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(54) **POWERTRAIN FOR A UTILITY VEHICLE**

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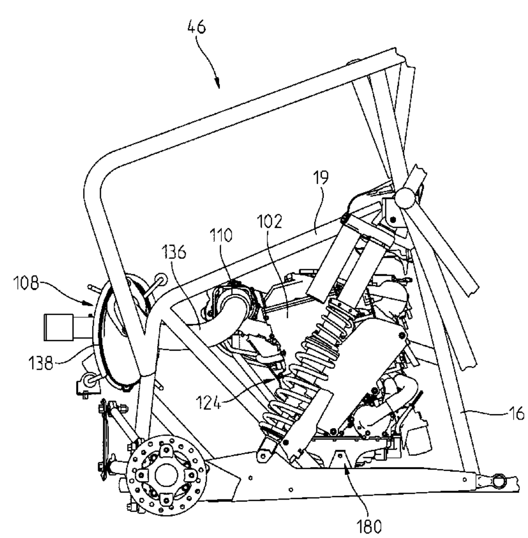
(57) **ABSTRACT**

A utility vehicle including a plurality of ground-engaging members, a frame supported by the ground-engaging members, and a powertrain assembly supported by the frame and including an engine supported by the frame, the engine including an exhaust side and a turbocharger operably coupled to the engine, the turbocharger having a turbine housing supporting a turbine and a compressor housing supporting a compressor, the turbocharger being positioned on the exhaust side of the engine and rearward of the engine, a space between the turbocharger and the engine being less than 9 inches.

13 Claims, 33 Drawing Sheets



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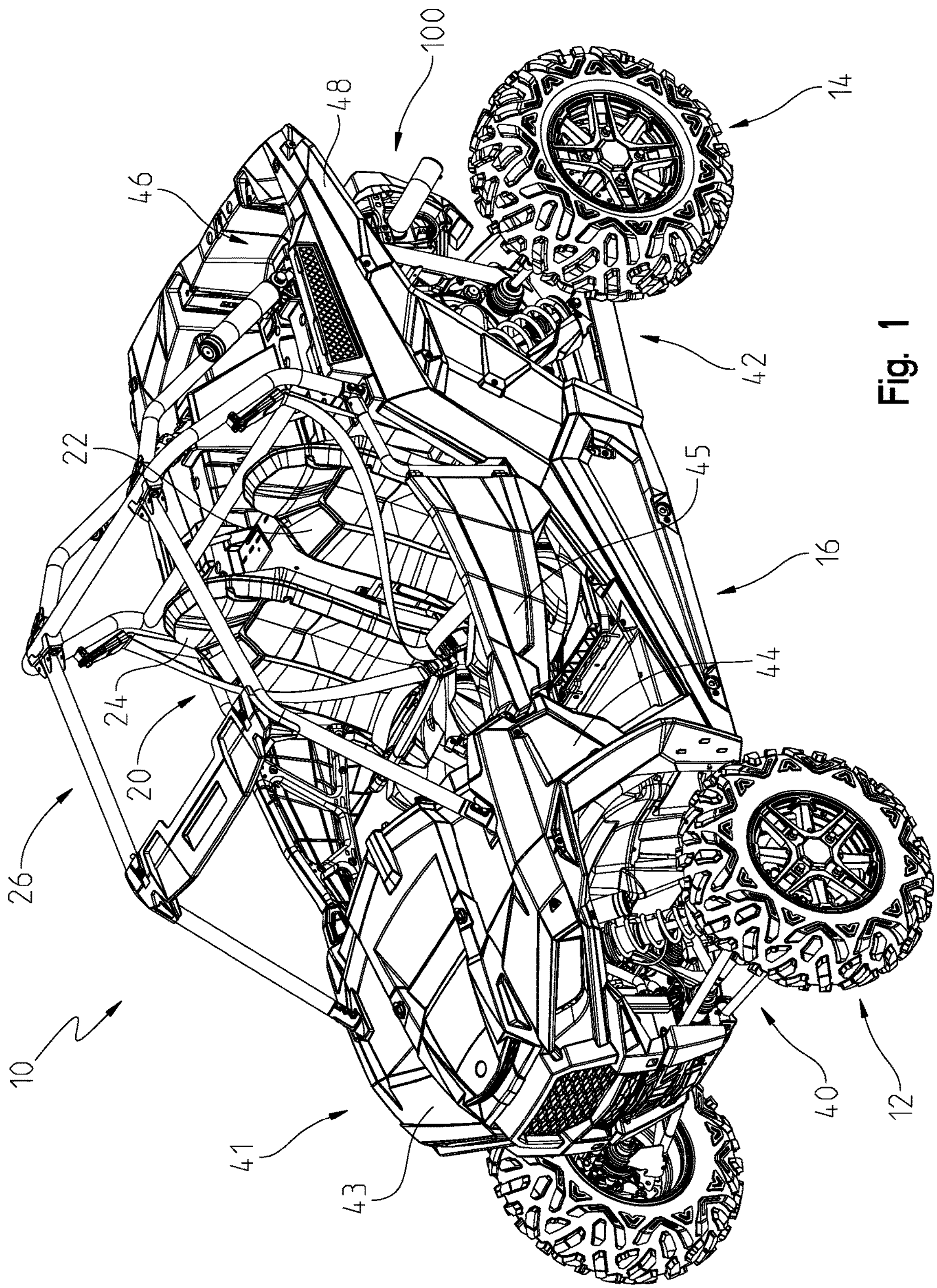

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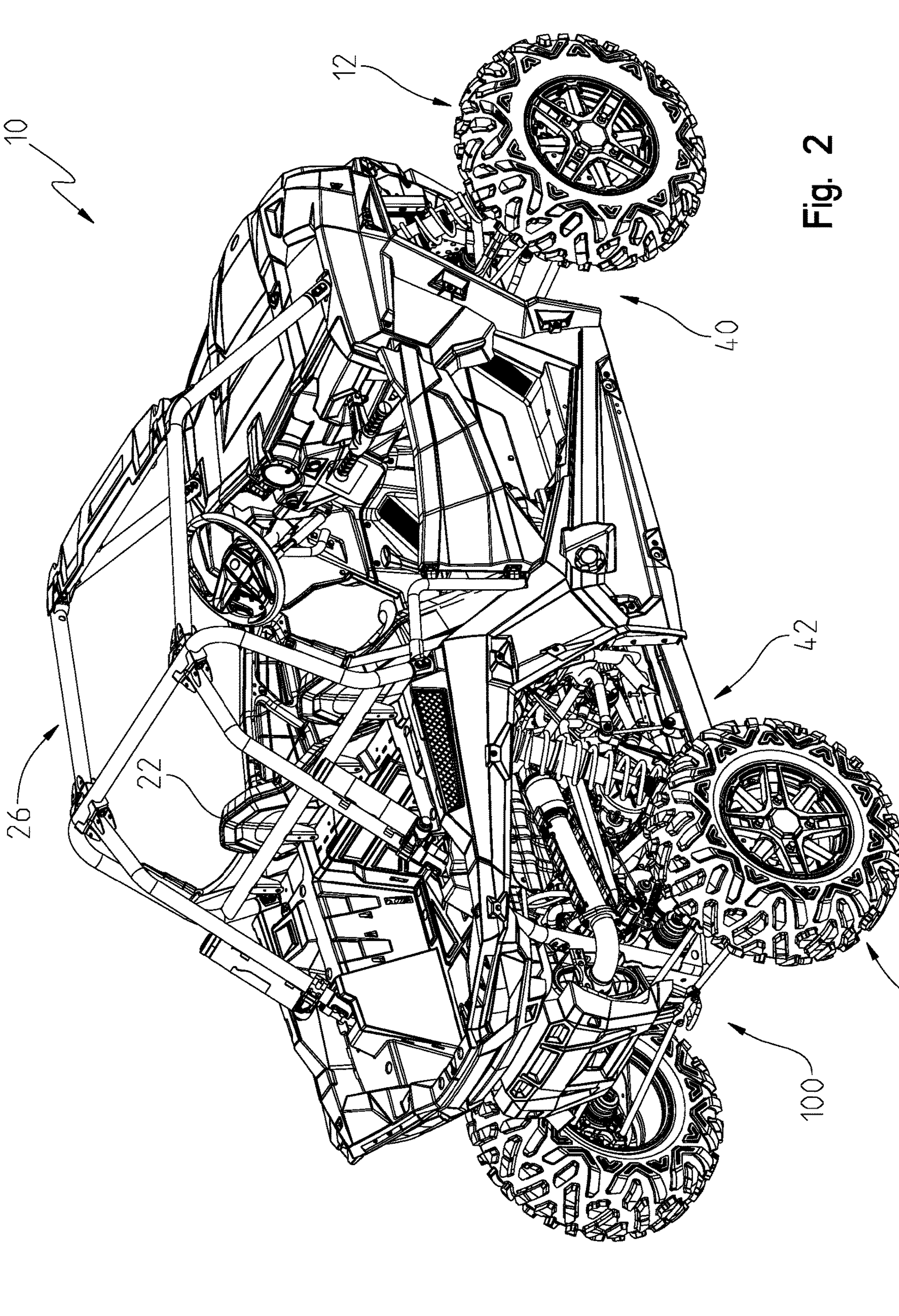

