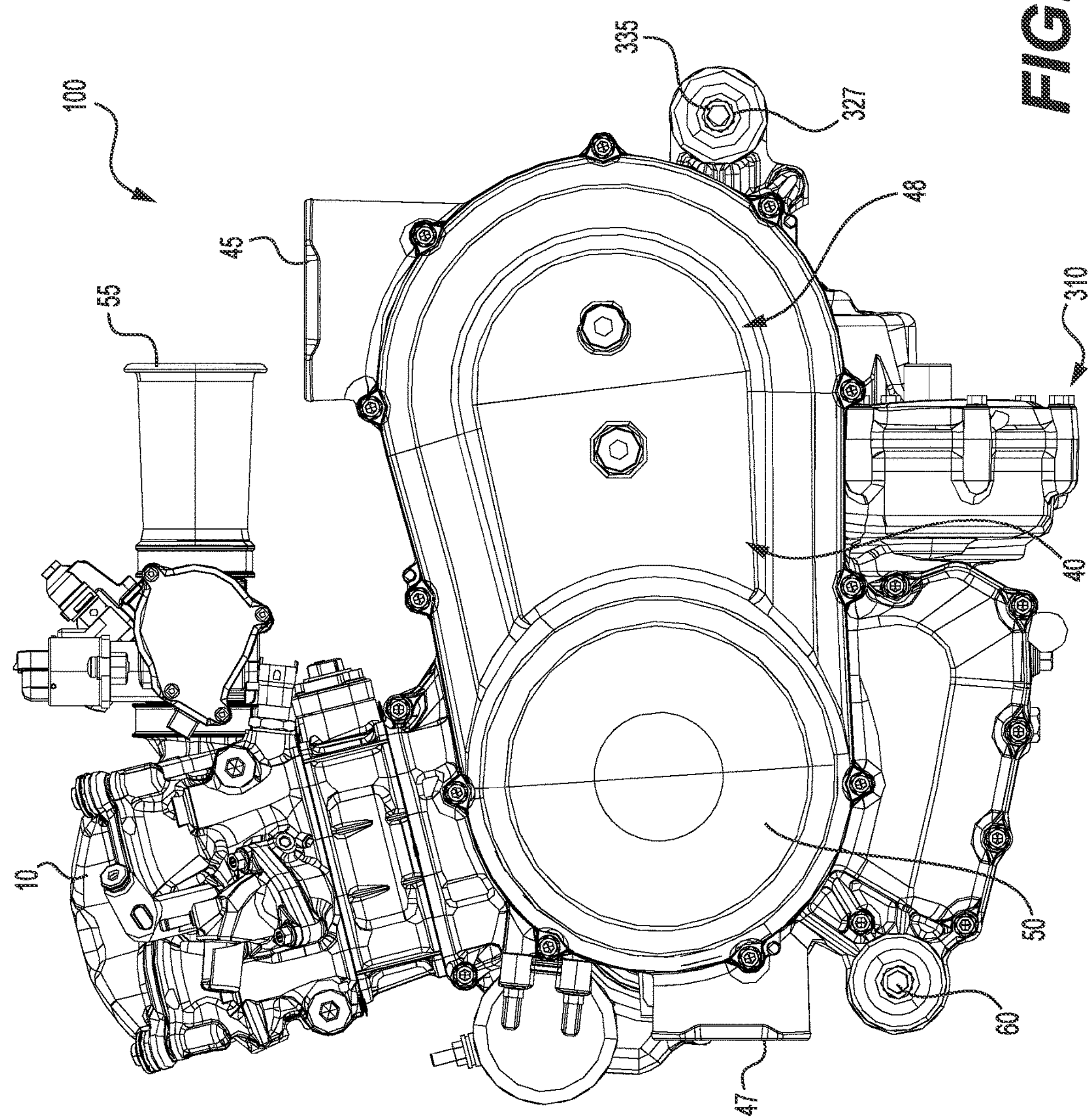

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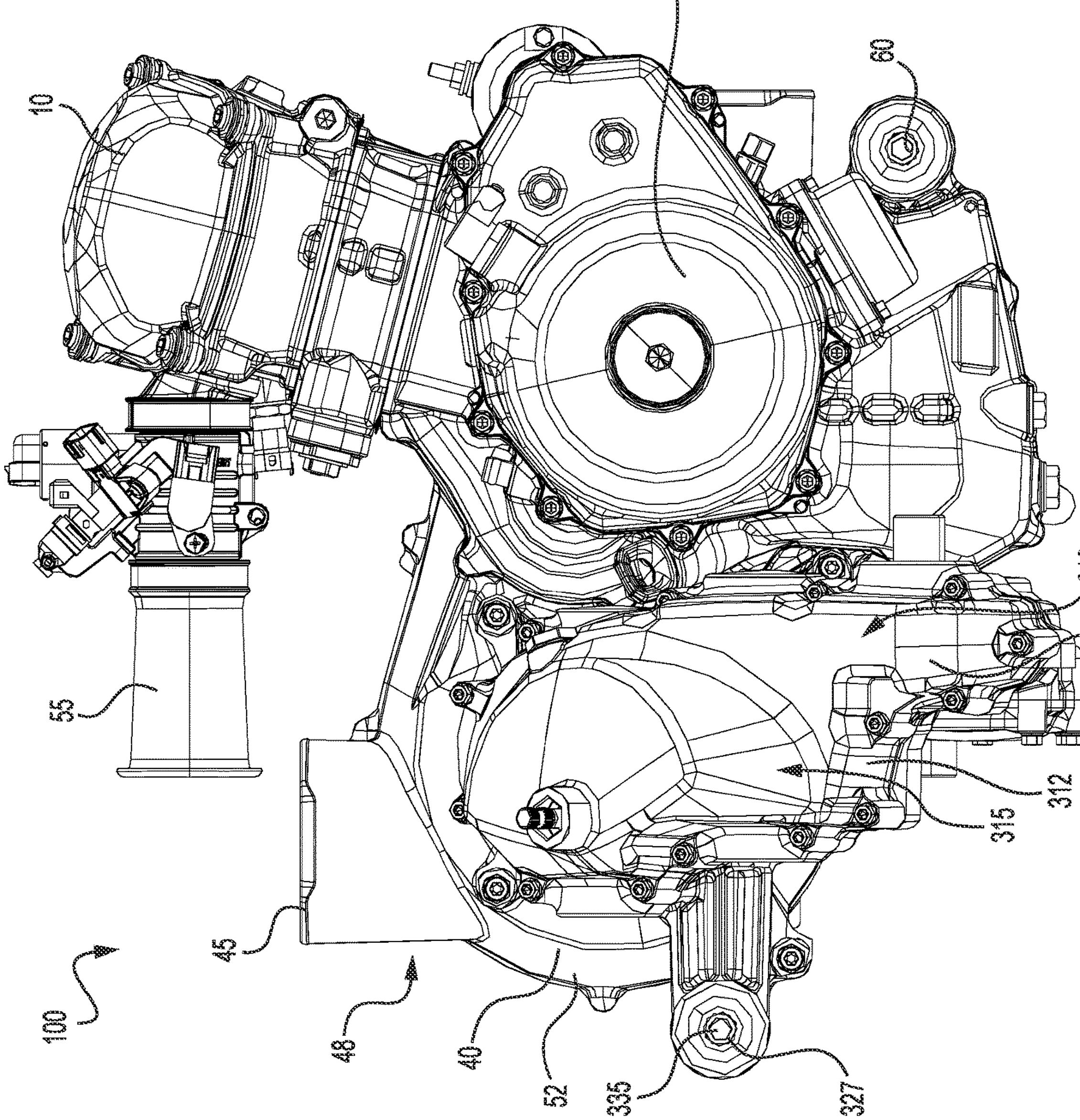

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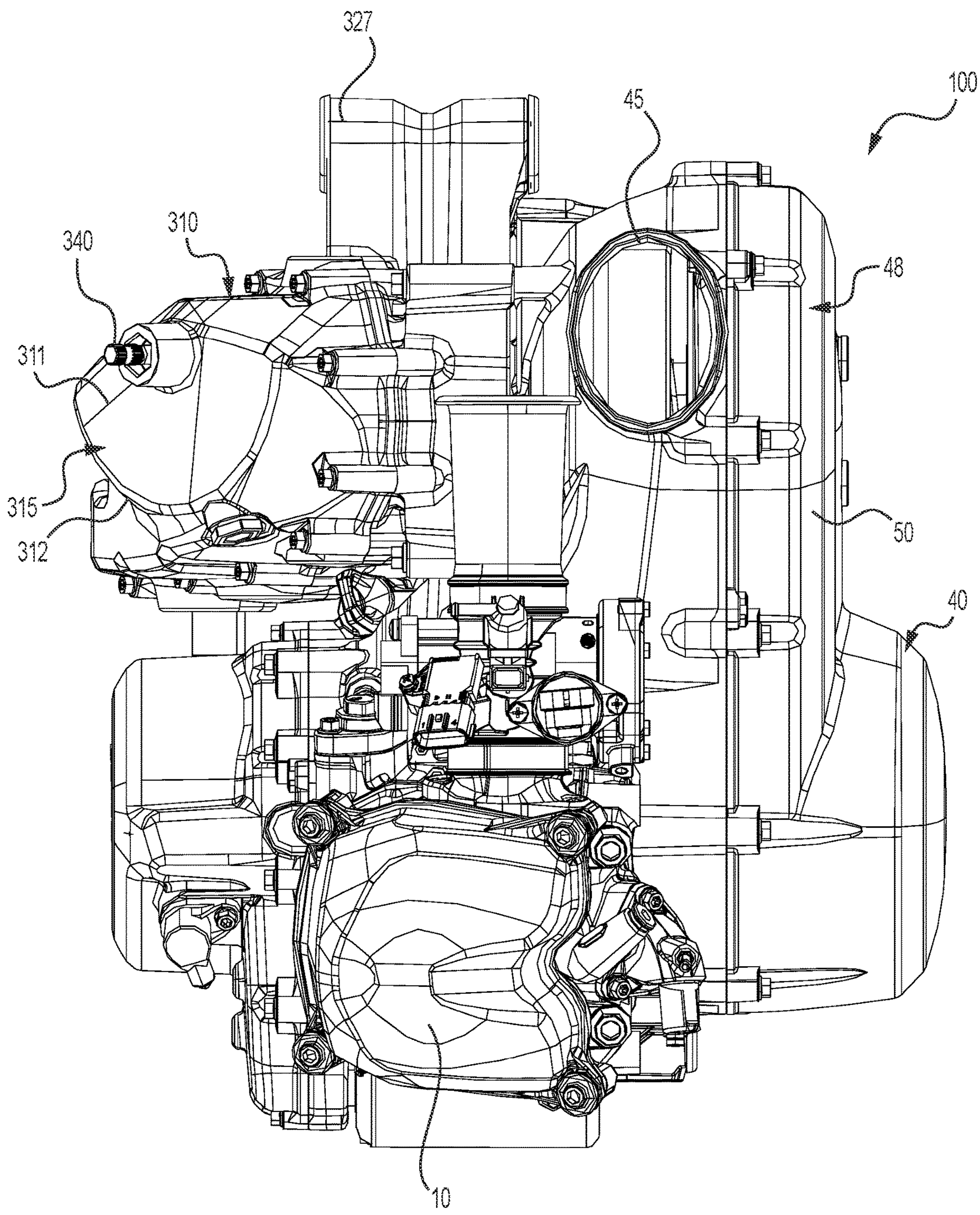

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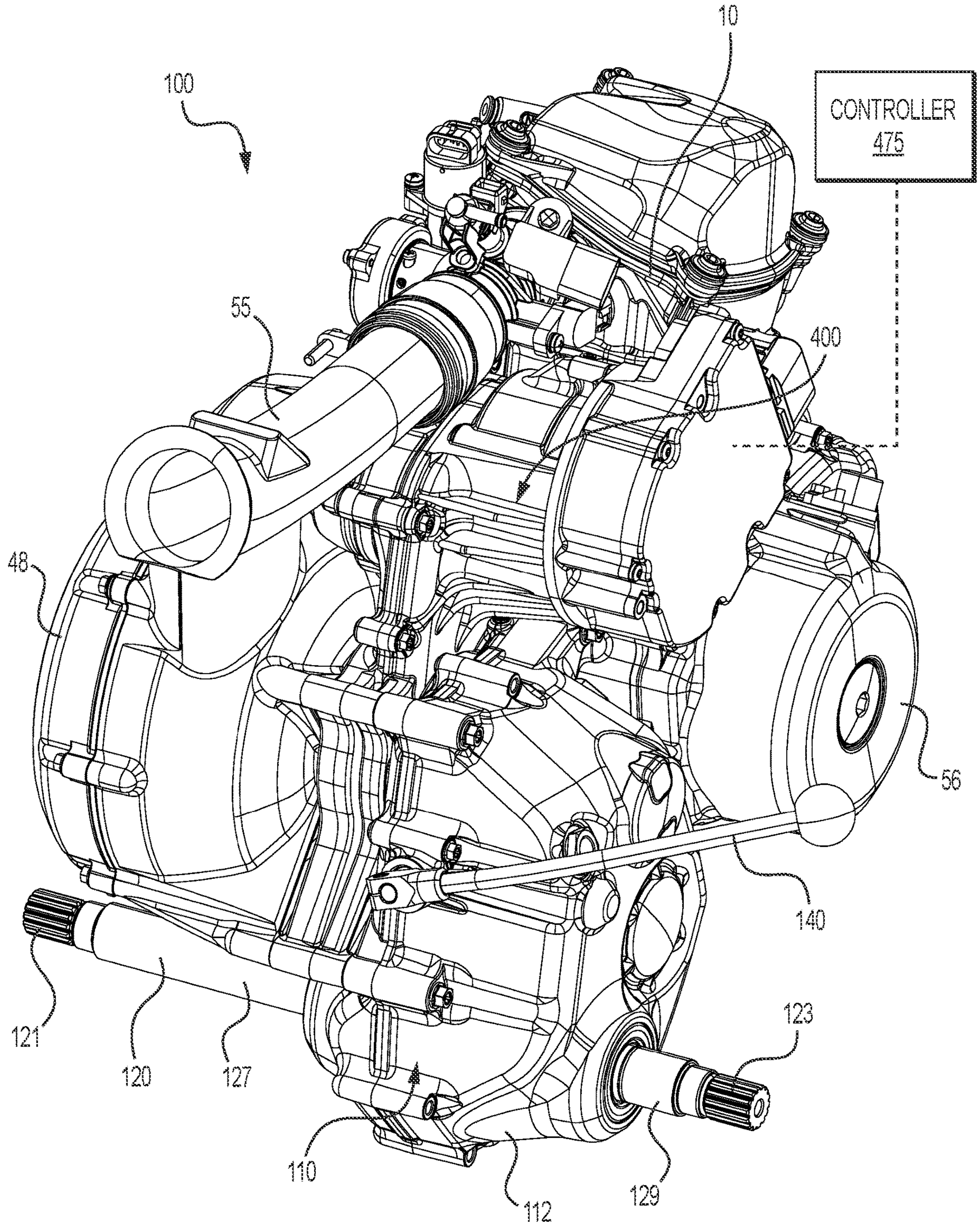
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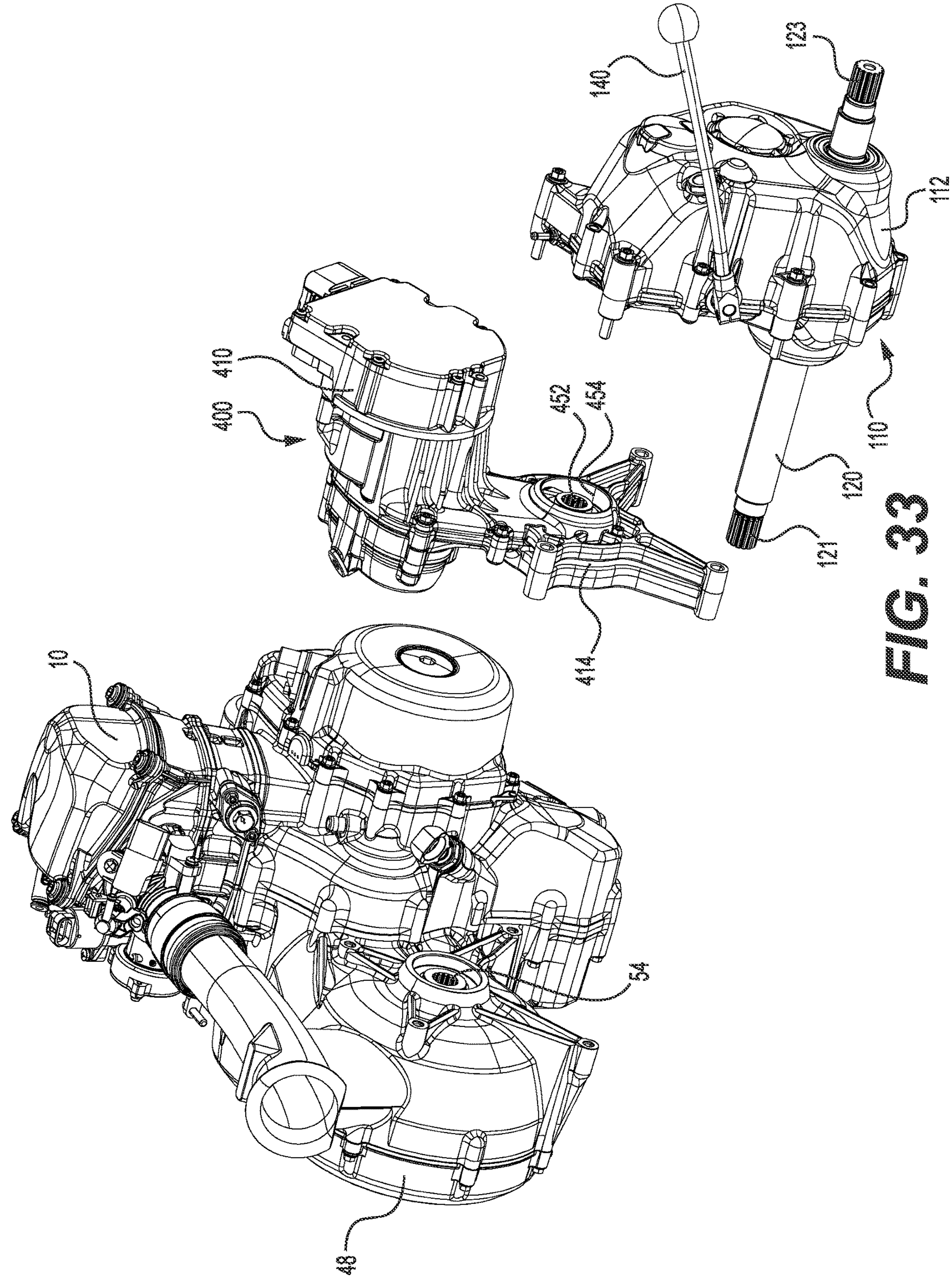