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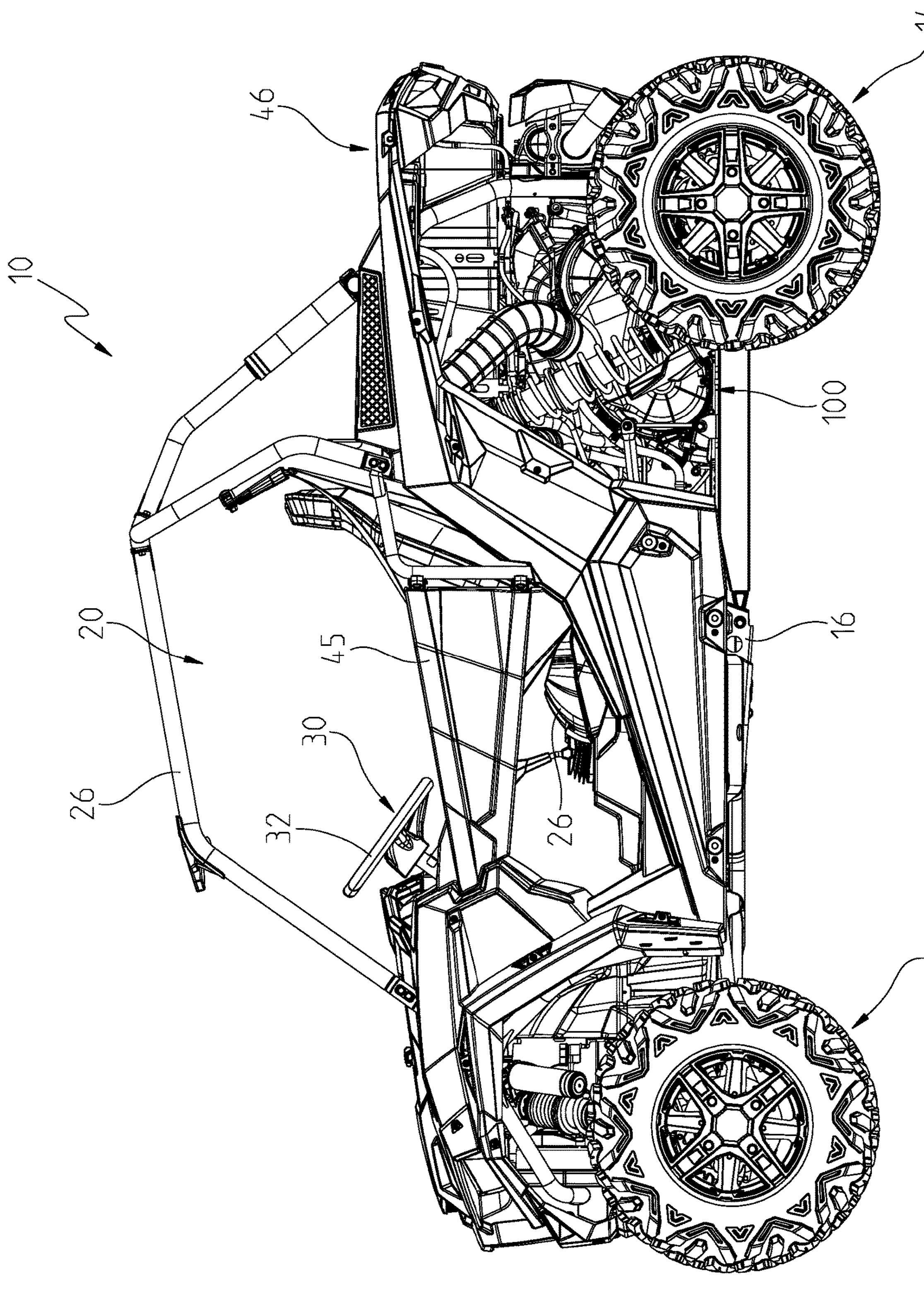

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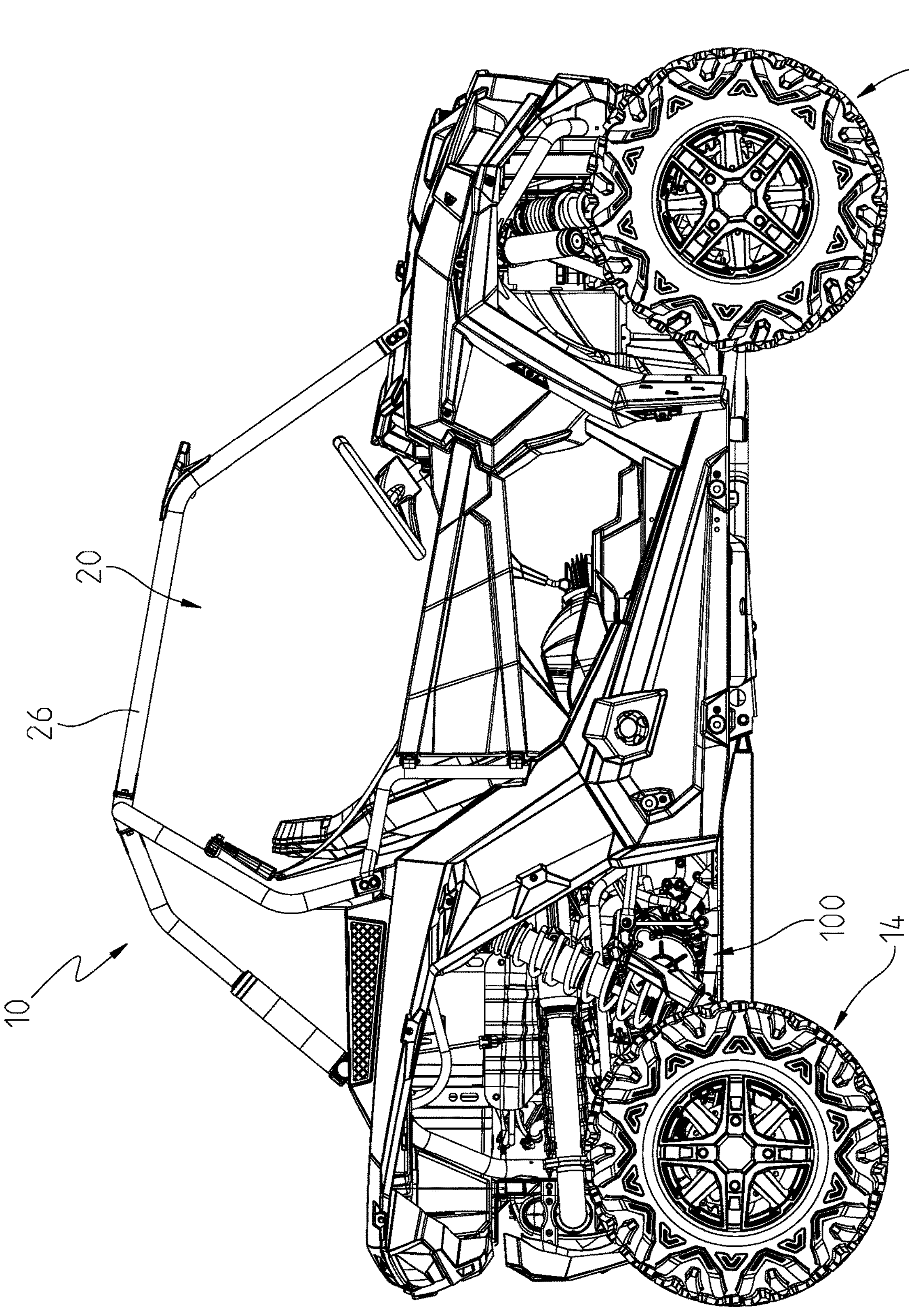

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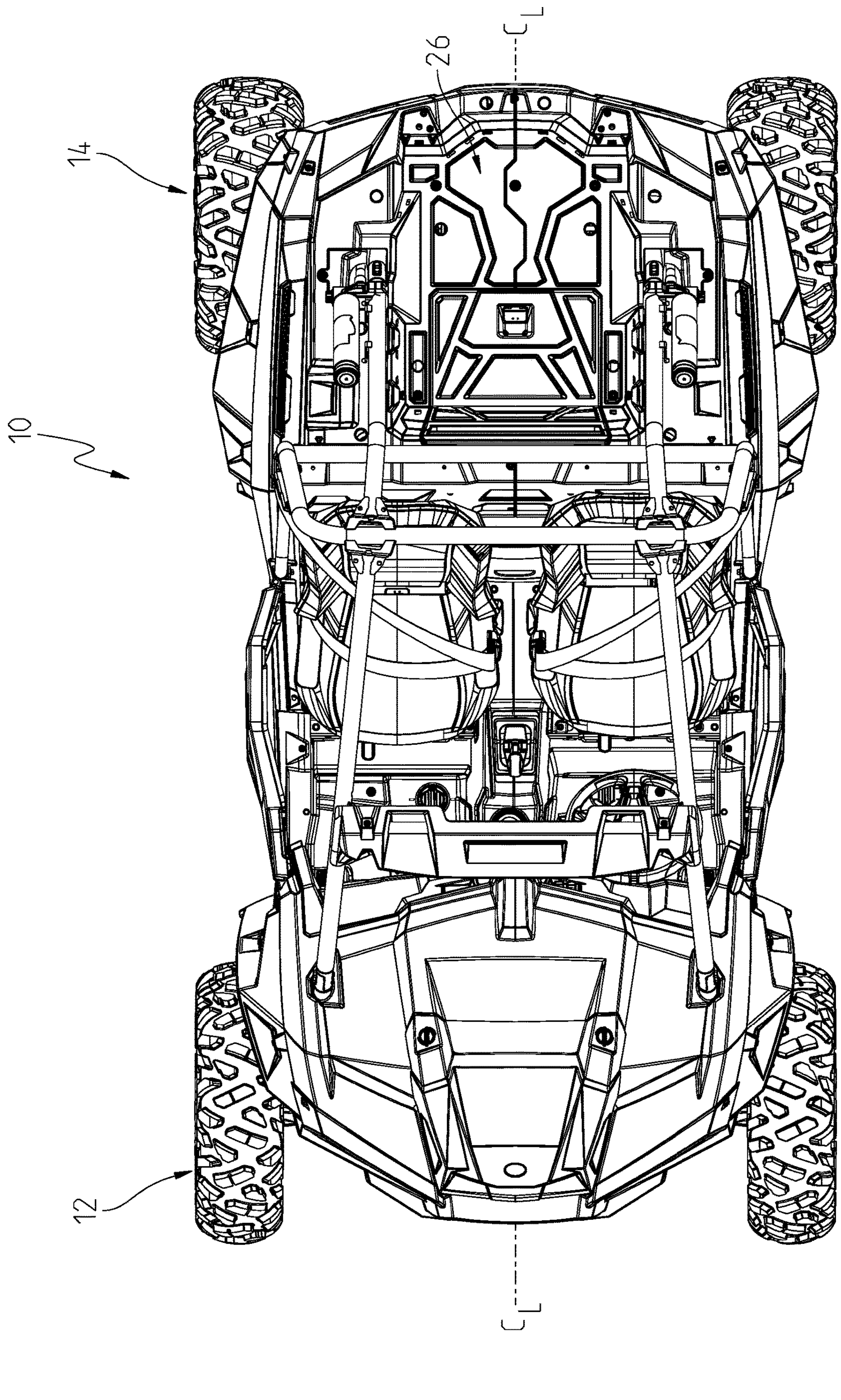

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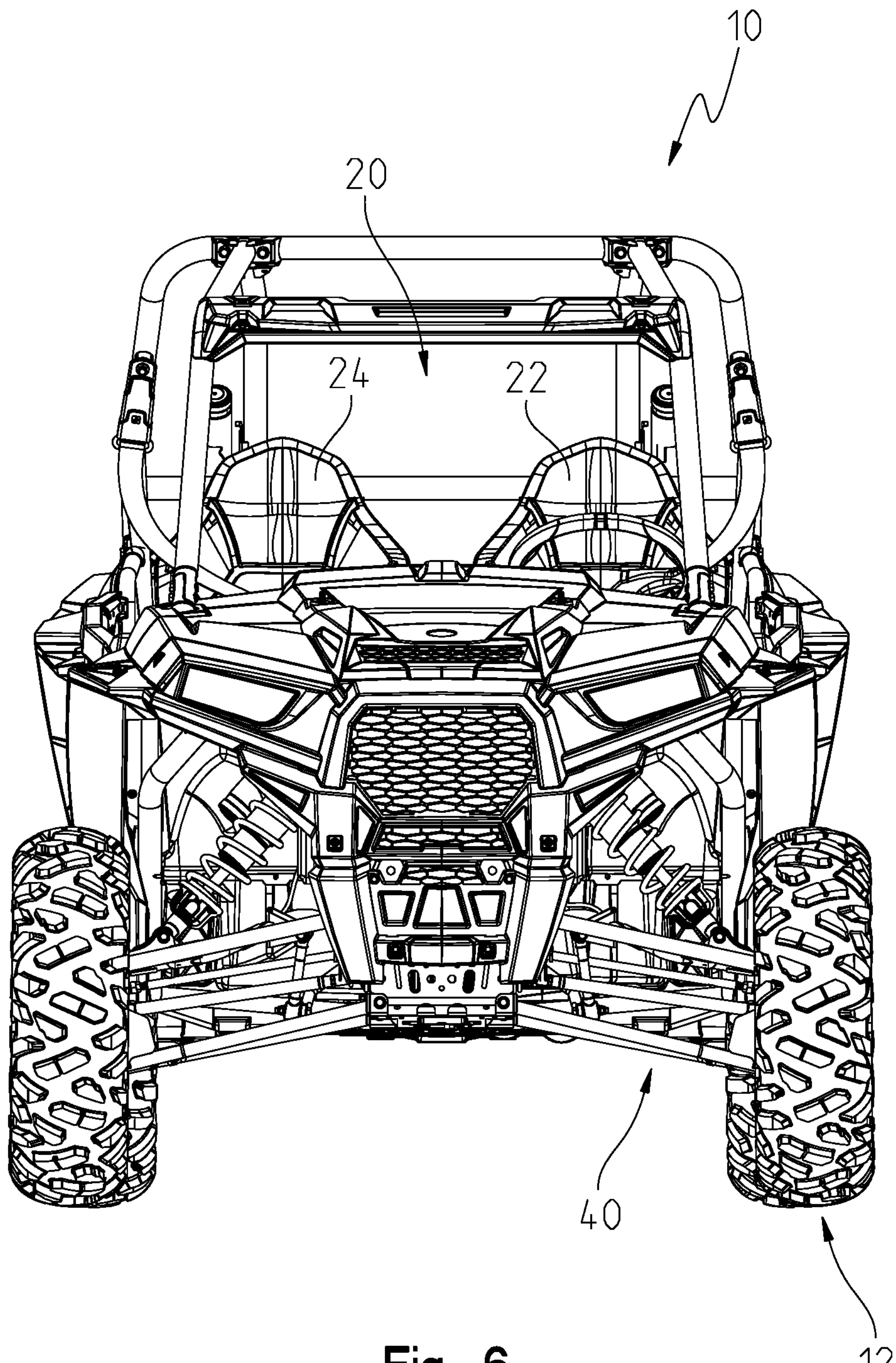