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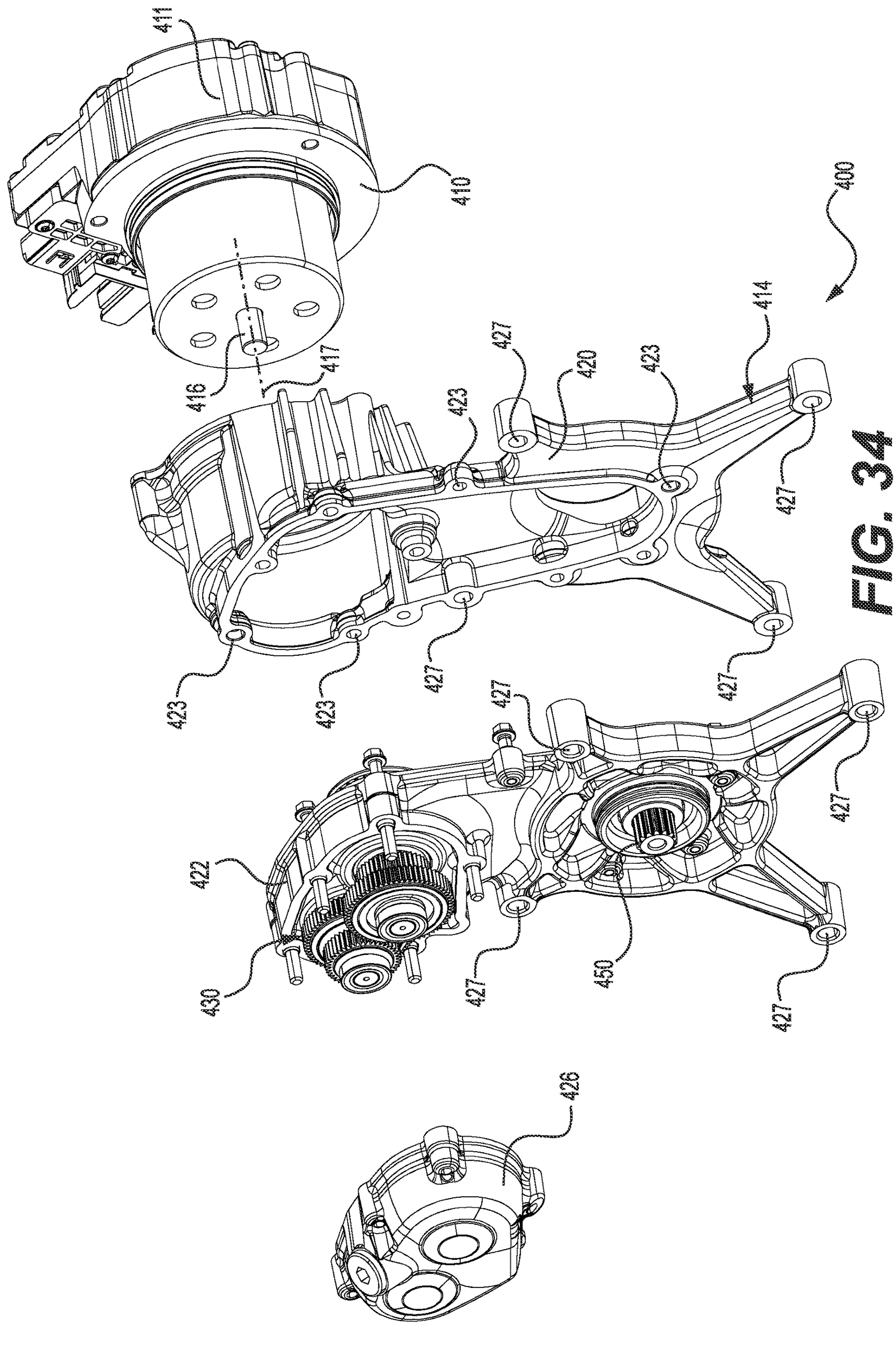
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FIG. 34

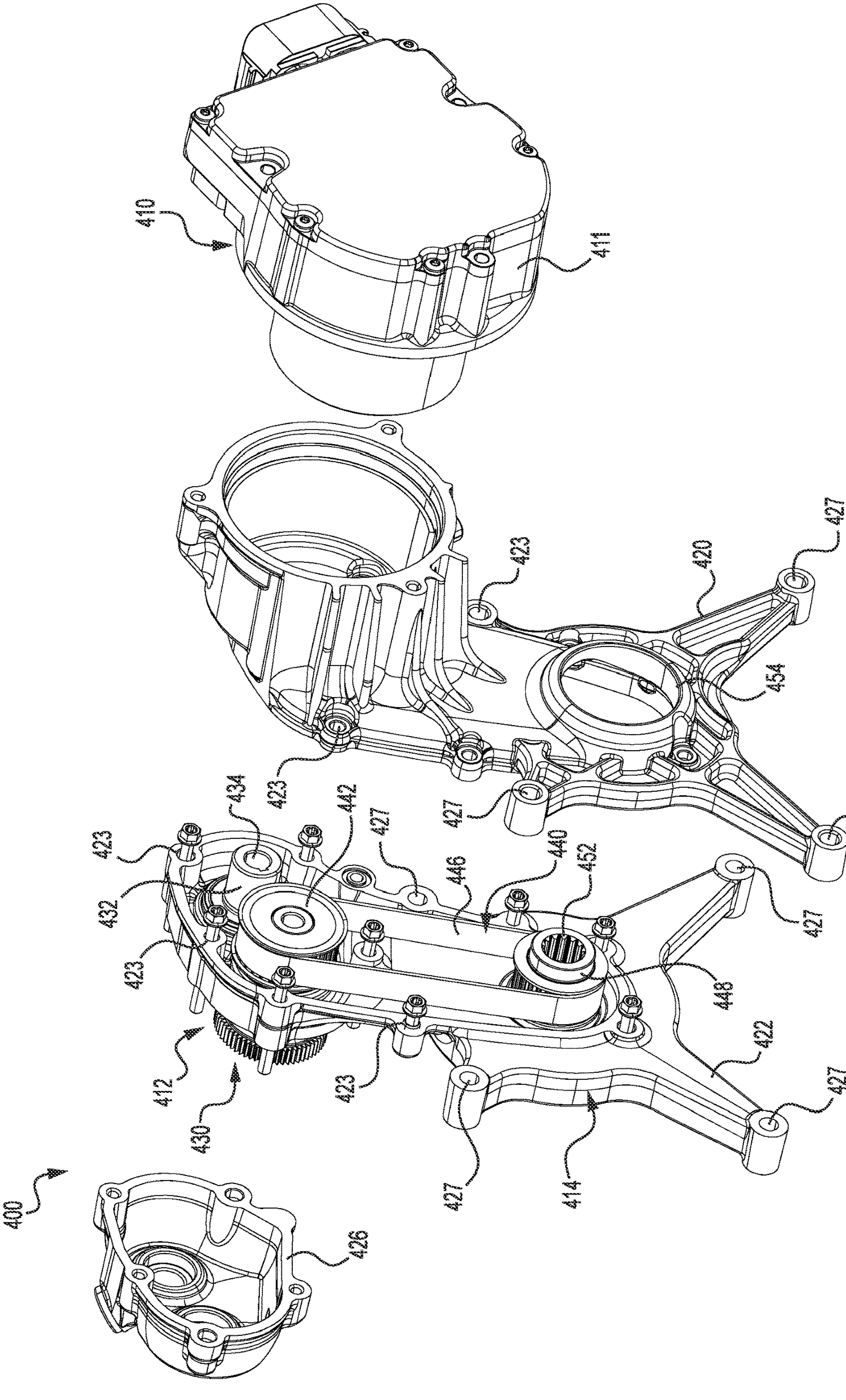
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FIG. 35

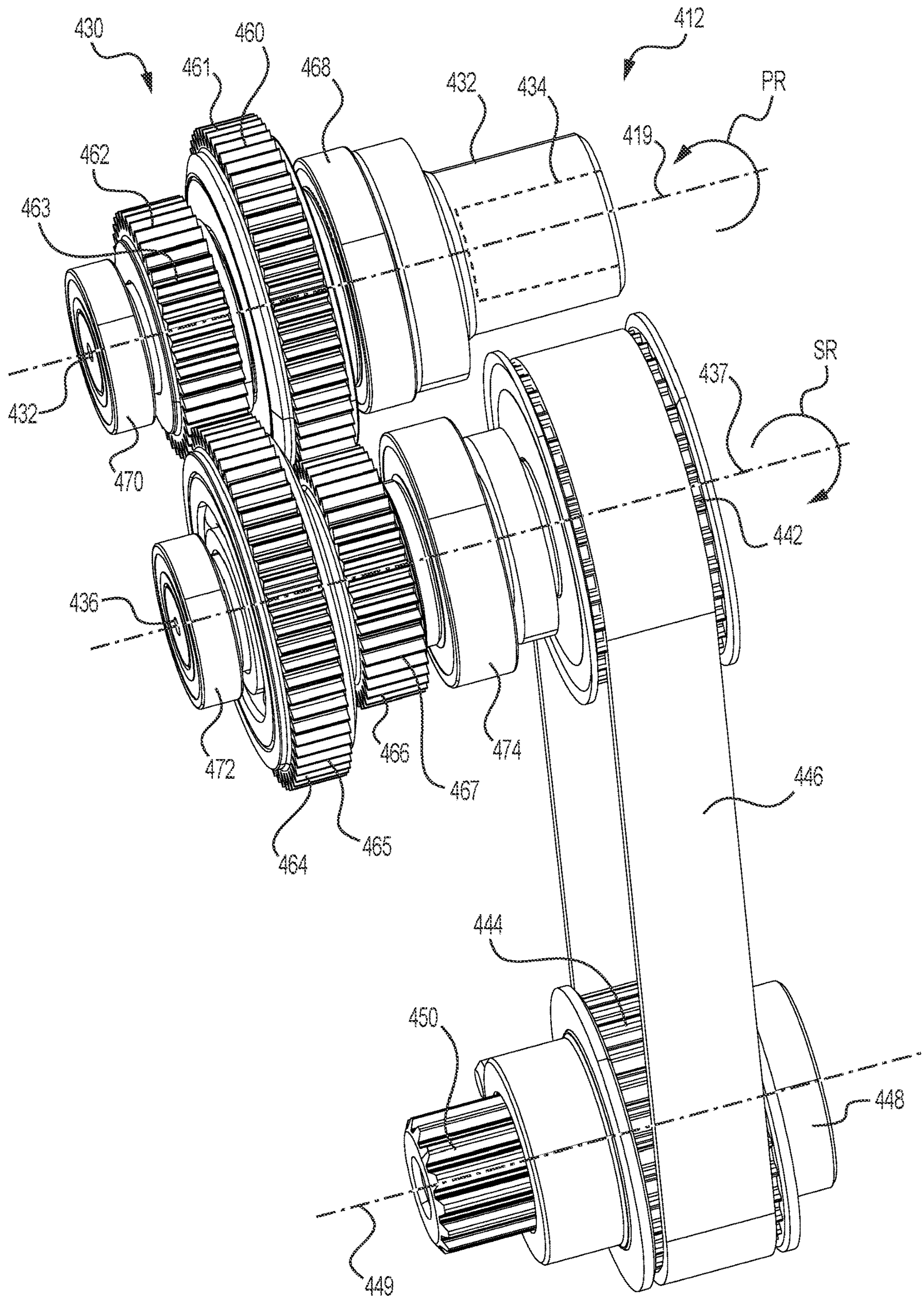
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FIG. 36