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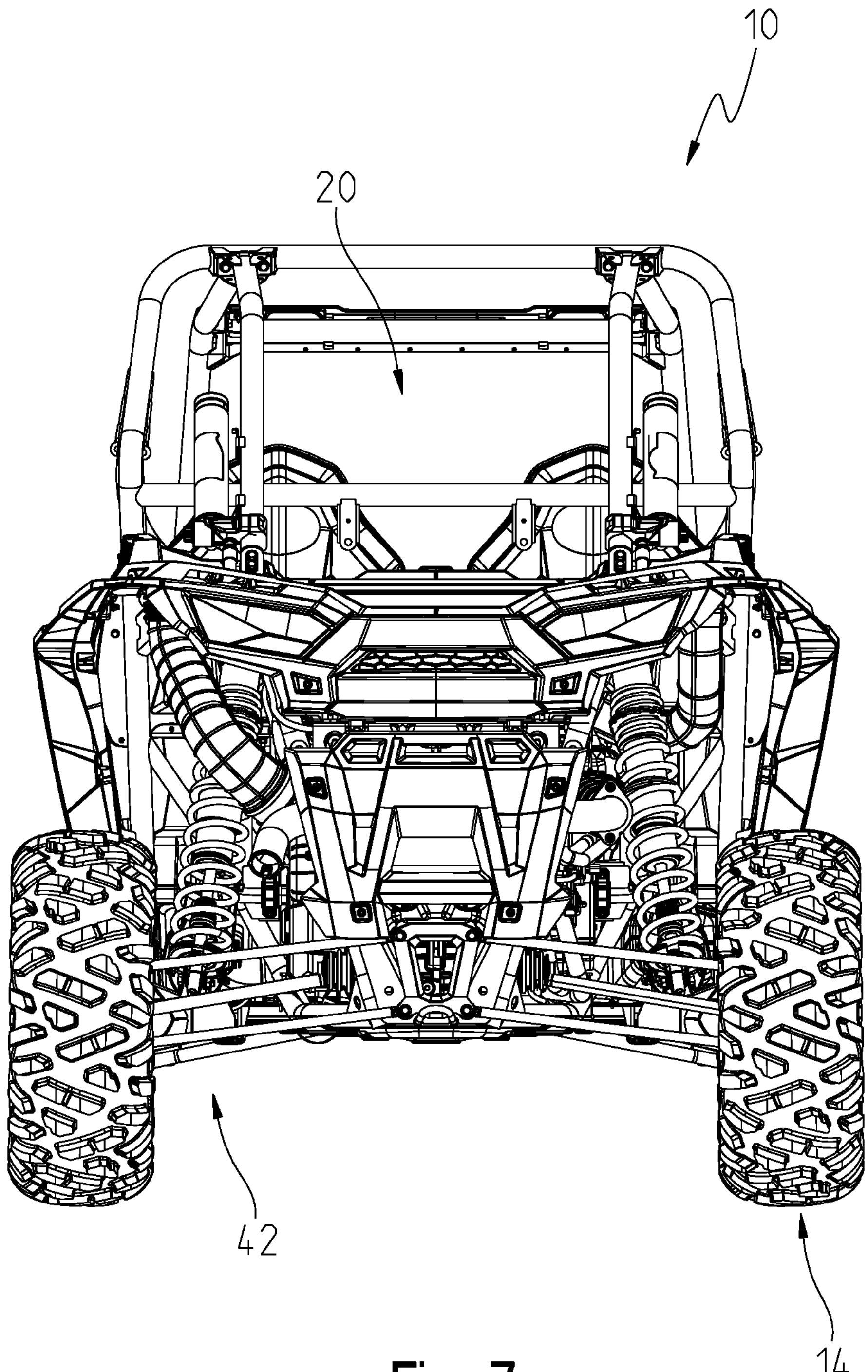

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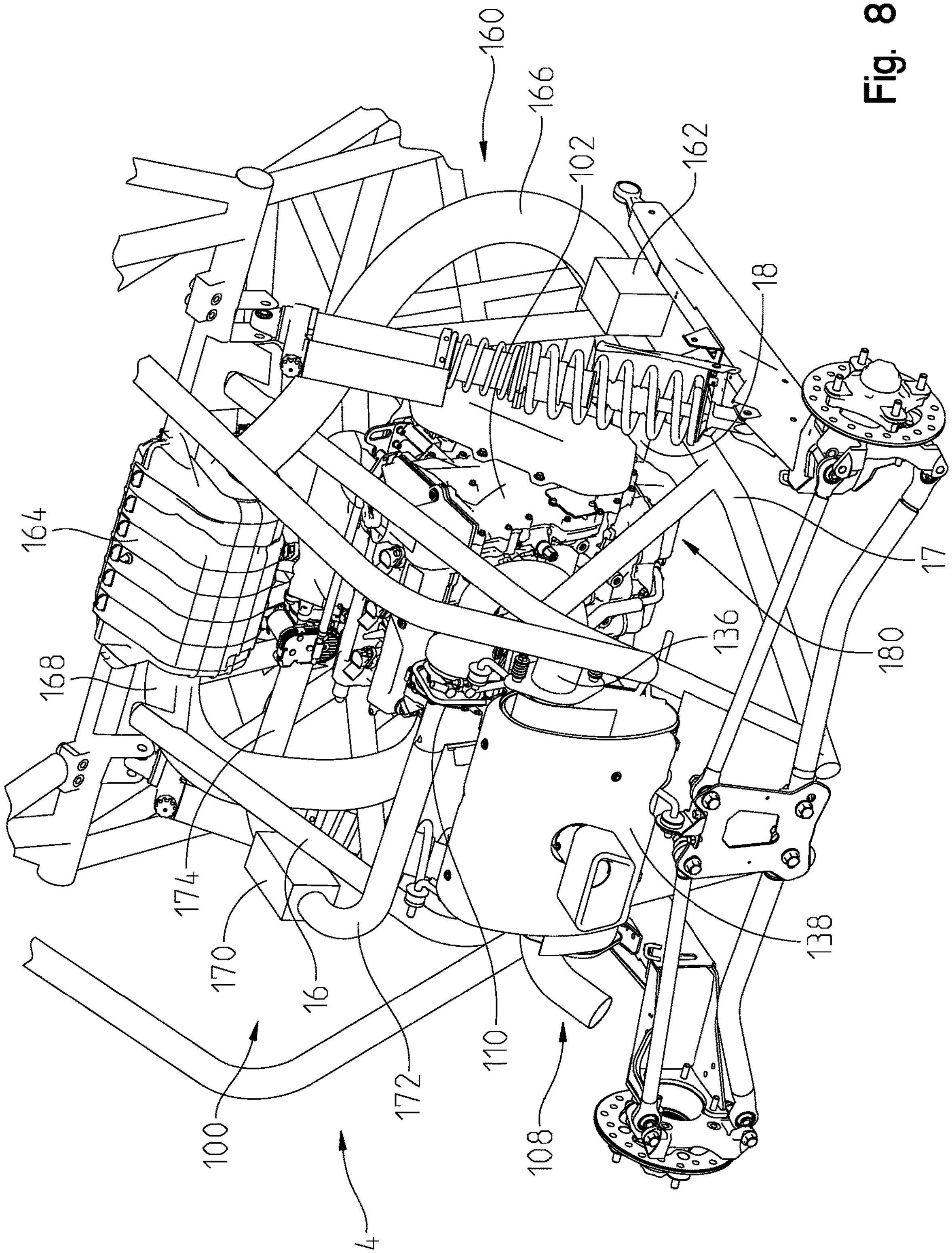
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Fig. 8