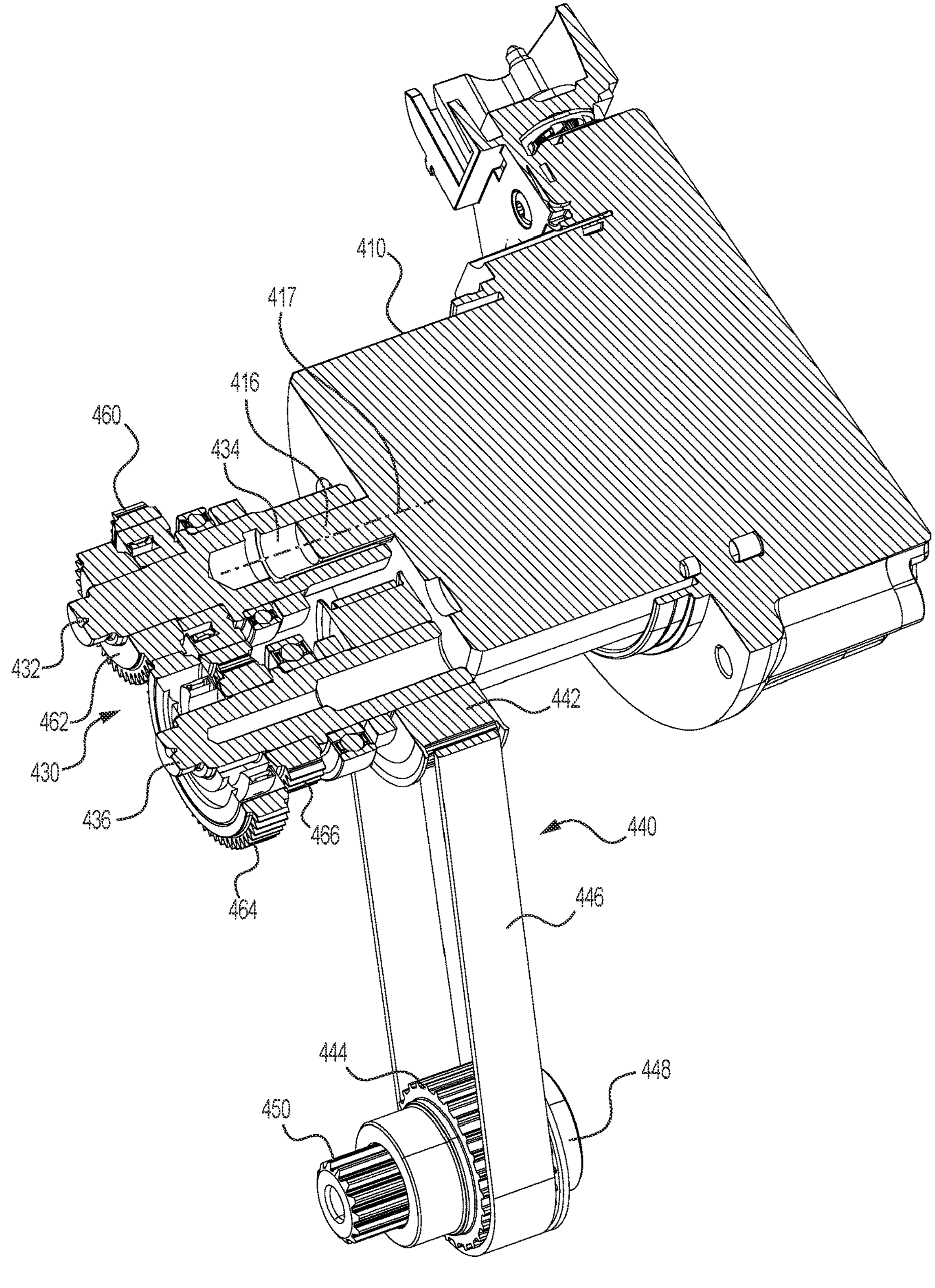
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FIG. 37

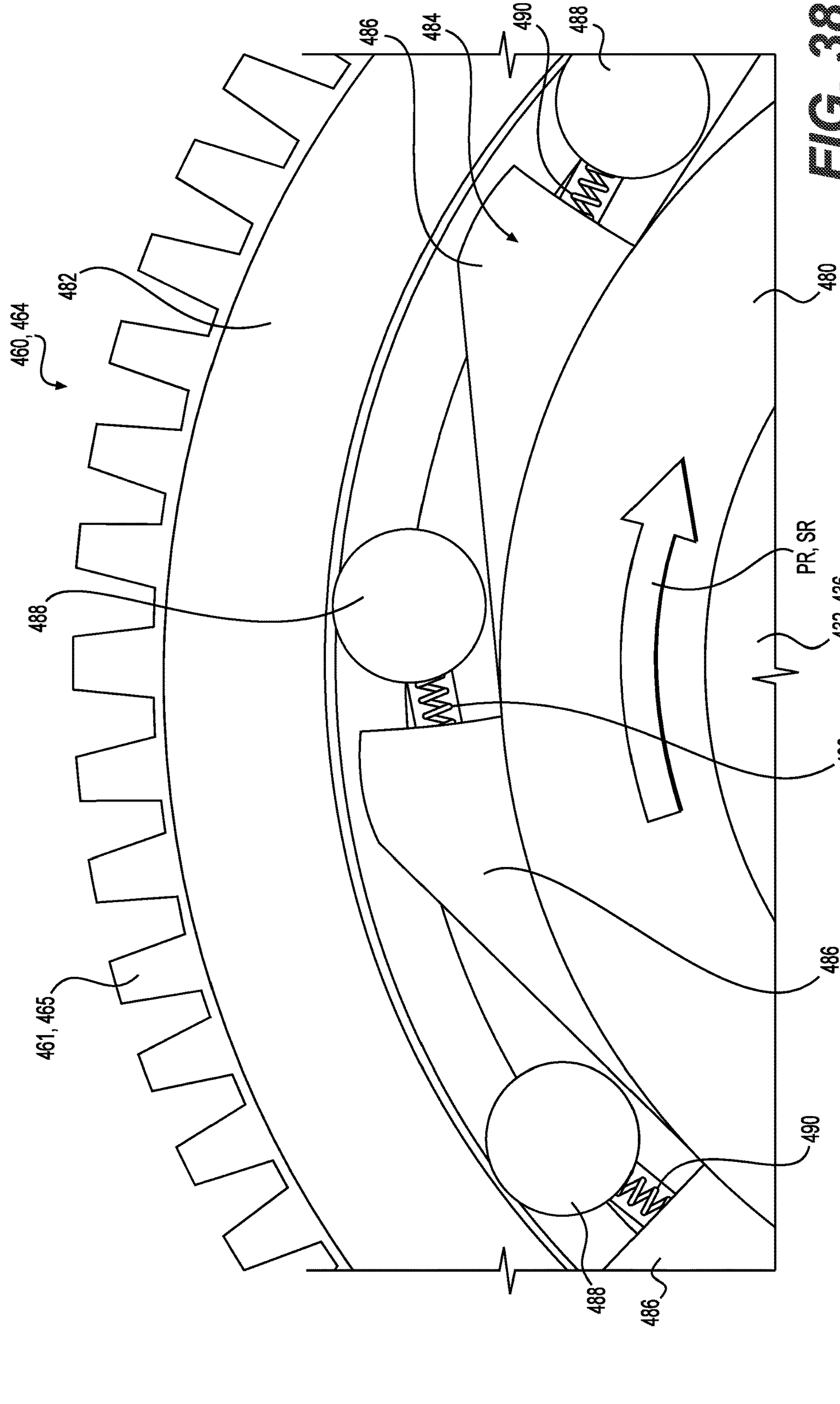
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FIG. 38

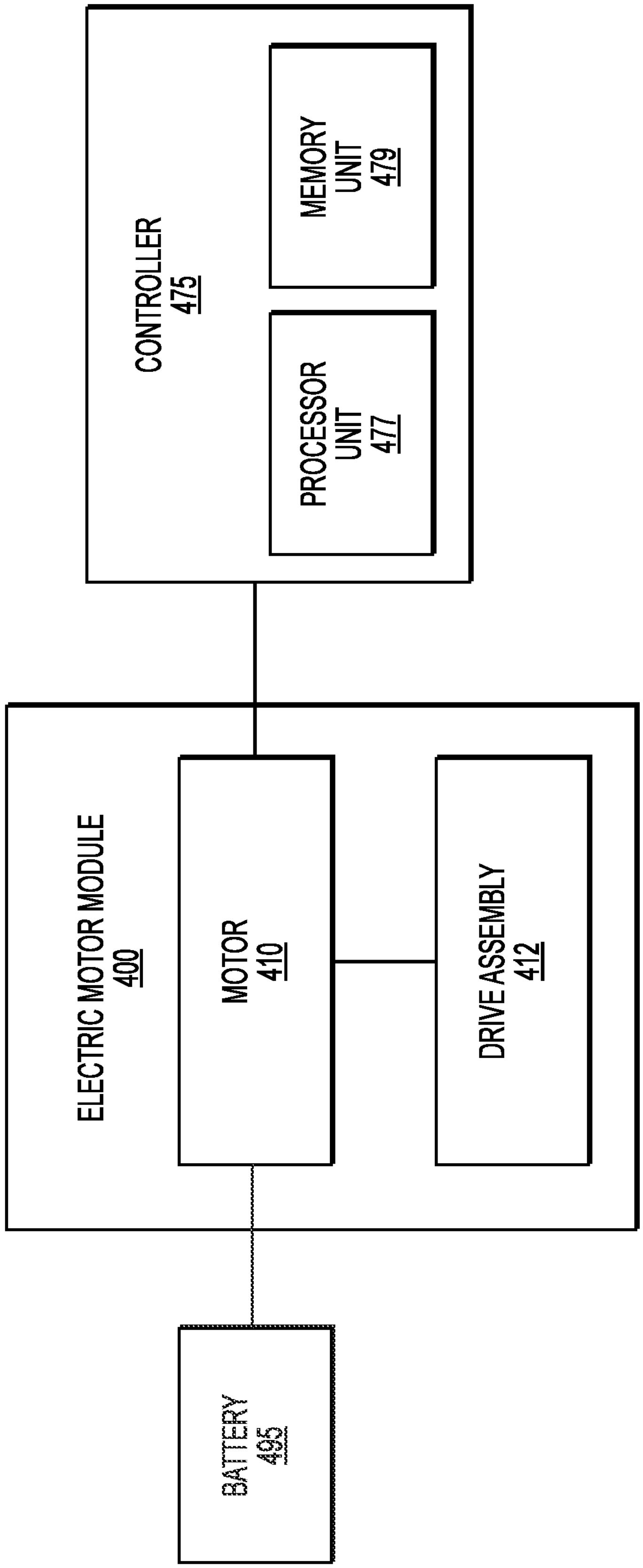
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FIG. 39