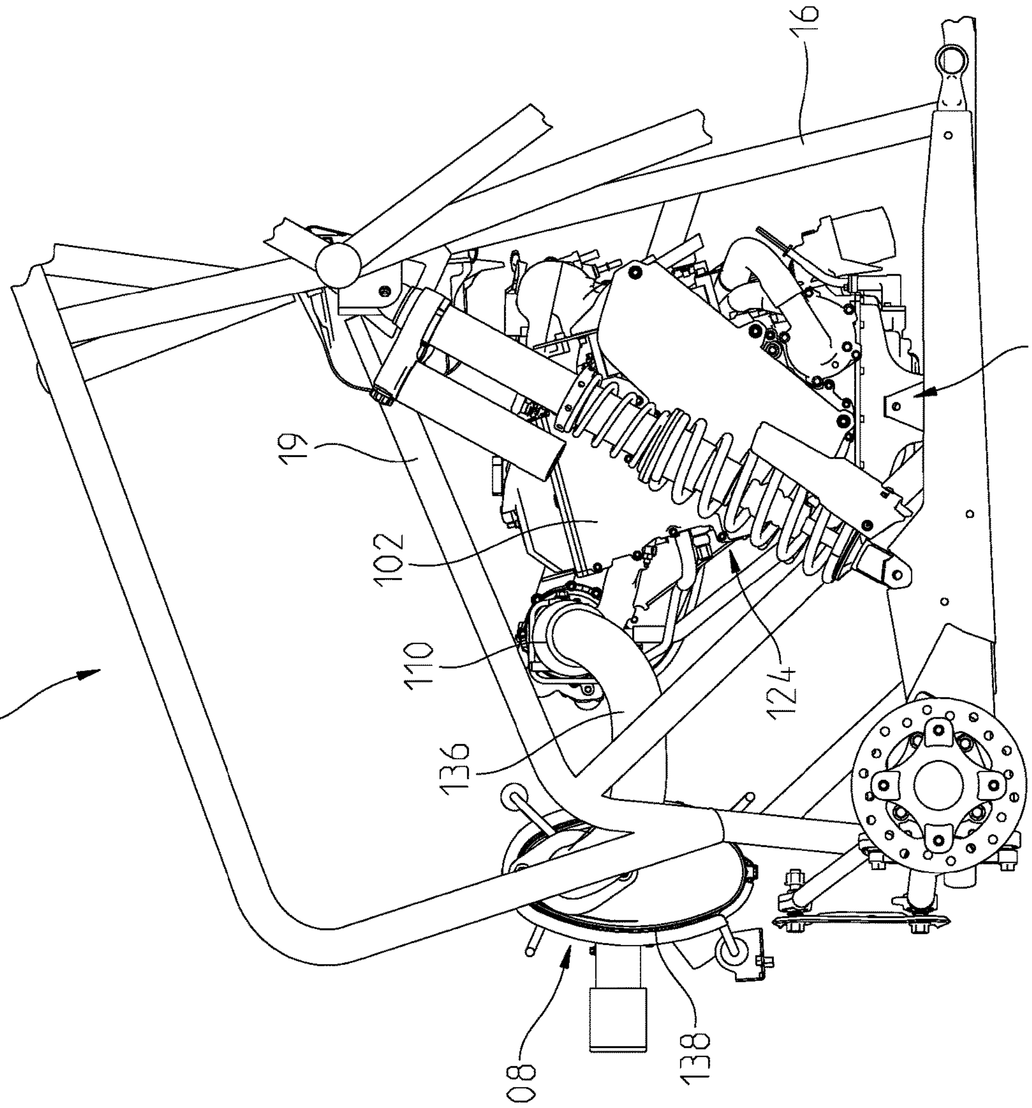
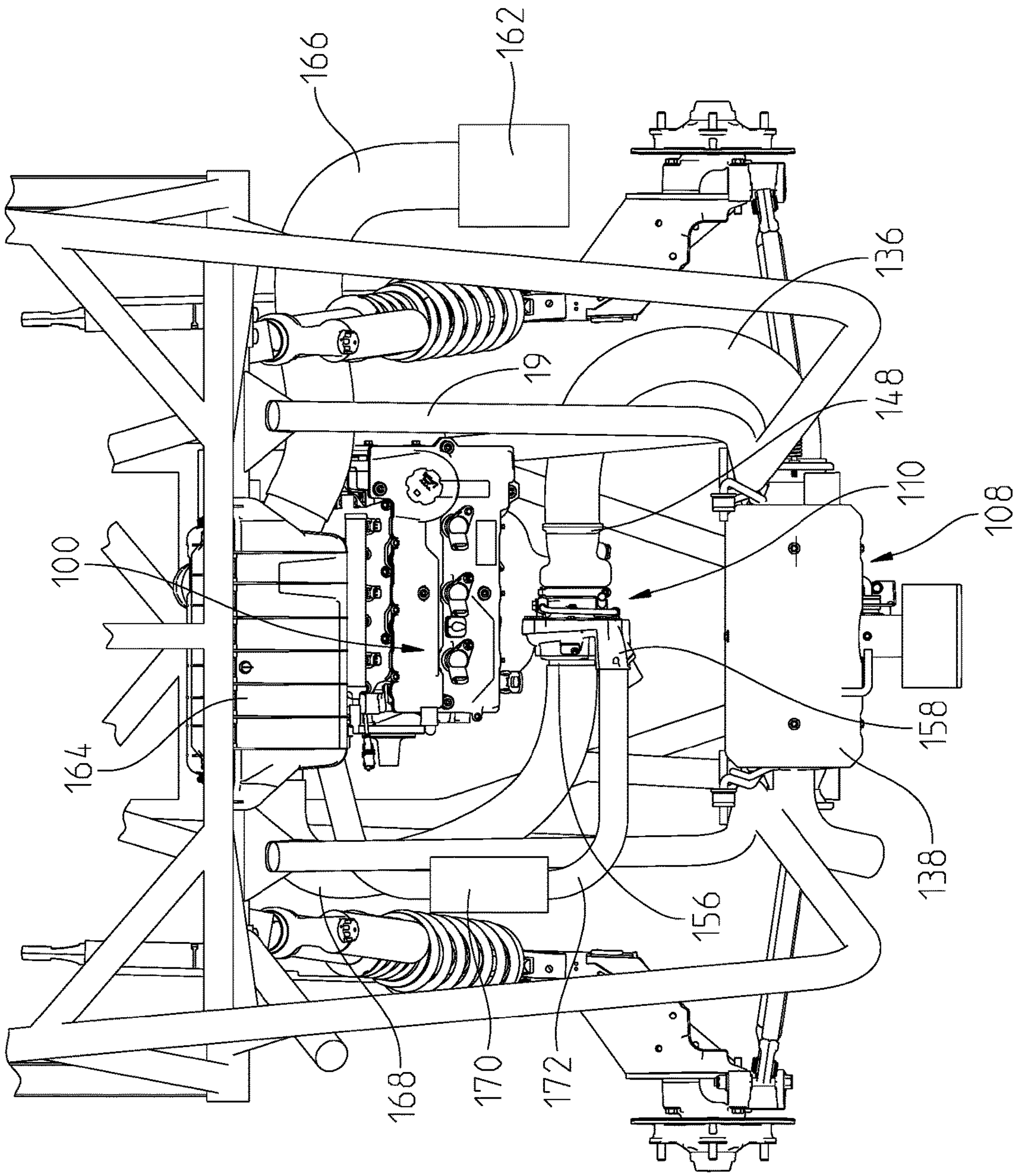


Fig. 9



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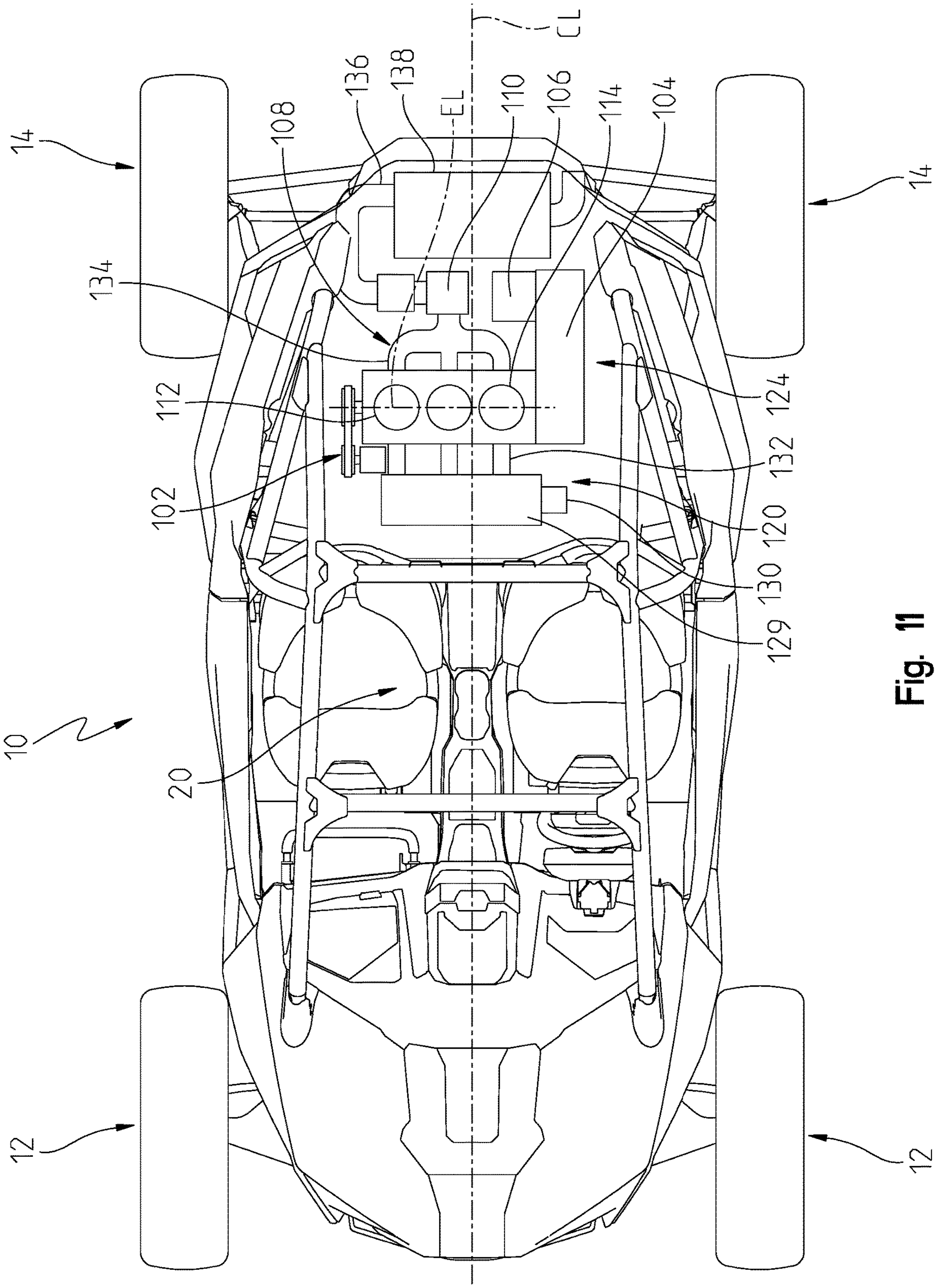
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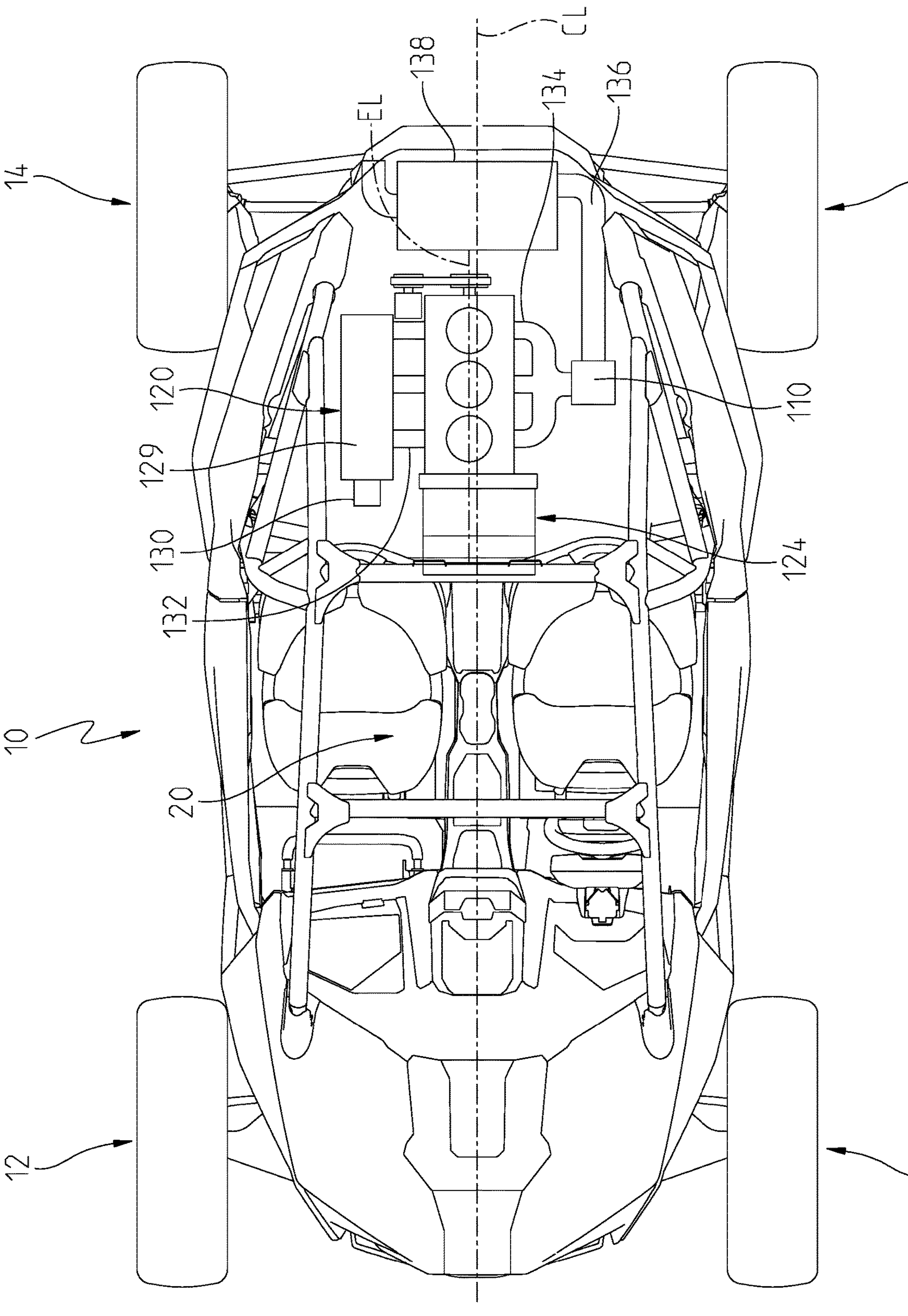
Fig. 11