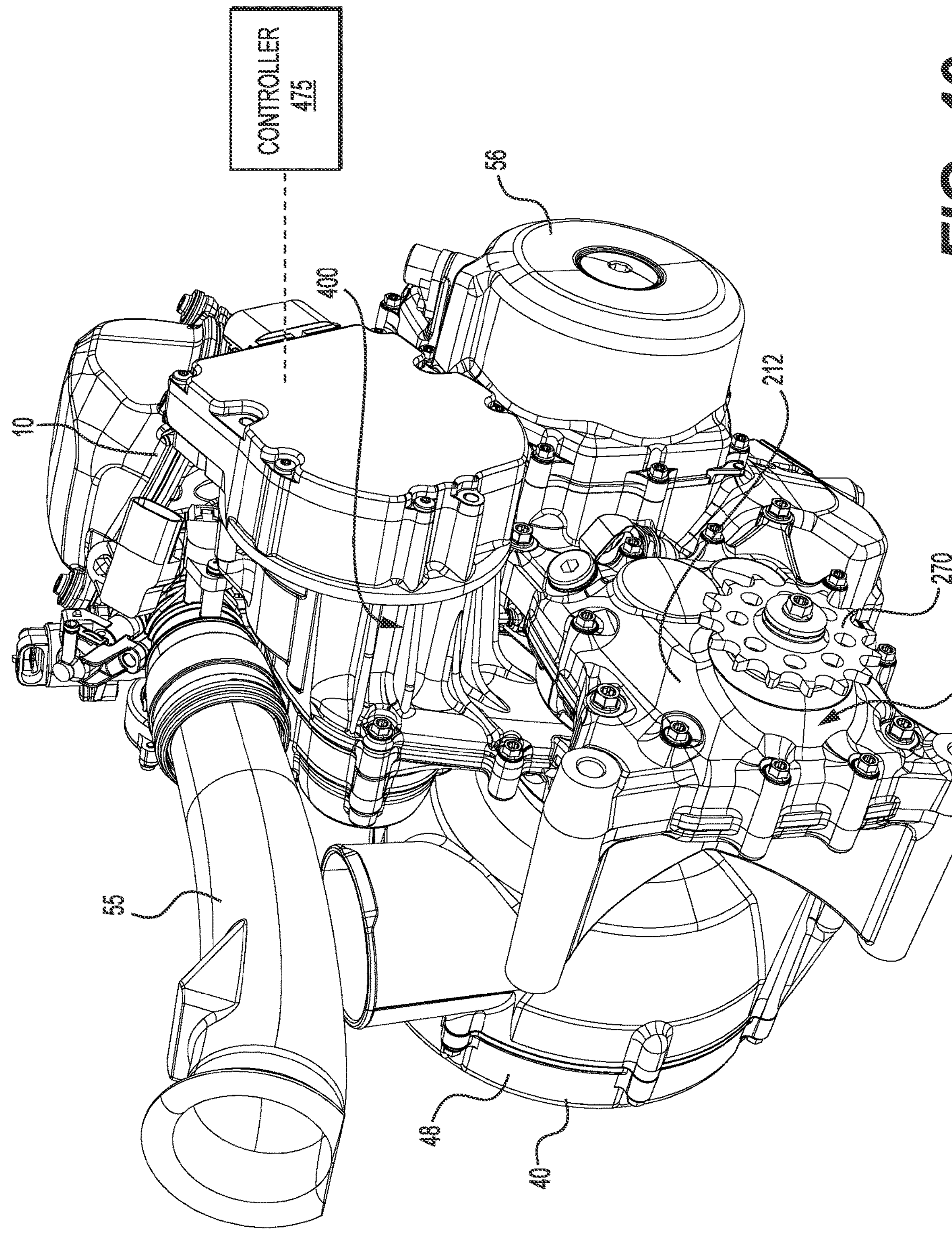

FIG. 40

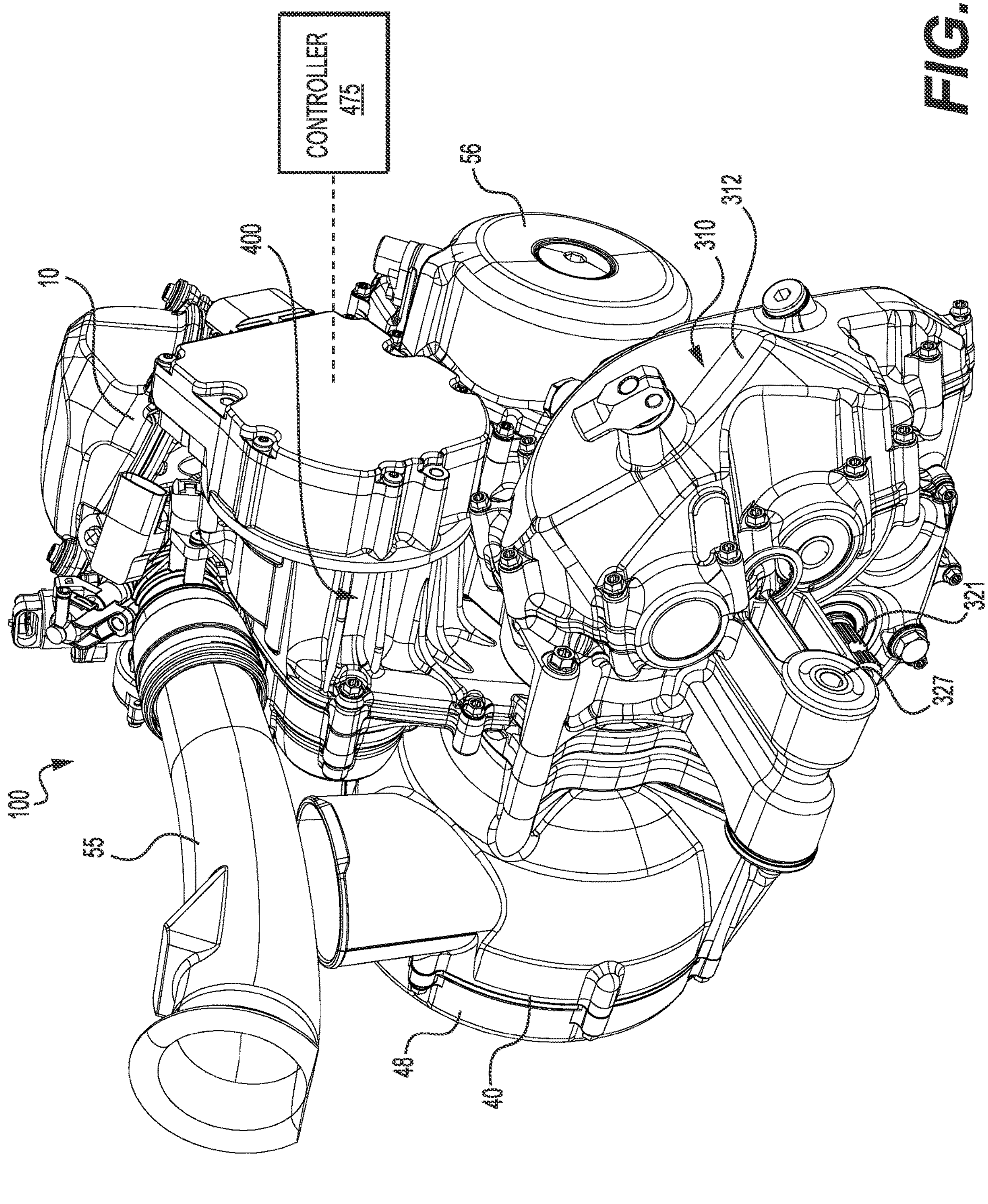

FIG. 41

GEAR ASSEMBLY FOR A VEHICLE

CROSS-REFERENCE

The present application is a divisional application of U.S. patent application Ser. No. 17/639,231, entitled "Power Pack for a Vehicle Selected from a Group of Different Vehicles and Method for Assembly Thereof," filed on Feb. 28, 2022, which is a 371 National Phase Stage Application of International Application No. PCT/EP2020/074166, filed on Aug. 28, 2020, which claims priority from U.S. Provisional Patent Application No. 62/893,901, filed on Aug. 30, 2019, the entirety of each of which is incorporated herein by reference.

TECHNICAL FIELD

The present technology relates to power packs for vehicles and methods for their assembly.

BACKGROUND

A vehicle's powertrain is designed to satisfy the drive requirements of the vehicle, including for example torque and speed requirements thereof. Consequently, vehicles which are used for different applications typically have distinct powertrains as their specific drive requirements may differ significantly. This can be particularly burdensome for a vehicle manufacturer that makes different types of vehicles and thus has to design and provide different powertrains for each type of vehicle. For instance, the manufacturer may have to store a large variety of components so as to be able to assemble any of the different powertrains depending on the vehicle being manufactured. Sourcing and storing such a large variety of components required to assemble the different powertrains can be costly and complex to the manufacturer.

Therefore, there is a desire for a solution addressing at least some of these drawbacks.

SUMMARY

It is an object of the present technology to ameliorate at least some of the inconveniences present in the prior art.

In accordance with an aspect of the present technology, there is provided a power pack for a vehicle selected from a group of different vehicles. The power pack includes: an internal combustion engine; a continuously variable transmission (CVT) operatively connected to the engine; and a sub-transmission selected from a group of different sub-transmissions depending on the selected vehicle of the group of different vehicles. The engine includes: a crankcase; a crankshaft disposed in the crankcase; and a cylinder body connected to the crankcase. The CVT includes: a drive pulley operatively connected to the crankshaft of the engine, the drive pulley being rotatable about a drive pulley axis; a driven pulley rotatable about a driven pulley axis; a belt connecting the drive pulley to the driven pulley; and a housing at least partly enclosing the drive pulley, the driven pulley and the belt. The selected sub-transmission is mounted to the housing of the CVT. The housing of the CVT is configured to mount any sub-transmission of the group of different sub-transmissions.

In some embodiments, the housing of the CVT defines a plurality of mounting points for mounting the selected sub-transmission to the housing. At least some of the mounting points defined by the housing are used to mount any one of the different sub-transmissions.

In some embodiments, all mounting points defined by the housing of the CVT are used to mount any one of the different sub-transmissions.

In some embodiments, when the power pack is installed on the selected vehicle, the drive pulley axis is vertically higher than the driven pulley axis.

In some embodiments, when the power pack is installed on the selected vehicle, the driven pulley axis extends generally laterally.

In some embodiments, at least part of the crankcase of the engine and the selected sub-transmission are disposed on a same side of the CVT.

In some embodiments, at least part of the selected sub-transmission extends laterally away from the CVT past the engine.

In some embodiments, the selected sub-transmission includes an output shaft configured to be operatively connected to at least one ground-engaging member of the vehicle. The output shaft is rotatable about an output shaft axis. The output shaft axis extends along a direction generally transverse to the driven pulley axis.

In some embodiments, when the power pack is installed on the selected vehicle, the output shaft axis extends generally longitudinally.

In some embodiments, the selected sub-transmission includes an output shaft configured to be operatively connected to at least one ground-engaging member of the vehicle. The output shaft axis extends along a direction generally parallel to the driven pulley axis.

In some embodiments, when the power pack is installed on the selected vehicle, the output shaft axis extends generally laterally.

In some embodiments, the output shaft axis is vertically lower than the driven pulley axis.

In some embodiments, at least one sub-transmission of the group of different sub-transmissions includes: a sub-transmission housing; a plurality of gears enclosed within the sub-transmission housing; an input shaft operatively connected to the driven pulley of the CVT; a shifter for selectively engaging the input shaft with one of the plurality of gears; and an output shaft configured to be operatively connected to at least one ground-engaging member of the vehicle. The output shaft is operatively connected to the input shaft via the one of the plurality of gears.

In some embodiments, at least one sub-transmission of the group of different sub-transmissions includes: a sub-transmission housing; a plurality of gears enclosed within the sub-transmission housing; an input shaft operatively connected to the driven pulley of the CVT, the input shaft being in driving engagement with the plurality of gears; and an output shaft extending laterally outwardly from a first lateral side and a second lateral side of the sub-transmission housing.

In some embodiments, the group of different sub-transmissions includes a first sub-transmission, a second sub-transmission and a third sub-transmission. The first sub-transmission includes: an input shaft operatively connected to the driven pulley of the CVT; a plurality of gears; and an output shaft operatively connected to the input shaft via the plurality of gears, the output shaft being rotatable about an output shaft axis extending laterally, each of a first end portion and a second end portion of the output shaft being configured to be operatively connected to a respective ground-engaging member of the selected vehicle. The second sub-transmission includes: an input shaft operatively connected to the driven pulley of the CVT; a plurality of gears; and an output sprocket operatively connected to the input shaft via the plurality of gears, the output sprocket being configured to be operatively connected to a ground-engaging member of the selected vehicle for driving thereof. The third sub-transmission includes: an input shaft operatively connected to the driven pulley of the CVT; a plurality of gears; and first and second output members operatively connected to one another and driven by the input shaft via the plurality of gears, the first and second output members being disposed on opposite sides of the third sub-transmission, the first and second output members being rotatable about respective axes extending generally longitudinally.

In some embodiments, the second sub-transmission also includes a sub-transmission housing enclosing the plurality of gears therein. The output sprocket is positioned outside of the sub-transmission housing.

In some embodiments, the engine defines a plurality of engine mounts for mounting the engine to a frame of the selected vehicle. For at least some vehicles of the group of different vehicles, only some of the engine mounts are used to mount the engine to the frame.

In some embodiments, the selected sub-transmission defines an additional vehicle mount to mount the power pack to the frame of the selected vehicle.

In some embodiments, at least one sub-transmission of the group of different sub-transmissions includes a sub-transmission housing. The sub-transmission housing defines an interior space of the at least one sub-transmission. The sub-transmission housing is sealed such that the interior space of the at least one sub-transmission is inaccessible without disassembly thereof.

In some embodiments, at least one sub-transmission of the group of different sub-transmissions includes a sub-transmission housing. The sub-transmission housing defines an interior space of the at least one sub-transmission. When the selected sub-transmission is one of the at least one sub-transmission, the sub-transmission housing of the at least one sub-transmission is sealed from the housing of the CVT.

In some embodiments, at least one sub-transmission of the group of different sub-transmissions includes a reverse gear. When the selected sub-transmission is the at least one sub-transmission including the reverse gear, the power pack is operable to drive the vehicle in reverse via engagement of the reverse gear.

In some embodiments, the housing of the CVT defines an air inlet and an air outlet; and the air inlet and the air outlet are always in a same position irrespective of the selected sub-transmission.

In some embodiments, the engine is a single-cylinder engine.

According to another aspect of the present technology, there is provided a method for assembling a power pack for a vehicle selected from a group of different vehicles. The method includes: providing an engine and a continuously variable transmission (CVT), the CVT being operatively connected to the engine; determining the selected vehicle for which the power pack is to be provided; selecting a sub-transmission from a group of different sub-transmissions based on the selected vehicle for which the power pack is to be provided; and mounting the selected sub-transmission to a housing of the CVT, the housing of the CVT being configured to mount any sub-transmission of the group of different sub-transmissions.

In some embodiments, for any one of the different sub-transmissions being the selected sub-transmission, mounting the selected sub-transmission includes: fastening the selected sub-transmission to all mounting points of a plurality of mounting points defined by a housing of the CVT for mounting the selected sub-transmission.

In some embodiments, for at least one of the different sub-transmissions being the selected sub-transmission, mounting the selected sub-transmission includes: positioning the selected sub-transmission such that an output shaft axis thereof extends along a direction generally transverse to a driven pulley axis of the CVT.

In some embodiments, for at least one of the different sub-transmissions being the selected sub-transmission, mounting the selected sub-transmission includes: positioning the selected sub-transmission such that an output shaft axis thereof extends along a direction generally parallel to a driven pulley axis of the CVT.

According to another aspect of the present technology, there is provided a gearing assembly for a drivetrain of a vehicle. The gearing assembly includes: a first shaft rotating about a first shaft axis; a second shaft operatively connected to the first shaft, the second shaft rotating about a second shaft axis extending parallel to the first shaft axis; a first gear mounted to the first shaft, the first gear being a freewheel clutch gear; a second gear fixedly mounted to the first shaft for rotation therewith; a third gear mounted to the second shaft, the third gear being a freewheel clutch gear, the third gear being drivingly engaged with the second gear; and a fourth gear fixedly mounted to the second shaft for rotation therewith, the fourth gear being drivingly engaged with the first gear. When a rotational speed of the first shaft is greater than a rotational speed of the second shaft, the first shaft drives the second shaft via driving engagement between the second gear and the third gear, the first gear being overrun. When the rotational speed of the second shaft is greater than the rotational speed of the first shaft, the second shaft drives the first shaft via driving engagement between the fourth gear and the first gear, the third gear being overrun.

In some embodiments, each of the first gear and the third gear comprises: an inner race mounted to a corresponding one of the first shaft and the second shaft; an outer race disposed radially outwardly of the inner race, the outer race comprising a plurality of gear teeth; and a clutch engager disposed between the inner race and the outer race, the gear being overrun when the clutch engager disengages the outer race from the inner race so that the inner race rotates relative to the outer race.

In some embodiments, the clutch engager comprises a plurality of rollers selectively coupling rotation of the outer race with the inner race.

In some embodiments, the first gear and the fourth gear counter-rotate relative to one another; and the second gear and the third gear counter-rotate relative to one another.

In some embodiments, the first gear is meshed with the fourth gear; and the second gear is meshed with the third gear.

In some embodiments, the first gear and the second gear are adjacent to one another; and the third gear and the fourth gear are adjacent to one another.

In some embodiments, the first shaft is configured to be connected to an electric motor; and the second shaft is configured to be connected to a transmission of the drivetrain of the vehicle.

In some embodiments, the gearing assembly also includes a sprocket mounted to the second shaft for rotation therewith, the sprocket being configured to be connected to the transmission of the drivetrain of the vehicle.

In some embodiments, a diameter of the first gear is greater than a diameter of the fourth gear; and a diameter of the third gear is greater than a diameter of the second gear.

In some embodiments, the second gear and the fourth gear are spur gears.

According to another aspect of the present technology, there is provided a power pack for a vehicle. The power pack includes: an internal combustion engine comprising: a crankcase; a crankshaft disposed in the crankcase; and a cylinder body connected to the crankcase; a continuous variable transmission (CVT) operatively connected to the engine, the CVT comprising: a drive pulley operatively connected to the crankshaft of the engine, the drive pulley being rotatable about a drive pulley axis; a driven pulley rotatable about a driven pulley axis; a belt connecting the drive pulley to the driven pulley; and a housing at least partly enclosing the drive pulley, the driven pulley and the belt; an electric motor module operatively connected to the CVT, the electric motor module comprising: an electric motor having a motor shaft rotatable about a motor shaft axis; a gearing assembly operatively connected to the motor shaft; and a drive connection shaft operatively connected between the driven pulley of the CVT and the gearing assembly, the motor shaft being selectively operable to drive the drive connection shaft via the gearing assembly and to be driven by the drive connection shaft via the gearing assembly; and a sub-transmission operatively connected to the drive connection shaft of the electric motor module, the sub-transmission comprising an output shaft configured to be operatively connected to at least one ground-engaging member of the vehicle.

In some embodiments, the power pack also includes a controller operable to control operation of the electric motor module in a plurality of modes including: an engine driving mode whereby torque produced by the electric motor is null, the output shaft of the sub-transmission being driven by torque transmitted thereto by the engine via the CVT and the drive connection shaft; an electric motor driving mode whereby the output shaft of the sub-transmission is driven by torque transmitted thereto by the electric motor via the gearing assembly and the drive connection shaft, the driven pulley of the CVT being drivingly disengaged from the output shaft of the sub-transmission and from the drive connection shaft of the electric motor module; and a hybrid driving mode whereby the output shaft of the sub-transmission is driven by torque transmitted thereto by both the motor shaft of the electric motor and the driven pulley of the CVT.

In some embodiments, in the engine driving mode, the drive connection shaft of the electric motor module transmits torque to the motor shaft via the gearing assembly, the electric motor operating as a generator.