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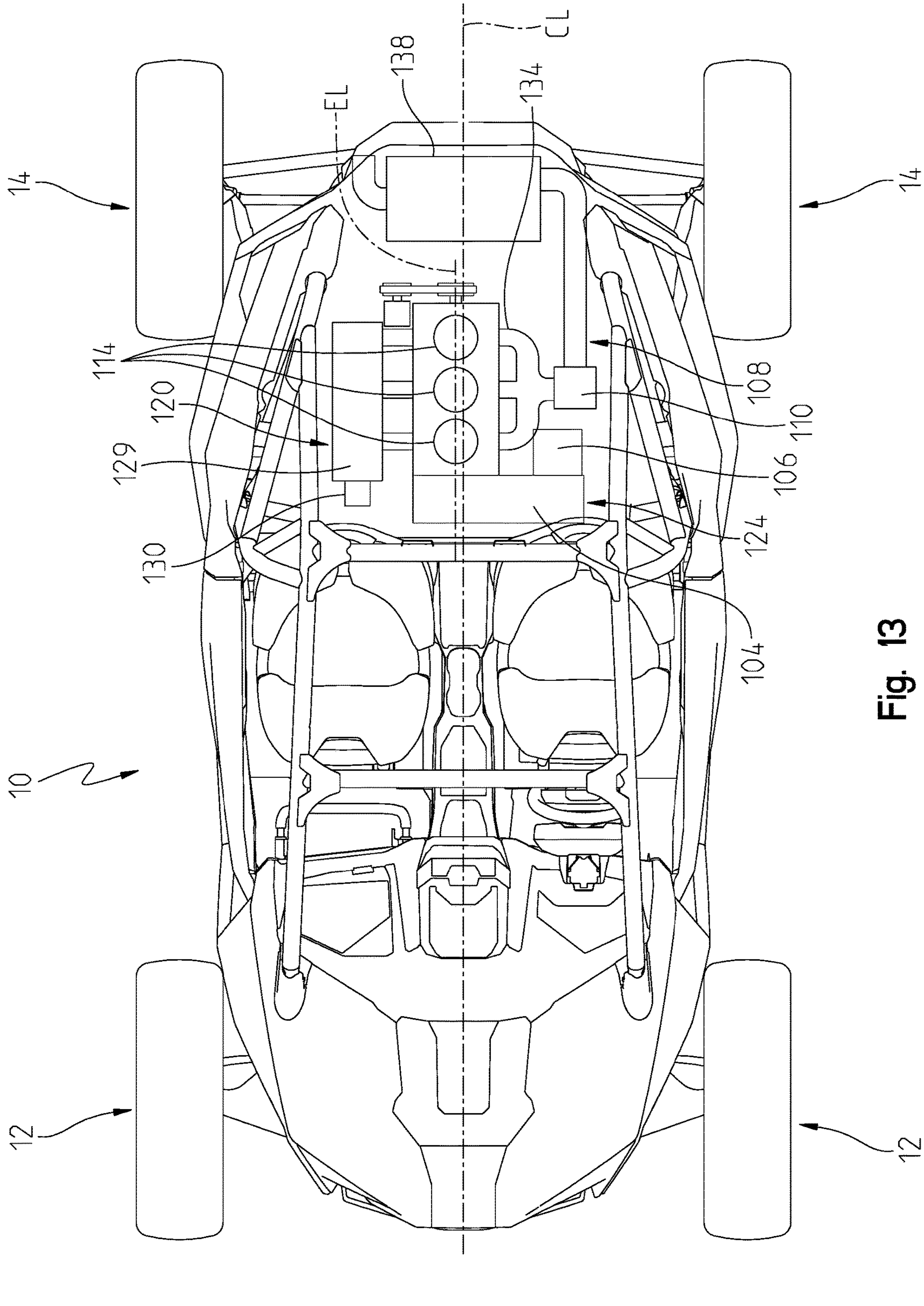