In some embodiments, the power pack also includes a centrifugal clutch operatively connected between the driven pulley of the CVT and the drive connection shaft of the electric motor module.

In some embodiments, the centrifugal clutch operates in one of an open position and a closed position based on a rotational speed of the driven pulley of the CVT; and when the electric motor module is operating in the electric motor driving mode, the centrifugal clutch is in the open position.

In some embodiments, the electric motor module further comprises a housing at least partially enclosing the gearing assembly and the motor shaft; and the housing of the electric motor module is mounted to the housing of the CVT.

In some embodiments, the housing of the electric motor module defines a plurality of mounting points; and the sub-transmission is mounted to the housing of the motor module via at least some of the mounting points defined thereby.

In some embodiments, the housing of the CVT defines a plurality of mounting points for mounting the electric motor module thereto; and the mounting points of the housing of the CVT are aligned with the mounting points of the housing of the electric motor module.

In some embodiments, the power pack also includes a centrifugal clutch operatively connected between the driven pulley of the CVT and the drive connection shaft of the electric motor module, the housing of the CVT at least partly enclosing the centrifugal clutch therein.

In some embodiments, when the power pack is installed on the vehicle, the motor shaft axis extends generally laterally.

In some embodiments, the driven pulley axis extends generally parallel to the motor shaft axis.

In some embodiments, the drive connection shaft of the electric motor module is disposed laterally between the CVT and the sub-transmission.

In some embodiments, the sub-transmission comprises: a sub-transmission housing; a plurality of gears enclosed within the sub-transmission housing; a transmission input shaft operatively connected between the drive connection shaft of the electric motor module and the output shaft; and a shifter for selectively engaging the transmission input shaft with one of the plurality of gears, the output shaft being operatively connected to the transmission input shaft via the one of the plurality of gears.

In some embodiments, the gearing assembly comprises: a first shaft rotating about a first shaft axis; a second shaft operatively connected to the first shaft, the second shaft rotating about a second shaft axis extending parallel to the first shaft axis; a first gear mounted to the first shaft, the first gear being a freewheel clutch gear; a second gear fixedly mounted to the first shaft for rotation therewith; a third gear mounted to the second shaft, the third gear being a freewheel clutch gear, the third gear being drivingly engaged with the second gear; and a fourth gear fixedly mounted to the second shaft for rotation therewith, the fourth gear being drivingly engaged with the first gear. When a rotational speed of the first shaft is greater than a rotational speed of the second shaft, the first shaft drives the second shaft via driving engagement between the second gear and the third gear, the first gear being overrun. When the rotational speed of the second shaft is greater than the rotational speed of the first shaft, the second shaft drives the first shaft via driving engagement between the fourth gear and the first gear, the third gear being overrun.

In some embodiments, the first shaft is operatively connected to the motor shaft, the first shaft axis being coaxial to the motor shaft axis.

In some embodiments, each of the first gear and the third gear comprises: an inner race mounted to a corresponding one of the first shaft and the second shaft; an outer race disposed radially outwardly of the inner race, the outer race comprising a plurality of gear teeth; and a clutch engager disposed between the inner race and the outer race, the gear being overrun when the clutch engager disengages the outer race from the inner race so that the inner race rotates relative to the outer race.

In some embodiments, the clutch engager comprises a plurality of rollers selectively coupling rotation of the outer race with the inner race.

In some embodiments, the first gear and the fourth gear counter-rotate relative to one another; and the second gear and the third gear counter-rotate relative to one another.

In some embodiments, the first gear is meshed with the fourth gear; and the second gear is meshed with the third gear.

In some embodiments, the first gear and the second gear are adjacent to one another; and the third gear and the fourth gear are adjacent to one another.

In some embodiments, a diameter of the first gear is greater than a diameter of the fourth gear; and a diameter of the third gear is greater than a diameter of the second gear.

In some embodiments, the second gear and the fourth gear are spur gears.

In some embodiments, the electric motor module further comprises a belted transmission operatively connected between the gearing assembly and the drive connection shaft.

In some embodiments, the first shaft is operatively connected to the motor shaft; the second shaft is operatively connected to the belted transmission; an the belted transmission operatively connects the gearing assembly to the drive connection shaft.

In some embodiments, the belted transmission assembly comprises a sprocket mounted to the second shaft for rotation therewith.

For purposes of this application, terms related to spatial orientation when referring to the vehicle orientation and positioning of its components such as forwardly, rearwardly, left, and right are as they would normally be understood by a driver of the vehicle sitting thereon in a normal riding position.

Embodiments of the present technology each have at least one of the above-mentioned aspects, but do not necessarily have all of them.

Additional and/or alternative features, aspects, and advantages of embodiments of the present technology will become apparent from the following description, the accompanying drawings, and the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

For a better understanding of the present technology, as well as other aspects and further features thereof, reference is made to the following description which is to be used in conjunction with the accompanying drawings, where:

FIG. **1** is a perspective view, taken from a rear, right side, of part of a power pack for a vehicle, including an engine and a continuous variable transmission (CVT) in an exploded configuration;

FIG. **2** is a top plan view of the exploded configuration of the engine and the CVT of FIG. **1**;

FIG. **3** is a left side elevation view of the engine and the CVT of FIG. **1**, in an assembled configuration;

FIG. **4** is a front elevation view of the engine and the CVT of FIG. **3**;

FIG. **5** is a perspective view of the power pack of FIG. **1**, including the engine, the CVT and a first sub-transmission selected from a group of different sub-transmissions, in an exploded configuration;

FIG. **6** is a perspective view, taken from a rear, right side, of the first sub-transmission of FIG. **5**;

FIG. **7** is a left side elevation view of the first sub-transmission of FIG. **5**;

FIG. **8** is a right side elevation view of the first sub-transmission of FIG. **5**;

FIG. **9** is a top plan view of the first sub-transmission of FIG. **5**;

FIG. **10** is a rear elevation view of the power pack of FIG. **5** in an assembled configuration;

FIG. **11** is a front elevation view of the power pack of FIG. **10**;

FIG. **12** is a left side elevation view of the power pack of FIG. **10**;

FIG. **13** is a right side elevation view of the power pack of FIG. **10**;

FIG. **14** is a perspective view of the power pack of FIG. **1**, including the engine, the CVT and a second sub-transmission selected from the group of different sub-transmissions, in an exploded configuration;

FIG. **15** is a perspective view, taken from a rear, left side, of the second sub-transmission of FIG. **14**;

FIG. **16** is a perspective view, taken from a rear, right side, of the second sub-transmission of FIG. **15**;

FIG. **17** is a left side elevation view of the second sub-transmission of FIG. **15**;

FIG. **18** is a top plan view of the second sub-transmission of FIG. **15**;

FIG. **19** is a rear elevation view of the power pack of FIG. **14** in an assembled configuration;

FIG. **20** is a left side elevation view of the power pack of FIG. **19**;

FIG. **21** is a right side elevation view of the power pack of FIG. **19**;

FIG. **22** is a top plan view of the power pack of FIG. **19**;

FIG. **23** is a perspective view of the power pack of FIG. **1**, including the engine, the CVT and a third sub-transmission selected from the group of different sub-transmissions, in an exploded configuration;

FIG. **24** is a rear elevation view of the third sub-transmission of FIG. **23**;

FIG. **25** is a front elevation view of the third sub-transmission of FIG. **24**;

FIG. **26** is a left side elevation view of the third sub-transmission of FIG. **24**;

FIG. **27** is a rear elevation view of the power pack of FIG. **23** in an assembled configuration;

FIG. **28** is a front elevation view of the power pack of FIG. **27**;

FIG. **29** is a left side elevation view of the power pack of FIG. **27**;

FIG. **30** is a right side elevation view of the power pack of FIG. **27**;

FIG. **31** is a top plan view of the power pack of FIG. **27**;

FIG. **32** is a perspective view, taken from a rear, right side, of part of the power pack in accordance with another embodiment of the present technology in which the power pack includes the engine, the CVT, the first sub-transmission and an electric motor module;

FIG. **33** is a partially exploded perspective view of the power pack of FIG. **32**;

FIG. **34** is a partially exploded perspective view, taken from a rear, left side, of the electric motor module of FIG. **32**;

FIG. **35** is a partially exploded perspective view, taken from a rear, right side, of the electric motor module of FIG. **32**;

FIG. **36** is a perspective view, taken from a rear, left side, of a drive assembly of the electric motor module of FIG. **32**;

FIG. **37** is a perspective view of the drive assembly of FIG. **36** showing a cross-section taken across a gearing assembly thereof;

FIG. **38** is a cross-sectional view of part of a freewheel clutch gear of the gearing assembly of FIG. **37**;

FIG. **39** is a schematic representation of the electric motor module of FIG. **32** and of a corresponding controller;

FIG. **40** is a perspective view, taken from a rear, right side, of part of the power pack in accordance with another embodiment in which the power pack includes the engine, the CVT, the electric motor module and the second sub-transmission; and

FIG. **41** is a perspective view, taken from a rear, right side, of part of the power pack in accordance with another embodiment in which the power pack includes the engine, the CVT, the electric motor module and the third sub-transmission.

DETAILED DESCRIPTION

In accordance with the present technology, a power pack **100** is provided which, by switching a modular component thereof, can be used for any vehicle selected from a predefined group of different vehicles having different drive requirements. For instance, the predefined group of vehicles can include an all-terrain vehicle (ATV), a snowmobile, and an on-road vehicle, all of which are driven differently.

With reference to FIG. **1**, the power pack **100** includes an internal combustion engine **10** which is configured to be supported by a frame of the vehicle to which the power pack **100** is to be installed. In this embodiment, the engine **10** operates on a two-stroke engine cycle such that the engine **10** completes a power cycle with two strokes (an upstroke and a downstroke) of the engine's piston (not shown). The engine **10** can thus be referred to as a two-stroke engine. It is contemplated that the engine **10** could be a four-stroke engine in other embodiments. With reference to FIG. **3**, the engine **10** has a crankcase **12**, a cylinder block **14** defining a single cylinder (not shown) connected on top of the crankcase **12** and a cylinder head **19** connected on top of the cylinder block **14**. The engine **10** also has a crankshaft (not shown) disposed in the crankcase **12** and driven by the motion of the piston. An engine exhaust conduit **55** through which exhaust gas is discharged extends rearwardly from the engine **10**.

In order to mount the engine **10** to the selected vehicle to which the power pack **100** is to be installed, as shown in FIGS. **3** and **4**, the engine **10** defines a plurality of engine mounts **60** for mounting the engine **10** to a frame of the vehicle. In this embodiment, each of the engine mounts **60** comprises an opening **61** for insertion therein of a corresponding protruding mounting member of the frame of the vehicle. Depending on the vehicle for which the power pack **100** is to be provided, only one of the engine mounts **60** may be used for mounting the engine **10** to the frame of the selected vehicle.

Although in this embodiment the engine **10** is a single-cylinder engine, having a single cylinder and a single piston movable therein, it is contemplated that the engine **10** could be a two-cylinder engine in other embodiments.

It is contemplated that, in some embodiments, the engine **10** could have an electronic reverse function for operating the engine **10** in reverse so that the crankshaft can be selectively rotated in a forward rotation direction and a reverse rotation direction. This can be achieved by controlling the fuel injection and ignition within the cylinders of the engine **10**. For instance, U.S. Pat. No. 5,036,802, issued Aug. 6, 1991, the entirety of which is incorporated herein by reference, describes in detail a manner in which this electronic reverse function can be achieved. The electronic reverse function could be selectively activated via an electronic reverse function control element (e.g., a push button) disposed on the vehicle to which the power pack **100** is to be installed.

As shown in FIGS. **1**, **2** and **4**, a generator **56** is connected to the side of the crankcase **12** opposite the power take-off side. The generator **56** uses power produced by the engine **10** to generate electrical energy for storage in a battery (not shown). An electric starter motor **58** is also connected to the front of the crankcase **12**. The starter motor **58** selectively engages the crankshaft via gears (not shown) to cause the crankshaft to turn before the engine **10** can run on its own as a result of the internal combustion process in order to start the engine **10**.

The power pack **100** also includes a continuously variable transmission (CVT) **40** to which the engine **10** is operatively connected. The CVT **40** includes a drive pulley **42** operatively connected to the crankshaft of the engine **10**, a driven pulley **44**, and a transmission belt **46** disposed around both pulleys **42**, **44** to transmit torque from the drive pulley **42** to the driven pulley **44**. In particular, as shown in FIG. **2**, the drive pulley **42** is operatively connected to the crankshaft of the engine **10** via an output shaft **16** thereof which rotates about an axis **17** which extends laterally when the power pack **100** is installed on the vehicle **10**. Notably, the drive pulley **42** is mounted to the output shaft **16** such that the drive pulley **42** is rotatable about the axis **17**. The axis **17** may thus be referred to as a "drive pulley axis". The driven pulley **44** rotates about an axis **67** defined by a countershaft **51**, which extends parallel to the axis **17** (i.e., generally laterally when the power pack **100** is installed on the selected vehicle). The axis **67** may thus be referred to as a "driven pulley axis". As will be explained below, the driven pulley **44** is operatively connected to the countershaft **51** by a centrifugal clutch **65**. The driven pulley **44** is rearward and upward of the drive pulley **42** such that the driven pulley axis **67** is located rearward and upward of the drive pulley axis **17** as shown in FIG. **3**.

Each of the pulleys **42**, **44** includes a movable sheave that can move axially relative to a fixed sheave to modify an effective diameter of the corresponding pulley **42**, **44**. The drive pulley **42** is a centrifugal pulley in that the sheaves thereof move in response to a centrifugal force applied thereon. The effective diameters of the pulleys **42**, **44** are in inverse relationship. In the illustrated embodiment, the CVT **40** is a purely mechanical CVT **40**, in which the diameter of the driven pulley **44** increases with increasing rotational speed of the drive pulley **42** (i.e., with increasing engine speed). The diameter of the driven pulley **44** therefore decreases when the torque required at the countershaft **51** increases. The CVT **40** may thus be referred to as an "unassisted" CVT in that a gear ratio of the CVT **40** (i.e., an effective diameter of the driven pulley **44** over the effective diameter of the drive pulley **42**) is automatically mechanically adjusted in accordance with the speed of the engine **10** and the torque requirement at the countershaft **51**.

It is contemplated that, in other embodiments, the CVT **40** could be an assisted CVT such as a hydraulic CVT.

With continued reference to FIGS. **1** and **2**, the driven pulley **44** is operatively connected to an input of the centrifugal clutch **65** which is disposed adjacent to the driven pulley **44**. As shown, the centrifugal clutch **65** is coaxial with the driven pulley **44**. The centrifugal clutch **65** has a clutch housing **68** and an outer coupling **69** that rotates together with the clutch housing **68**. In this embodiment, the outer coupling **69** has inner splines (not shown) to receive and drivingly engage the countershaft **51**. The centrifugal clutch

65 also has clutch shoes (not shown) enclosed within the clutch housing **68**. The centrifugal clutch **65** operates in one of an open position and a closed position based on a rotational speed of the driven pulley **44** of the CVT **40**. The centrifugal clutch **65** operates in the closed position beginning at a given rotational speed at which the clutch shoes drive the clutch housing **68** when the centrifugal force exerted on the clutch shoes overcomes the resistance posed by a set of springs (not shown) retaining the clutch shoes so that the clutch shoes frictionally engage the inner side of the clutch housing **68**. The manner in which centrifugal clutches operate is known in the art and thus will not be described in detail herein. In this embodiment, the centrifugal clutch **65** starts operating in the closed position (i.e., the clutch housing **68** and outer coupling **69** rotate) when the rotational speed of the countershaft **51** reaches a speed approximately between 2000 rpm and 3000 rpm inclusively. Thus, in this embodiment, when the engine **10** is running at idle speed, the centrifugal clutch **65** is the open position such that the outer coupling **69** is not driven by the driven pulley **44**. The centrifugal clutch **65** may transition from the open position to the closed position at different rotational speeds in other embodiments.