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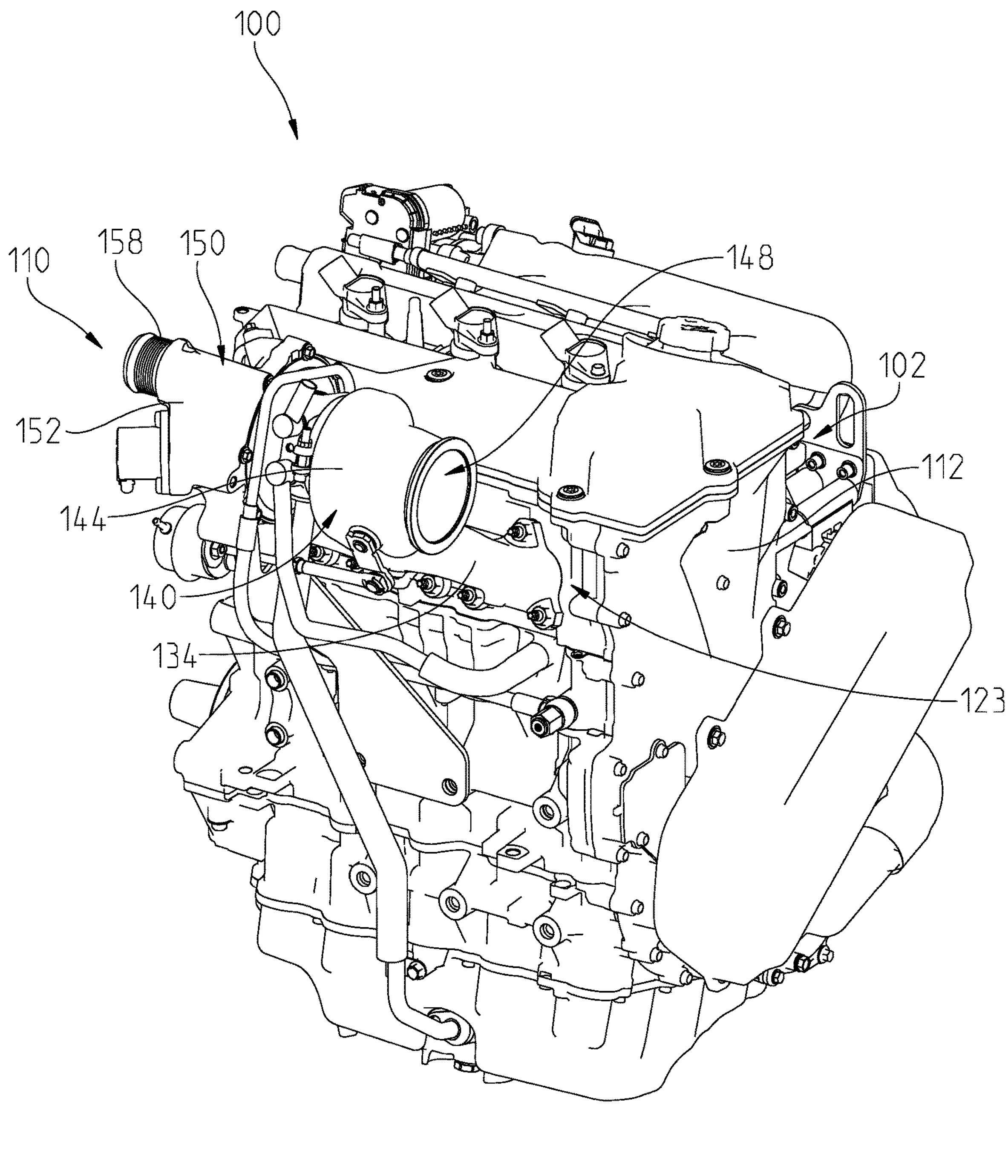

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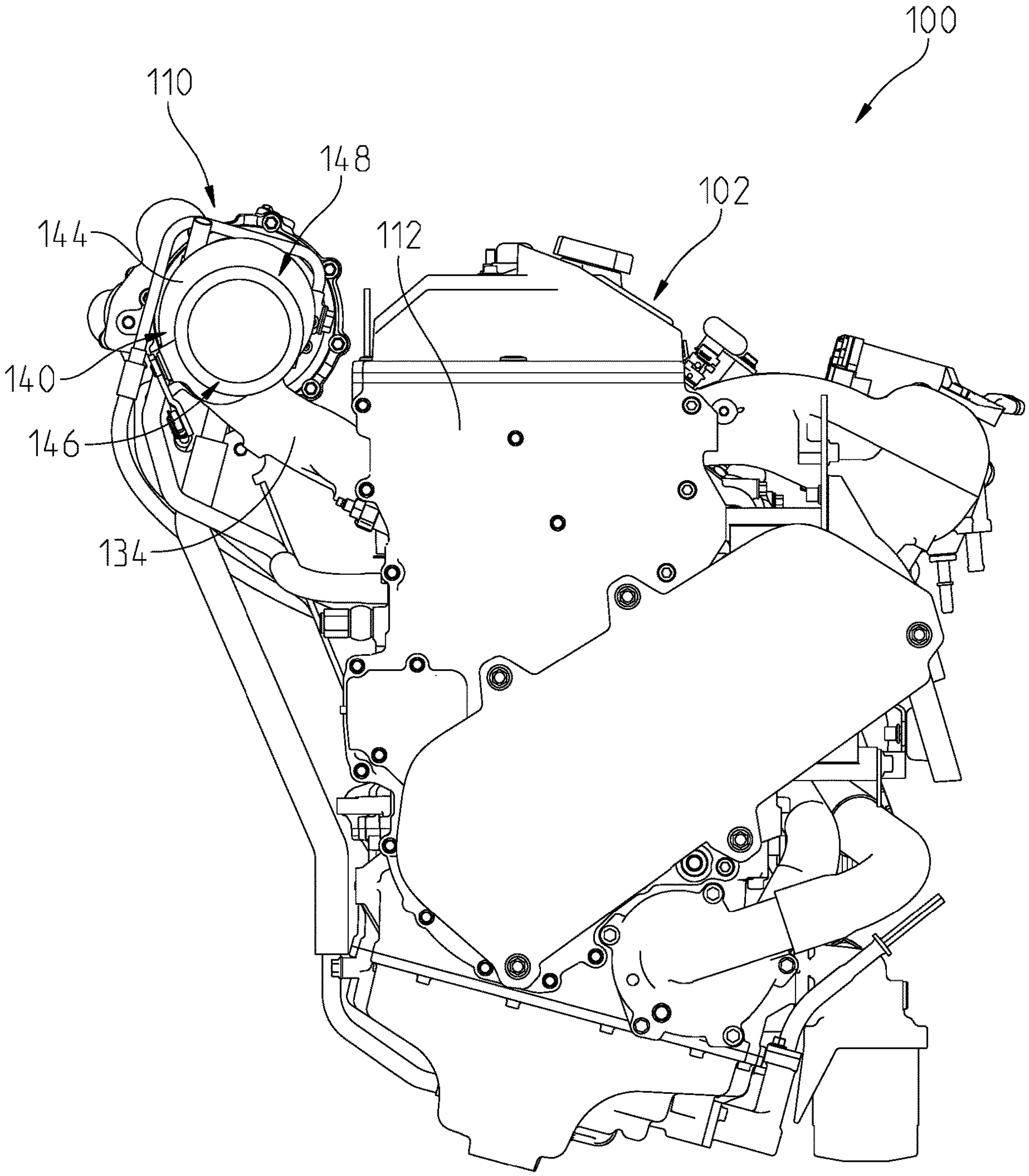

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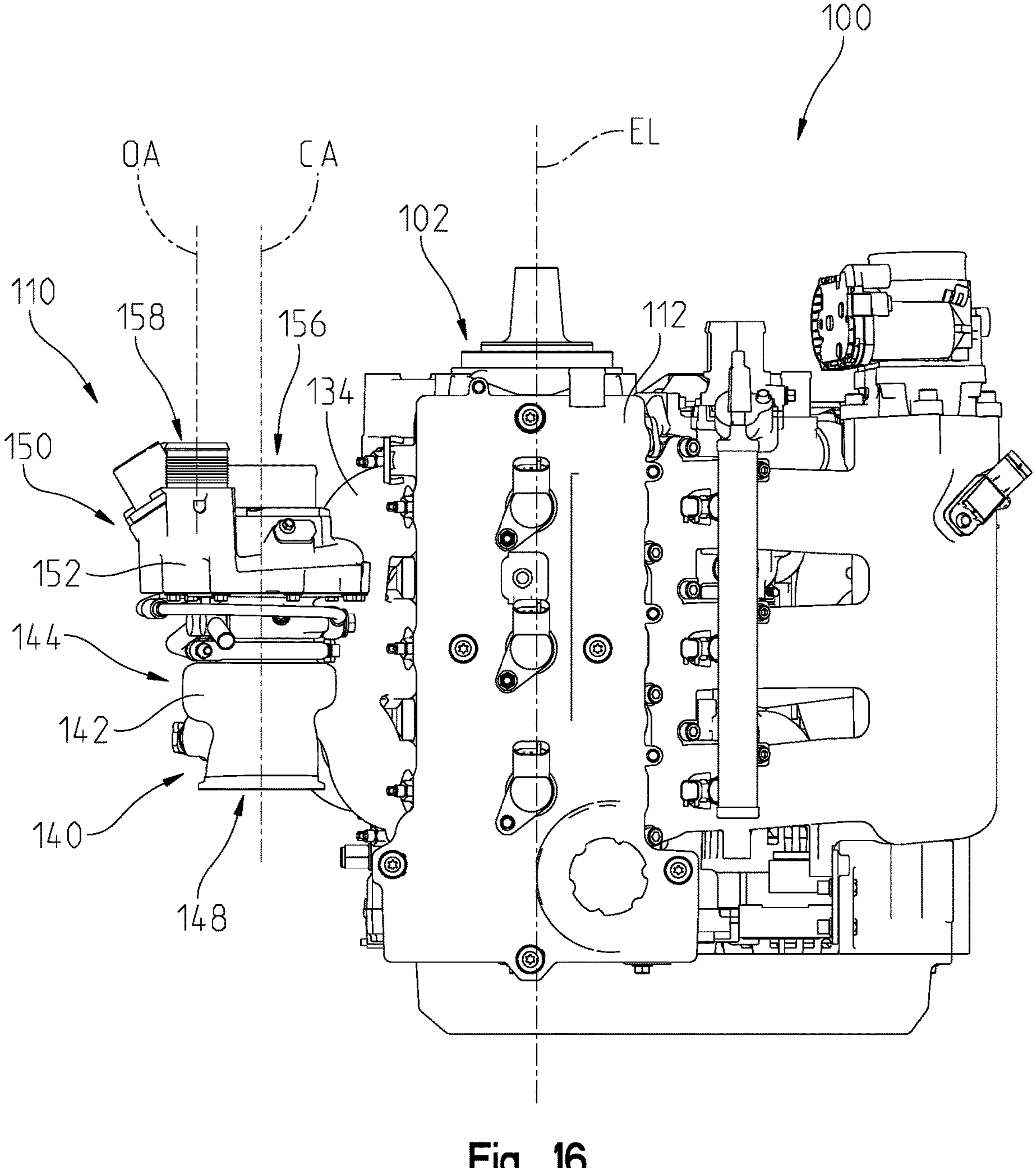