A CVT housing **48** encloses the drive and driven pulleys **42**, **44**, the transmission belt **46** and the centrifugal clutch **65** therein. Notably, the CVT housing **48** has a left portion **50** and a right portion **52** which are affixed to one another via a plurality of fasteners. The outer coupling **69** of the centrifugal clutch **65** is operatively connected to an output coupling **54** (FIG. **1**) via the countershaft **51**. Notably, in this embodiment, the output coupling **54** is defined by a right end of the countershaft **51**. As can be seen, the output coupling **54** is rotatably connected to the right portion **52** of the CVT housing **48**. As such, when the centrifugal clutch **65** is closed, the outer coupling **69** drives the output coupling **54**. The output coupling **54** is accessible on the right side of the power pack **100** for allowing driving engagement with the driven pulley **44**, as will be described in greater detail below.

As shown in FIGS. **1** and **4**, the right portion **52** of the CVT housing **48** defines an air inlet **45** and an air outlet **47** for respectively receiving and discharging air from the CVT housing **48**. Air circulation through the air inlet and outlets **45**, **47** allows cooling of the CVT components, namely of the belt **46** which may degrade if subjected to excessive heat. In this embodiment, the air inlet **45** faces upwardly while the air outlet **47** faces forwardly.

The CVT housing **48** also has a plurality of mounts $\mathbf{64_1}$-$\mathbf{64_4}$ for mounting a sub-transmission thereto. The mounts $\mathbf{64_1}$-$\mathbf{64_4}$ may thus be referred to as "sub-transmission mounts". Each one of the sub-transmission mounts $\mathbf{64_1}$-$\mathbf{64_4}$ thus defines a respective mounting point to which the sub-transmission is mounted. In particular, in this embodiment, each sub-transmission mount $\mathbf{64_1}$-$\mathbf{64_4}$ is an internally threaded opening defined by the CVT housing **48**. In this embodiment, the right portion **52** of the CVT housing **48** defines the sub-transmission mounts $\mathbf{64_1}$-$\mathbf{64_4}$ such that the sub-transmission is mounted to the right side of the CVT housing **48**. As will be described in greater detail below, the configuration of the sub-transmission mounts $\mathbf{64_1}$-$\mathbf{64_4}$ allows the CVT housing **48** to mount any selected sub-transmission of a group of different sub-transmissions.

In order for the power pack **100** to be able to be used for any vehicle of the predefined group of different vehicles, the power pack **100** is provided with a sub-transmission that is selected from a predefined group of different sub-transmissions **110**, **210**, **310** depending on the selected vehicle for which the power pack **100** is to be provided. In other words, each sub-transmission **110**, **210**, **310** is associated with a corresponding vehicle of a group of different vehicles, and therefore by providing the power pack **100** with a selected one of the sub-transmissions **110**, **210**, **310**, the power pack **100** can be used for the vehicle to which the sub-transmission **110**, **210**, **310** corresponds. In this embodiment, the sub-transmissions **110**, **210**, **310** correspond to a snowmobile, an on-road vehicle, and an all-terrain vehicle (ATV) respectively. The sub-transmissions **110**, **210**, **310** will thus be referred to as a "snowmobile sub-transmission" **110**, an "on-road sub-transmission" **210** and an "ATV sub-transmission" **310**. Their configurations and respective implementation on the power pack **100** will be described in greater detail below.

It is to be understood that the predefine group of vehicles is not limited to a snowmobile, an on-road vehicle and an ATV, and the power pack **100** could be provided for other vehicles requiring corresponding drive output(s). Thus, the terms "snowmobile sub-transmission", "on-road sub-transmission" and "ATV sub-transmission" are used herein to differentiate the sub-transmissions from one another and to identify one possible intended use, but are not intended to limit the use of these sub-transmissions to a single type of vehicle.

Power Pack for a Snowmobile

With reference to FIG. **5**, in one potential configuration, the power pack **100** is to be provided for a snowmobile and therefore the snowmobile sub-transmission **110** is selected from the sub-transmissions **110**, **210**, **310** to be a part of the power pack **100**. An example of a snowmobile for which this configuration of the power pack **100** could be provided can be found for example in U.S. Pat. No. 9,114,852, issued on Aug. 25, 2015, which is incorporated in its entirety by reference herein. The snowmobile sub-transmission **110** is configured to be operatively connected between the CVT **40** and a ground-engaging member (i.e., a drive track) of the snowmobile for driving thereof.

The snowmobile sub-transmission **110** will now be described with reference to FIGS. **6** to **9**. The snowmobile sub-transmission **110** has a sub-transmission housing **112** which defines an interior space of the snowmobile sub-transmission **110** and encloses a plurality of gears **150** therein (schematically illustrated in FIG. **7**). Notably, the sub-transmission housing **112** has a right portion **111** and a left portion **113** which are fastened to one another to enclose the gears **150** and other components therein. The attachment of the portions **111**, **113** of the sub-transmission housing **112** results in the snowmobile sub-transmission being sealed such that the interior space thereof is inaccessible without disassembly of the sub-transmission housing **112**.

A lubrication inlet **148** extends upwardly from a top portion of the sub-transmission housing **112** for lubricating the gearing system of the snowmobile sub-transmission **110**.

As shown in FIGS. **7** and **9**, the snowmobile sub-transmission **110** has an input shaft **118** extending outwardly from the sub-transmission housing **112** on a left side **117** of the snowmobile sub-transmission **110**. The input shaft **118** is configured to be received by the output coupling **54** so that the CVT **40** and the snowmobile sub-transmission **110** are in driving engagement. Notably, the input shaft **118** and the output coupling **54** are splined and thus are drivingly connected. Thus, in use, the input shaft **118** rotates about the driven pulley axis **67**.

The gears **150** operatively connect the input shaft **118** to an output shaft **120** of the snowmobile sub-transmission **110**. The output shaft **120** is rotatable about an output shaft axis **125** which extends along a direction generally parallel to the driven pulley axis **67** such that, when the power pack **100** is installed on the snowmobile, the output shaft axis **125** extends generally laterally. The output shaft **120** is configured to be operatively connected to the drive track of the snowmobile. As can be seen, the output shaft **120** has two driving portions **121**, **123** for driving respective drive sprockets of the snowmobile which in turn engage the drive track thereof to propel the snowmobile. As shown in FIG. **6**, the output shaft **120** extends laterally outwardly from both lateral sides of the sub-transmission housing **112**.

As shown in FIGS. **7** and **9**, in order to be connected to the CVT **40**, the snowmobile sub-transmission **110** has a plurality of mount connectors 145_1-145_4 which are configured to be engaged with the sub-transmission mounts 64_1-64_4 of the CVT housing **48**. Notably, in this embodiment, each of the mount connectors 145_1-145_4 is a fastener which extends through both portions **111**, **113** of the sub-transmission housing **112** to threadedly engage a corresponding one of the sub-transmission mounts 64_1-64_4.

With particular reference to FIG. **9**, the snowmobile sub-transmission **110** defines two shaft mounting portions **127**, **129** through which, in addition to the vehicle mounts **60** of the engine **10**, the power pack **100** can be mounted to the snowmobile. In particular, the shaft mounting portions **127**, **129** are portions of the output shaft **120** which are configured to be supported by the frame of the snowmobile via bearings **135** (schematically illustrated in FIG. **9**). For instance, in use, the shaft mounting portions **127**, **129** of the snowmobile sub-transmission **110** will be supported by a tunnel of the snowmobile via the bearings **135**.

The snowmobile sub-transmission **110** also has a shifter **140**, including a shifter lever, for selectively engaging the input shaft **118** with one of the gears **150**. More specifically, in use, the shifter **140** is operable by a user of the snowmobile to engage a gear of the sub-transmission **110** so as to modify the driving operation of the output shaft **120**. Notably, the shifter **140** allows the user to operate the snowmobile sub-transmission **110** in one of a plurality of "gears", which, in this embodiment, includes a high gear, a low gear, a neutral gear and a reverse gear. Notably, particular ones of the gears **150** are associated with the high, low and reverse gears such that, when engaged via the shifter **140**, the snowmobile drives in high gear, in low gear and in reverse respectively.

It is contemplated that the snowmobile sub-transmission **110** could be operable in a different number of gears in other embodiments.

The power pack **100** including the snowmobile sub-transmission **110** is shown assembled in FIGS. **10** to **13**. As can be seen, the power pack **100** is configured such that part of the crankcase **12** of the engine **10** and the snowmobile sub-transmission **110** are disposed on the right side of the CVT **40**. Notably, as shown in FIG. **10**, part of the snowmobile sub-transmission **110** extends laterally away from the CVT **40** (i.e., toward the right) past the engine **10**. For instance, in this embodiment, part of the sub-transmission housing **112** and the output shaft **120** extend laterally away from the CVT **40** past the engine **10**. Moreover, with reference to FIGS. **10** and **12**, the output shaft **120** of the snowmobile sub-transmission **110** is positioned relatively low. For instance, the output shaft axis **125** of the output shaft **120** is vertically lower than the driven pulley axis **67**.

Also, as can be seen, all the mounting points defined by the sub-transmission mounts 64_1-64_4 of the CVT housing **48** are used to mount the snowmobile sub-transmission **110** to the CVT housing **48**. That is, every one of the sub-transmission mounts 64_1-64_4 of the CVT housing **48** receives a corresponding one of the mount connectors 145_1-145_4.

The snowmobile sub-transmission **110** is a modular unit of the power pack **100** which is attached to the CVT **40** but that is otherwise spatially independent therefrom. Notably, the interior space of the snowmobile sub-transmission **110**, as defined by the sub-transmission housing **112**, is sealed from the CVT housing **48**. As such, air flow within the CVT housing **48** is independent of the snowmobile sub-transmission **110**. In other words, air flow entering into the CVT housing **48** (via the air inlet **45**) does not enter into the interior space of the snowmobile sub-transmission **110**.

It is to be understood that this particular configuration of the power pack **100** is not limited for use with a snowmobile, but could instead be used on other vehicles that are driven by the two laterally-extending driving portions **121**, **123**.

With reference to FIGS. **32** and **33**, in some embodiments, the power pack **100** also includes an electric motor module **400** that is operatively connected between the CVT **40** and the snowmobile sub-transmission **110**. The electric motor module **400** includes an electric motor **410** and a drive assembly **412** (FIGS. **34**, **35**) operatively connected to the electric motor **410**.

With reference to FIGS. **34** and **35**, the drive assembly **412** is enclosed by a housing **414** that includes a right portion **420**, a middle portion **422** and a left portion **426**. The right and middle portions **420**, **422** of the housing **414** extend vertically lower than the left portion **426** and are connected to one another via fasteners received in respective openings **423** of each of the right and middle portions **420**, **422**. Moreover, the right portion **420** of the housing **414** is connected to a motor housing **411** enclosing the motor **410**. The housing **414** is mounted to the CVT housing **48** on the right side thereof. Notably, each of the right and middle portions **420**, **422** of the housing **414** has a plurality of mounts **427** which are used for mounting the housing **414** of the electric motor module **400** to the CVT housing **48**. Notably, the mounts **427** of the right portion **420** are aligned with the mounts **427** of the middle portion **422** to define a plurality of mounting points of the housing **414**. The mounting points of the housing **414** are aligned with the mounting points defined by the mounts 64_1-64_4 of the CVT housing **48** so as to mount the electric motor module **400** to the CVT housing **48**. As such, the electric motor module **400** defines the same pattern of mounting points as the CVT housing **48**, thereby facilitating the subsequent mounting of the sub-transmission **110**.

As shown in FIG. **34**, the electric motor **410** has a motor shaft **416** that rotates about a motor shaft axis **417**. The motor shaft axis **417** extends generally laterally (i.e., generally parallel to the driven pulley axis **67**). The motor shaft **416** is operatively connected to the drive assembly **412** so that torque can be transferred from the electric motor **410** to the drive assembly **412** and vice-versa as will be explained in detail below.

As shown in FIGS. **34** to **37**, the drive assembly **412** includes a gearing assembly **430** and a belted transmission **440** that are operatively connected to one another. As best shown in FIG. **35**, the gearing assembly **430** includes a primary shaft **432** that rotates about a primary shaft axis **419** coaxial with the motor shaft axis **417**. The primary shaft **432** operatively connects the motor shaft **416** to the drive assembly **412**. In particular, the primary shaft **432** defines a bore **434** that receives the motor shaft **416** therein and is drivingly engaged therewith via a key and shaft arrangement. The gearing assembly **430** also includes secondary shaft **436** operatively connected to the primary shaft **432**. The secondary shaft **436** rotates about a secondary shaft axis **437** that extends parallel to the primary shaft axis **419**. As can be seen, two bearings **468**, **470** are mounted to the primary shaft **432** and two bearings **472**, **474** are mounted to the secondary shaft **436**. Notably, the primary and secondary shafts **432**, **436** are rotatably supported by the housing **414** via the bearings **468**, **470**, **472**, **474**. The gearing assembly **430** also includes a plurality of gears **460**, **462**, **464**, **466** configured to transmit torque between the primary and secondary shafts **432**, **436**. The manner in which the gearing assembly **430** operates will be described in greater detail further below.

The secondary shaft **436** operatively connects the belted transmission **440** to the gearing assembly **430**. The belted transmission **440** includes an upper sprocket **442**, a lower sprocket **444** and a belt **446** operatively connecting the upper and lower sprockets **442**, **444**. The upper sprocket **442** and the lower sprocket **444** are mounted, respectively, to the secondary shaft **436** and to a drive connection shaft **448** for rotation therewith. The drive connection shaft **448** is rotatable about a connection shaft axis **449** that extends parallel to the primary and secondary shaft axes **419**, **437**. The drive connection shaft **448** is disposed laterally between the CVT housing **48** of the CVT **40** and the sub-transmission **110**.

The drive connection shaft **448** is operatively connected between the driven pulley **44** of the CVT **40** and the gearing assembly **430**. More specifically, the drive connection shaft **448** is operatively connected to the driven pulley **44** by the centrifugal clutch **65**, while being operatively connected to the gearing assembly **430** by the belted transmission **440**. As such, as will be explained below, torque can be transmitted from the driven pulley **44** to the gearing assembly **430** by the drive connection shaft **448**. The drive connection shaft **448** is also operatively connected to the sub-transmission **110** so that torque can be transmitted from the drive connection shaft **448** to the output shaft **120** of the sub-transmission **110**. In other words, the input shaft **118** of the sub-transmission **110** is operatively connected between the drive connection shaft **448** and the output shaft **120** of the sub-transmission **110**.

As shown in FIGS. **35** and **36**, the drive connection shaft **448** defines an outer splined connector **450** at a left end thereof and an inner splined connector **452** at a right end thereof. Notably, the outer splined connector **450** is inserted into the splined output coupling **54** on the right portion **52** of the CVT housing **48** for driving engagement therewith. At the opposite end, the inner splined connector **452** receives the input shaft **118** of the sub-transmission **110**. In particular, as shown in FIG. **33**, the inner splined connector **452** is exposed on the right side of the electric motor module **400** via an opening **454** of the right portion **420** of the housing **414** so that the splined end **121** of the input shaft **118** can be received in the inner splined connector **452**.

As will be understood from the above, both the outer splined connector **450** and the input shaft **118** have matching connecting features since both can be received by the output coupling **54**. Thus, in cases where the electric motor module **400** is not included as part of the power pack **100**, the sub-transmission **110** can be connected to the output coupling **54** irrespective of the absence of the electric motor module **400**.

The gearing assembly **430** will now be described in greater detail with reference to FIGS. **36** and **37**. As can be seen, the gears **460**, **462**, **464**, **466** are positioned so as to be enclosed by the housing **414**, namely between the middle portion **422** and the left portion **426** of the housing **414**. The gears **460**, **462**, **464**, **466** include two primary gears **460**, **462** adjacent to one another and mounted to the primary shaft **432** and two secondary gears **464**, **466** adjacent to one another and mounted to the secondary shaft **436**. The primary gear **460** and the secondary gear **466** are disposed to the right of the primary gear **462** and the secondary gear **464** respectively and therefore the gears can be referred to as right and left primary gears **460**, **462** and right and left secondary gears **466**, **464**. A diameter of the right primary gear **460** is greater than a diameter of the right secondary gear **466**, while a diameter of the left secondary gear **464** is greater than a diameter of the left primary gear **462**.

In this embodiment, the primary gears **460**, **462** are meshed together with the secondary gears **464**, **466** for selective driving engagement therebetween. Notably, the right primary gear **460** is meshed together with the right secondary gear **466** for selective driving engagement therebetween (i.e., teeth **461** of the right primary gear **460** are meshed with teeth **467** of the right secondary gear **466**), while the left primary gear **462** is meshed together with the left secondary gear **464** for selective driving engagement therebetween (i.e., teeth **463** of the left primary gear **462** are meshed with teeth **465** of the left secondary gear **464**). As such, the right primary gear **460** counter-rotates relative to the right secondary gear **466**, and the left primary gear **462** counter-rotates relative to the left secondary gear **464**.

It is contemplated that, in other embodiments, the primary gears **460**, **462** could be operatively connected to the secondary gears **464**, **466** via intermediary idler gears.

The two primary gears **460**, **462** are disposed between the two bearings **468**, **470** that are mounted on the primary shaft **432**. The bearing **468** is rotatably supported by the middle portion **422** of the housing **414** while the bearing **470** is rotatably supported by the left portion **426** of the housing **414**. Similarly, the two secondary gears **464**, **466** are disposed between the two bearings **472**, **474** that are mounted on the secondary shaft **436**. The bearing **474** is rotatably supported by the middle portion **422** of the housing **414** while the bearing **472** is rotatably supported by the left portion **426** of the housing **414**.

As will be explained below, the configuration of the gears **460**, **462**, **464**, **466** allows torque to be transmitted between the primary and secondary shafts **432**, **436** in either direction, namely from the primary shaft **432** to the secondary shaft **436** and vice-versa. To that end, the right primary gear **460** and the left secondary gear **464** are freewheel clutch gears that are driven by the primary and secondary shafts **432**, **436** in a single rotation direction about their respective axes **419**, **437**. In particular, the right primary gear **460** is driven in a rotation direction PR about the primary shaft axis **419** (which corresponds to the direction of forward rotation of the primary shaft **432**) while the left secondary gear **464** is driven in a rotation direction SR about the secondary shaft axis **437** (which corresponds to the direction of forward rotation of the secondary shaft **436**). The rotation directions PR, SR may thus be referred as driving rotation directions PR, SR. As freewheel clutch gears, the right primary gear **460** and the left secondary gear **464** can be "overrun", whereby respective teeth **461**, **465** of the right primary gear **460** and the left secondary gear **464** rotate at a different speed than the corresponding one of the primary shaft **432** and secondary shaft **436** to which the gear is mounted. This will be explained in greater detail further below. The right primary gear **460** and the left secondary gear **464** can also be overrun if the primary and secondary shafts **432**, **436** were to rotate in directions opposite to the rotation directions PR, SR.

As for the other gears, the left primary gear **462** and the right secondary gear **466** are spur gears that are fixedly mounted to the primary shaft **432** and the secondary shaft **436** respectively for rotation therewith such that the left primary gear **462** and the right secondary gear **466** can be driven by the primary and secondary shafts **432**, **436** in both rotation directions about their respective axes **419**, **437**.

In this embodiment, the freewheel clutch gears **460**, **464** have identical configurations to allow their functionality, however they are disposed on their respective primary and secondary shaft **432**, **436** so as to rotationally lock in opposite directions of rotation for accommodating the counter-rotation of the primary and secondary shafts **432**, **436**. Notably, with reference to FIG. **38**, each of the freewheel clutch gears **460**, **464** is a trapped roller clutch having an inner race **480**, an outer race **482** disposed radially outwardly of the inner race **480**, and a clutch engager **484** disposed between the inner and outer races **480**, **482**. The inner race **480** is fixedly mounted to a corresponding one of the primary shaft **432** and the secondary shaft **436** for rotation therewith. For instance, the inner race **480** is fixed via a shaft key to the corresponding one of the primary shaft **432** and the secondary shaft **436**. The outer race **482** includes the teeth of the gear **460**, **464** (i.e., teeth **461** or **465**).

The clutch engager **484** is configured to selectively rotationally lock the outer race **482** with the inner race **480** so that the inner and outer races **480**, **482** rotate together at the same speed. However, if the inner race **480** rotates faster than the outer race **482** in the direction PR or SR, the clutch engager **484** disengages the outer race **482** from the inner race **480** so that the inner and outer races **480**, **482** are in freewheel motion with respect to one another and the gear **460** or **464** is said to be overrun. In order to provide this functionality, in this embodiment, the clutch engager **484** includes a plurality of ramps **486** connected to the inner race **480** and distributed circumferentially thereabout, and a plurality of rollers **488** connected to the ramps **486**. In particular, each roller **488** is operatively connected to a corresponding ramp **486** by a spring **490**. In use, when the outer race **482** of the respective freewheel clutch gear **460**, **464** is driven in the corresponding driving rotation direction PR, SR relative to the inner race **480**, the rollers **488** move outwardly along the ramps **486** and become locked between the ramps **486** and the outer race **482**, thereby coupling rotation of the outer race **482** with the inner race **480**. However, when the freewheel clutch gear is overrun, the rollers **488** compress the springs **490** and are in rolling contact with the outer race **482** to allow freewheel motion of the outer race **482** relative to the inner race **480**.

It is contemplated that the freewheel clutch gears **460**, **464** could be configured differently in other embodiments. For instance, the freewheel clutch gears **460**, **464** could be of a type other than a trapped roller clutch (e.g., a sprag clutch).

The gearing assembly **430** is thus operable such that, in a first scenario, when a rotational speed of the primary shaft **432** is greater than a rotational speed of the secondary shaft **436**, the primary shaft **432** drives the secondary shaft **436** via driving engagement between the left primary gear **462** and the left secondary gear **464**. In this scenario, the right primary gear **460** is overrun since its driving engagement with the smaller sized right secondary gear **466** causes the outer race **482** of the right primary gear **460** to rotate slower than the secondary shaft **436** and therefore slower than the inner race **480** of the right primary gear **480** (which is rotating at the same speed as the primary shaft **432**). The inner and outer races **480**, **482** of the right primary gear **460** are thus in freewheel motion relative to one another. In this first scenario, the motor **410** can transmit torque to the gearing assembly **430** which in turn will transmit torque to the belted transmission **440** via the upper sprocket **442** which is operatively connected to the secondary shaft **436**. In turn, the belted transmission **440** transmits torque to the drive connection shaft **448** to drive the sub-transmission **110** operatively connected thereto.

In a second scenario, when the rotational speed of the secondary shaft **436** is greater than the rotational speed of the primary shaft **432**, the secondary shaft **436** drives the primary shaft **432** via driving engagement between the right secondary gear **466** and the right primary gear **460**. In this scenario, the left secondary gear **464** is overrun since its driving engagement with the smaller sized left primary gear **462** causes the outer race **482** of the left secondary gear **464** to rotate slower than the primary shaft **432** and therefore slower than the inner race **480** of the left secondary gear **464** (which is rotating at the same speed as the secondary shaft **436**). The inner and outer races **480**, **482** of the left secondary gear **464** are thus in freewheel motion relative to one another. In this second scenario, torque can be transmitted to the drive connection shaft **448** via the CVT **40** and the centrifugal clutch **65**, causing the belted transmission **440** to transmit torque to the gearing assembly **430**. In turn the gearing assembly **430** transmits torque to the motor shaft **416**. This can allow the motor **410** to function as a generator to produce and store energy. Alternatively, in some cases, in this second scenario, torque may be transmitted to the gearing assembly **430** when the vehicle's operator releases the throttle but the ground-engaging member(s) of the vehicle (e.g., an endless track in the case of a snowmobile) are still engaging the ground and cause the sub-transmission **110** to transmit torque to the gearing assembly **430**, similarly allowing the motor **410** to function as a generator.

In order to control operation of the electric motor module **400**, as shown schematically in FIGS. **32** and **39**, a controller **475** is provided in electronic communication with the motor **410** and is thereby operable to control the electric motor module **400** in various driving modes.

As shown in FIG. **39**, the controller **475** has a processor unit **477** for carrying out executable code, and a non-transitory memory unit **479** that stores the executable code in a non-transitory medium (not shown) included in the memory unit **479**. The processor unit **477** includes one or more processors for performing processing operations that implement functionality of the controller **475**. The processor unit **477** may be a general-purpose processor or may be a specific-purpose processor comprising one or more preprogrammed hardware or firmware elements (e.g., application-specific integrated circuits (ASICs), electrically erasable programmable read-only memories (EEPROMs), etc.) or other related elements. The non-transitory medium of the memory unit **479** may be a semiconductor memory (e.g., read-only memory (ROM) and/or random-access memory (RAM)), a magnetic storage medium, an optical storage medium, and/or any other suitable type of memory. While the controller **475** is represented as being one entity in this implementation, it is understood that the controller **475** could comprise separate entities for controlling components separately.

Amongst the various driving modes of the electronic motor module **400**, the controller **475** is operable to control the electric motor module **400** in an engine driving mode in which the output shaft **120** of the sub-transmission **110** is driven solely by torque transmitted thereto by the engine **10** via the CVT **40**, the centrifugal clutch **65** and the drive connection shaft **448**. Notably, in the engine driving mode, the torque produced by the electric motor **410** is null such that the gearing assembly **430** does not contribute in generating torque being transmitted to the sub-transmission **110**. Rather, in the engine driving mode, in this embodiment, the drive connection shaft **448** transmits torque to the belted transmission **440** which in turn transmits torque to the gearing assembly **430**. As such, the drive connection shaft **448** transmits torque to the motor shaft **416** via the gearing assembly **430** such that the electric motor **410** operates as a generator to store energy in a battery **495** (FIG. **39**).

The controller **475** can also control the electric motor module **400** in an electric motor driving mode in which the output shaft **120** of the sub-transmission **110** is solely driven by torque transmitted thereto by the electric motor **410** via the drive assembly **412**, including the gearing assembly **430** and the belted transmission **440**, and the drive connection shaft **448**. Notably, in the electric motor driving mode, the driven pulley **44** of the CVT **40** is drivingly disengaged from the output shaft **120** of the sub-transmission **110** and from the drive connection shaft **448**. In particular, when the electric motor module **400** is operating in the electric motor driving mode, the centrifugal clutch **65** is in its open position as a result of the engine **10** not running or running at a speed inferior to that needed for the centrifugal clutch **65** to be in the closed position. As such, the outer coupling **69** of the centrifugal clutch **65** does not transmit torque to the output coupling **54** which therefore in turn does not drive the drive connection shaft **448**.

Lastly, the controller **475** can also control the electric motor module **400** in a hybrid driving mode in which the output shaft **120** of the sub-transmission **110** is driven by torque transmitted thereto by both the motor shaft **416** of the electric motor **410** and the driven pulley **44** of the CVT **40**. In other words, in the hybrid driving mode, both the engine **10** and the electric motor **410** transmit torque to the drive connection shaft **448** which in turn drives the input shaft **118** of the sub-transmission **110** resulting in driving of the output shaft **120**.

The electric motor module **400** thus provides an additional source of torque with which the sub-transmission **110** can be driven. The various driving modes may be useful in different scenarios. For instance, the engine driving mode may be useful in scenarios in which a significant amount of torque is desired to drive the vehicle, while also contributing to generating energy that may recharge a battery. Conversely, the electric motor driving mode may be useful in scenarios in which a lesser torque is desired to drive the vehicle and/or for fuel conservation purposes. For its part, the hybrid driving mode can be also be useful for fuel efficiency purposes as the power pack **100** generates torque from both torque generating sources, thereby reducing the demand on the engine **10**. It is contemplated that the controller **475** could control the electric motor module **400** in additional driving modes.

The operator of the vehicle may choose in which driving mode to operate the electric motor module **400**. For instance, a selection switch (not shown) in communication with the controller **475** may be available to the operator on the dashboard of the vehicle to select the desired driving mode according to different parameters that the operator can observe (e.g., riding conditions, terrain, fuel availability, etc.). Alternatively, the controller **475** may have different input data transmitted thereto by various sensors of the vehicle on the basis of which the controller **475** can automatically select one of the driving modes. In other words, the controller **475** could select the driving mode based on different parameters of the vehicle (e.g., speed of the vehicle, fuel availability, battery charge level, etc.).

Power Pack for an On-Road Vehicle

With reference to FIG. **14**, in another potential configuration, the power pack **100** is to be provided for an on-road vehicle and therefore the on-road sub-transmission **210** is selected from the sub-transmissions **110**, **210**, **310** to be a part of the power pack **100**. An example of an on-road vehicle for which this configuration of the power pack **100** could be provided can be found for example in U.S. Pat. No. 10,336,387 issued on Jul. 2, 2019, which is incorporated in its entirety by reference herein. The on-road sub-transmission **210** is configured to be operatively connected between the CVT **40** and a ground-engaging member (i.e., a wheel) of the on-road vehicle for driving thereof.

The on-road sub-transmission **210** will now be described with reference to FIGS. **15** to **18**. The on-road sub-transmission **210** has a sub-transmission housing **212** which defines an interior space of the on-road sub-transmission **210** and encloses a plurality of gears **250** therein (schematically illustrated in FIG. **17**). Notably, the sub-transmission housing **212** has a right portion **211** and a left portion **213** which are fastened to one another to enclose the gears **250** and other components therein. The attachment of the portions **211**, **213** of the sub-transmission housing **212** results in the on-road sub-transmission **210** being sealed such that the interior space thereof is inaccessible without disassembly of the sub-transmission housing **212**.

A lubrication inlet **248** extends upwardly from a top portion of the sub-transmission housing **212** for lubricating the gearing system of the on-road sub-transmission **210**.

As shown in FIGS. **15** and **18**, the on-road sub-transmission **210** has an input shaft **218** extending outwardly from the sub-transmission housing **212** on a left side **217** of the on-road sub-transmission **210**. The input shaft **218** is configured to be received by the output coupling **54** so that the CVT **40** and the on-road sub-transmission **210** are in driving engagement. Notably, the input shaft **218** and the output coupling **54** are splined and thus are drivingly connected. Thus, in use, the input shaft **218** rotates about the driven pulley axis **67**.

The gears **250** operatively connect the input shaft **218** to an output shaft **220** (schematically represented in FIG. **18**) of the on-road sub-transmission **210**. The output shaft **220** is rotatable about an output shaft axis **225** which extends along a direction generally parallel to the driven pulley axis **67** such that, when the power pack **100** is installed on the on-road vehicle, the output shaft axis **225** extends generally laterally. A drive sprocket **270** is mounted and secured to the output shaft **220** for rotation therewith. The drive sprocket **270** configured to be operatively connected to a wheel of the on-road vehicle. Notably, in use, a drive chain is attached to the drive sprocket **270** and is operatively connected to the drive wheel of the on-road vehicle. To that end, as shown in FIGS. **16** and **18**, the drive sprocket **270** is positioned outside of the sub-transmission housing **212**. More specifically, the drive sprocket **270** is positioned rightward of the right portion **211** of the sub-transmission housing **212**.

As shown in FIGS. **15**, **17** and **18**, in order to be connected to the CVT **40**, the on-road sub-transmission **210** has a plurality of mount connectors **245**$_1$-**245**$_4$ which are configured to be engaged with the sub-transmission mounts **64**$_1$-**64**$_4$ of the CVT housing **48**. Notably, in this embodiment, each of the mount connectors **245**$_1$-**245**$_4$ is a fastener which extends through both portions **211**, **213** of the sub-transmission housing **212** to threadedly engage a corresponding one of the sub-transmission mounts **64**$_1$-**64**$_4$.

With particular reference to FIG. **16**, the sub-transmission housing **212** of the on-road sub-transmission **210** defines two vehicle mounts **227** through which, in addition to the vehicle mounts **60** of the engine **10**, the power pack **100** can be mounted to the on-road vehicle. In this embodiment, the vehicle mounts **227** include an upper vehicle mount **227** and a lower vehicle mount **227**. Each vehicle mount **227** is configured to receive therein a fastener for attachment to the frame of the on-road vehicle.

As can be seen, in contrast with the snowmobile sub-transmission **110**, the on-road sub-transmission **210** does not have a shifter for operating the sub-transmission **210** in different gears. Therefore, the change in speed and torque may be provided solely by the CVT **40** in this embodiment.

The power pack **100** including the on-road sub-transmission **210** is shown assembled in FIGS. **19** to **22**. As can be seen, the power pack **100** is configured such that part of the crankcase **12** of the engine **10** and the on-road sub-transmission **210** are disposed on the right side of the CVT **40**. As shown in FIG. **22**, the on-road sub-transmission **210** is disposed laterally between the lateral ends of the engine **10**. Moreover, with reference to FIG. **19**, the output shaft axis **225** of the output shaft **220** is coaxial with the driven pulley axis **67** (i.e., the driven pulley axis **67** and the drive sprocket **270** rotate about the same axis).

Also, as can be seen, all the mounting points defined by the sub-transmission mounts **64_1-64_4** of the CVT housing **48** are used to mount the on-road sub-transmission **210** to the CVT housing **48**. That is, every one of the sub-transmission mounts **64_1-64_4** of the CVT housing **48** receives a corresponding one of the mount connectors **245_1-245_4**.

Similarly to that described above with respect to the snowmobile sub-transmission **110**, the on-road sub-transmission **210** is a modular unit of the power pack **100** which is attached to the CVT **40** but that is otherwise spatially independent therefrom. Notably, the interior space of the on-road sub-transmission **210**, as defined by the sub-transmission housing **212**, is sealed from the CVT housing **48**. As such, air flow within the CVT housing **48** is independent of the on-road sub-transmission **210**. In other words, air flow entering into the CVT housing **48** (via the air inlet **45**) does not enter into the interior space of the on-road sub-transmission **210**.

It is to be understood that this particular configuration of the power pack **100** is not limited for use with an on-road vehicle, but could instead be used on other vehicles that are driven by the drive sprocket **270**.

Furthermore, as shown in FIG. **40**, as described above with respect to the snowmobile sub-transmission **110**, the on-road sub-transmission **210** can alternatively be operatively connected to the output coupling **54** via the electric motor module **400** rather than being directly connected to the output coupling **54**. The power pack **100** including the on-road sub-transmission **210** may thus benefit from the different driving modes provided by the electric motor module **400** as described above.

Power Pack for an All-Terrain Vehicle (ATV)

With reference to FIG. **23**, in another configuration, the power pack **100** is to be provided for an ATV and therefore the ATV sub-transmission **310** is selected from the sub-transmissions **110**, **210**, **310** to be a part of the power pack **100**. An example of an ATV for which this configuration of the power pack **100** could be provided can be found for example in U.S. Pat. No. 9,283,823 issued on Mar. 15, 2016, which is incorporated in its entirety by reference herein. The ATV sub-transmission **310** is configured to be operatively connected between the CVT **40** and two independent ground-engaging members (i.e., two separately driven wheels) of the ATV for driving thereof.

The ATV sub-transmission **310** will now be described with reference to FIGS. **24** to **26**. The ATV sub-transmission **310** has a sub-transmission housing **312** which defines an interior space of the ATV sub-transmission **310** and encloses a plurality of gears **350** therein (schematically illustrated in FIG. **25**). Notably, the sub-transmission housing **312** has a right portion **311** and a left portion **313** which are fastened to one another to enclose the gears **350** and other components therein. The attachment of the portions **311**, **313** of the sub-transmission housing **312** results in the ATV sub-transmission **310** being sealed such that the interior space thereof is inaccessible without disassembly of the sub-transmission housing **312**.

With reference to FIG. **26**, the ATV sub-transmission **310** has an input shaft **318** extending outwardly from the sub-transmission housing **312** on a left side **317** of the ATV sub-transmission **310**. The input shaft **318** is configured to be received by the output coupling **54** so that the CVT **40** and the ATV sub-transmission **310** are in driving engagement. Notably, the input shaft **318** and the output coupling **54** are splined and thus are drivingly connected. Thus, in use, the input shaft **318** rotates about the driven pulley axis **67**.

The gears **350** operatively connect the input shaft **318** to two output shafts **321**, **323** of the ATV sub-transmission **310** which may be referred to as a “rear output shaft” **321** and a “front output shaft” **323**. The rear and front output shafts **321**, **323** are rotatable about respective axes **325**, **329**, each extending along a direction generally transverse to the driven pulley axis **67** such that, when the power pack **100** is installed on the ATV, the output shaft axes **325**, **329** extend generally longitudinally. As can be seen in FIG. **26**, the output shaft axis **325** of the rear output shaft **321** is vertically higher than the output shaft axis **329** of the front output shaft **323**. Moreover, as shown in FIG. **25**, the rear and front output shafts **321**, **323** are laterally spaced apart from one another such that, in use, the rear output shaft **321** is closer to the CVT **40** than the front output shaft **323**. As such, the output shaft axes **325**, **329** are laterally offset from one another. The rear and front output shafts **321**, **323** are configured to be operatively connected to the rear wheels and the front wheels of the ATV respectively. Notably, in use, a respective drive shaft is attached to each of the rear and front output shafts **321**, **323** and is operatively connected to the rear wheels and the front wheels of the ATV via a rear differential and a front differential.

As shown in FIG. **26**, in order to be connected to the CVT **40**, the ATV sub-transmission **310** has a plurality of mount connectors **345_1-345_4** which are configured to be engaged with the sub-transmission mounts **64_1-64_4** of the CVT housing **48**. Notably, in this embodiment, each of the mount connectors **345_1-345_4** is a fastener which is inserted into a respective opening in the sub-transmission housing **312** to threadedly engage a corresponding one of the sub-transmission mounts **64_1-64_4**.

With particular reference to FIGS. **24**, **27**, **29** and **30**, the sub-transmission housing **312** of the ATV sub-transmission **310** defines a vehicle mount **327** through which, in addition to the vehicle mounts **60** of the engine **10**, the power pack **100** can be mounted to the ATV. In this embodiment, the vehicle mount **327** comprises an opening for insertion therein of a corresponding protruding mounting member of the frame of the ATV.

The ATV sub-transmission **310** also has a shifter **340**, including a shifter lever, for selectively engaging the input shaft **318** with one of the gears **350**. More specifically, in use, the shifter **340** is operable by a user of the ATV to engage a gear of the ATV sub-transmission **310** so as to modify the driving operation of the output shafts **321**, **323**. Notably, the shifter **340** allows the user to operate the ATV sub-transmission **310** in one of a plurality of "gears", which, in this embodiment, includes a high gear, a low gear, a neutral gear and a reverse gear. Notably, particular ones of the gears **350** are associated with the high, low and reverse gears such that, when engaged via the shifter **340**, the ATV drives in high gear, in low gear and in reverse respectively.

It is contemplated that the ATV sub-transmission **310** could be operable in a different number of gears in other embodiments.

The power pack **100** including the ATV sub-transmission **310** is shown assembled in FIGS. **27** to **31**. As can be seen, the power pack **100** is configured such that part of the crankcase **12** of the engine **10** and the ATV sub-transmission **310** are disposed on the right side of the CVT **40**. Notably, as shown in FIG. **31**, part of the ATV sub-transmission **310** extends laterally away from the CVT **40** (i.e., toward the right) past the engine **10**. For instance, in this embodiment, part of the sub-transmission housing **312** extends laterally away from the CVT **40** past the engine **10**.

Also, as can be seen, all the mounting points defined by the sub-transmission mounts **64_1-64_4** of the CVT housing **48** are used to mount the ATV sub-transmission **310** to the CVT housing **48**. That is, every one of the sub-transmission mounts **64_1-64_4** of the CVT housing **48** receives a corresponding one of the mount connectors **345_1-345_4**.

Similarly to that described above with respect to the sub-transmissions **110**, **210**, the ATV sub-transmission **310** is a modular unit of the power pack **100** which is attached to the CVT **40** but that is otherwise spatially independent therefrom. Notably, the interior space of the ATV sub-transmission **310**, as defined by the sub-transmission housing **312**, is sealed from the CVT housing **48**. As such, air flow within the CVT housing **48** is independent of the ATV sub-transmission **310**. In other words, air flow entering into the CVT housing **48** (via the air inlet **45**) does not enter into the interior space of the ATV sub-transmission **310**.

It is to be understood that this particular configuration of the power pack **100** is not limited for use with an ATV, but could instead be used on other vehicles that are driven by the two longitudinally-extending output shafts **321**, **323**.

Furthermore, as shown in FIG. **41**, as described above with respect to the snowmobile sub-transmission **110**, the ATV sub-transmission **310** can alternatively be operatively connected to the output coupling **54** via the electric motor module **400** rather than being directly connected to the output coupling **54**. The power pack **100** including the ATV sub-transmission **310** may thus benefit from the different driving modes provided by the electric motor module **400** as described above.

In the different possible configurations of the power pack **100**, irrespective of which of the sub-transmissions **110**, **210**, **310** is attached to the CVT housing **48** (or the electric motor module **400**), the configurations of the CVT **40** and the engine **10** remain unchanged. For example, the air inlet **45** and the air inlet **47** of the CVT housing **48** remain in the same position irrespective of the sub-transmission **110**, **210**, **310** being used. In other words, the same CVT **40** and the same engine **10** can be used to mount any selected one of the sub-transmissions **110**, **210**, **310**.

Thus a method for assembling the power pack **100** is simplified namely in part by its use of a common CVT and a common engine for any of the sub-transmissions **110**, **210**, **310**. In particular, in order to assemble the power pack **100**, the engine **10** and the CVT **40** are provided and operatively connected to one another. Then, it is determined for which of the snowmobile, the on-road vehicle and the ATV the power pack **100** is to be provided. Based on that determination, one of the sub-transmissions **110**, **210**, **310** is selected for mounting to the CVT **40** as described above. As each of the sub-transmissions **110**, **210**, **310** has the same configuration of mount connectors **145_1-145_4**, **245_1-245_4**, **345_1-345_4**, and that of the CVT housing **48** has the matching configuration of mounting points, the selected one of the sub-transmission **110**, **210**, **310** can then be easily mounted to the CVT housing **48**.

The power pack **100** can be provided in any of its potential configurations with relative ease as the engine **10** and the CVT **40** are similar in all configurations. Notably, the sub-transmission **110**, **210**, **310** which is used in the power pack **100** accommodates the drive requirements of a corresponding one of a snowmobile, an on-road vehicle and an ATV. This may facilitate manufacturing of all these different vehicles as fewer parts are needed to produce different vehicles and thus decrease associated costs.

Modifications and improvements to the above-described embodiments of the present technology may become apparent to those skilled in the art. The foregoing description is intended to be exemplary rather than limiting. The scope of the present technology is therefore intended to be limited solely by the scope of the appended claims.

What is claimed is:

1. A gearing assembly for a drivetrain of a vehicle, comprising:
- a first shaft rotating about a first shaft axis;
- a second shaft operatively connected to the first shaft, the second shaft rotating about a second shaft axis extending parallel to the first shaft axis;
- a first gear mounted to the first shaft, the first gear being a freewheel clutch gear;
- a second gear fixedly mounted to the first shaft for rotation therewith;
- a third gear mounted to the second shaft, the third gear being a freewheel clutch gear, the third gear being drivingly engaged with the second gear; and
- a fourth gear fixedly mounted to the second shaft for rotation therewith, the fourth gear being drivingly engaged with the first gear,

wherein:
- when a rotational speed of the first shaft is greater than a rotational speed of the second shaft, the first shaft drives the second shaft via driving engagement between the second gear and the third gear, the first gear being overrun; and
- when the rotational speed of the second shaft is greater than the rotational speed of the first shaft, the second shaft drives the first shaft via driving engagement between the fourth gear and the first gear, the third gear being overrun.

2. The gearing assembly of claim **1**, wherein each of the first gear and the third gear comprises:
- an inner race mounted to a corresponding one of the first shaft and the second shaft;
- an outer race disposed radially outwardly of the inner race, the outer race comprising a plurality of gear teeth; and
- a clutch engager disposed between the inner race and the outer race, the gear being overrun when the clutch engager disengages the outer race from the inner race so that the inner race rotates relative to the outer race.

3. The gearing assembly of claim **2**, wherein the clutch engager comprises a plurality of rollers selectively coupling rotation of the outer race with the inner race.

4. The gearing assembly of claim 1, wherein:
the first gear and the fourth gear counter-rotate relative to one another; and
the second gear and the third gear counter-rotate relative to one another.

5. The gear assembly of claim 4, wherein:
the first gear is meshed with the fourth gear; and
the second gear is meshed with the third gear.

6. The gearing assembly of claim 1, wherein:
the first gear and the second gear are adjacent to one another; and
the third gear and the fourth gear are adjacent to one another.

7. The gearing assembly of claim 1, wherein:
the first shaft is configured to be connected to an electric motor; and
the second shaft is configured to be connected to a transmission of the drivetrain of the vehicle.

8. The gearing assembly of claim 7, further comprising a sprocket mounted to the second shaft for rotation therewith, the sprocket being configured to be connected to the transmission of the drivetrain of the vehicle.

9. The gearing assembly of claim 1, wherein:
a diameter of the first gear is greater than a diameter of the fourth gear; and
a diameter of the third gear is greater than a diameter of the second gear.

10. The gearing assembly of claim 1, wherein the second gear and the fourth gear are spur gears.

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