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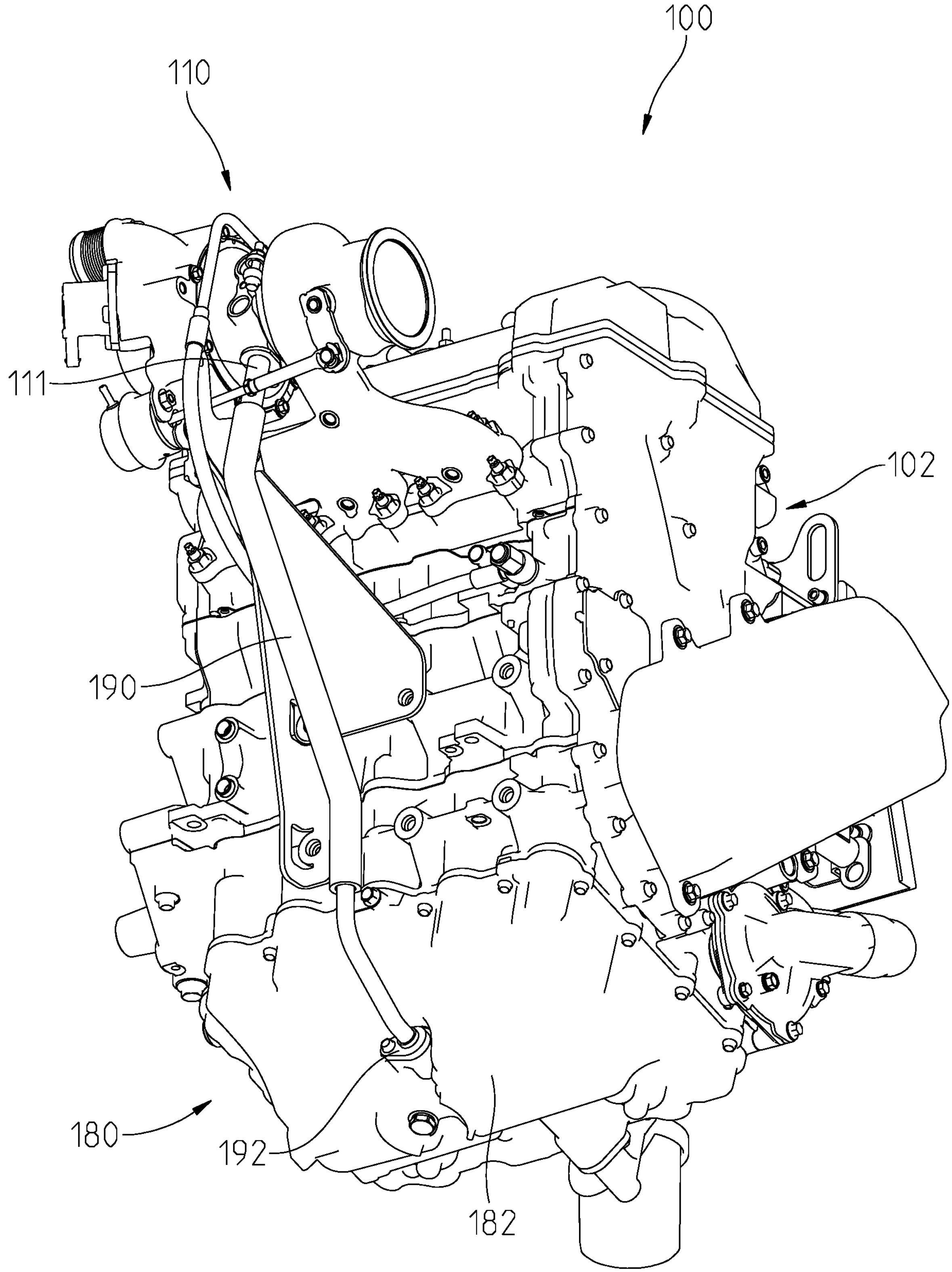

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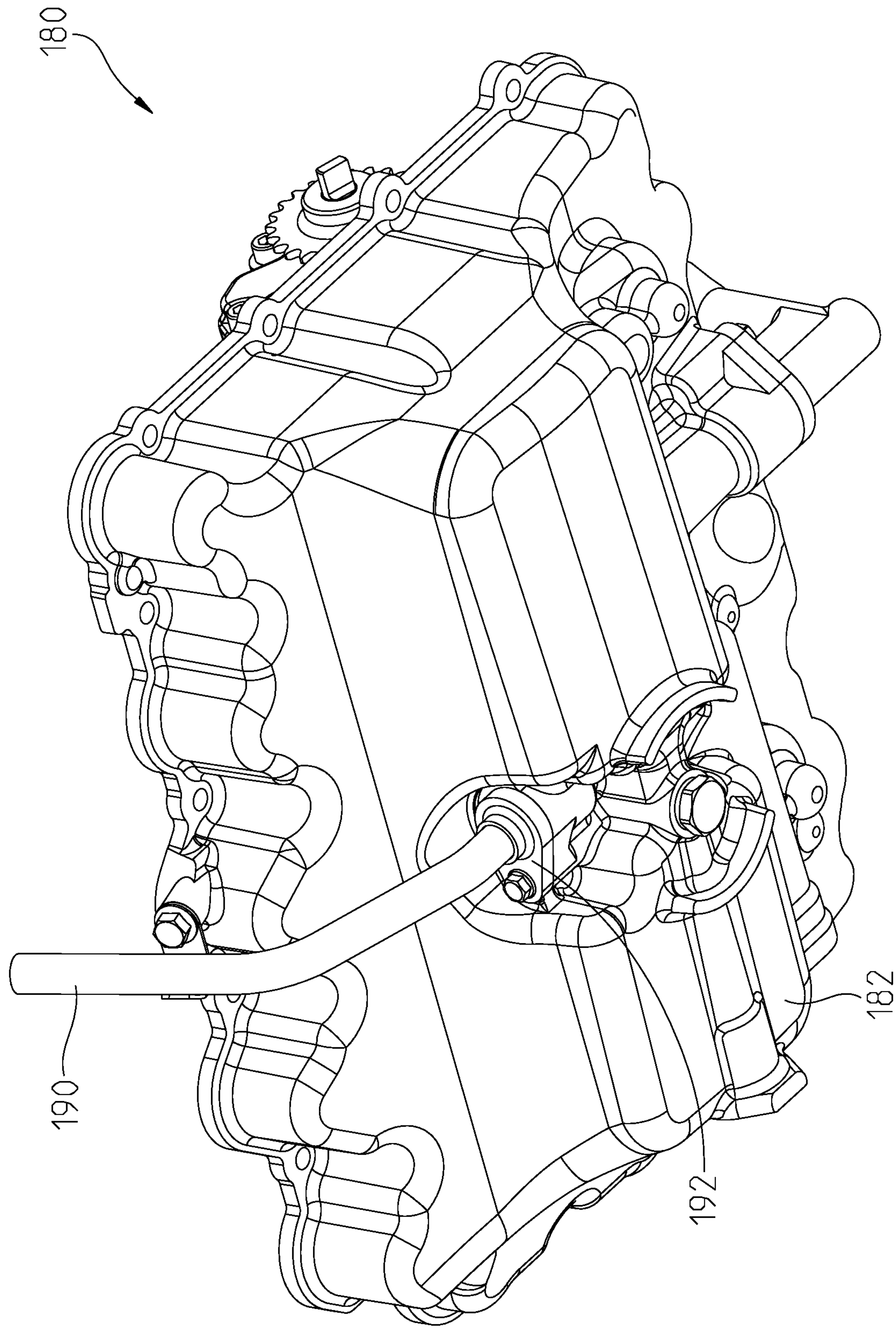

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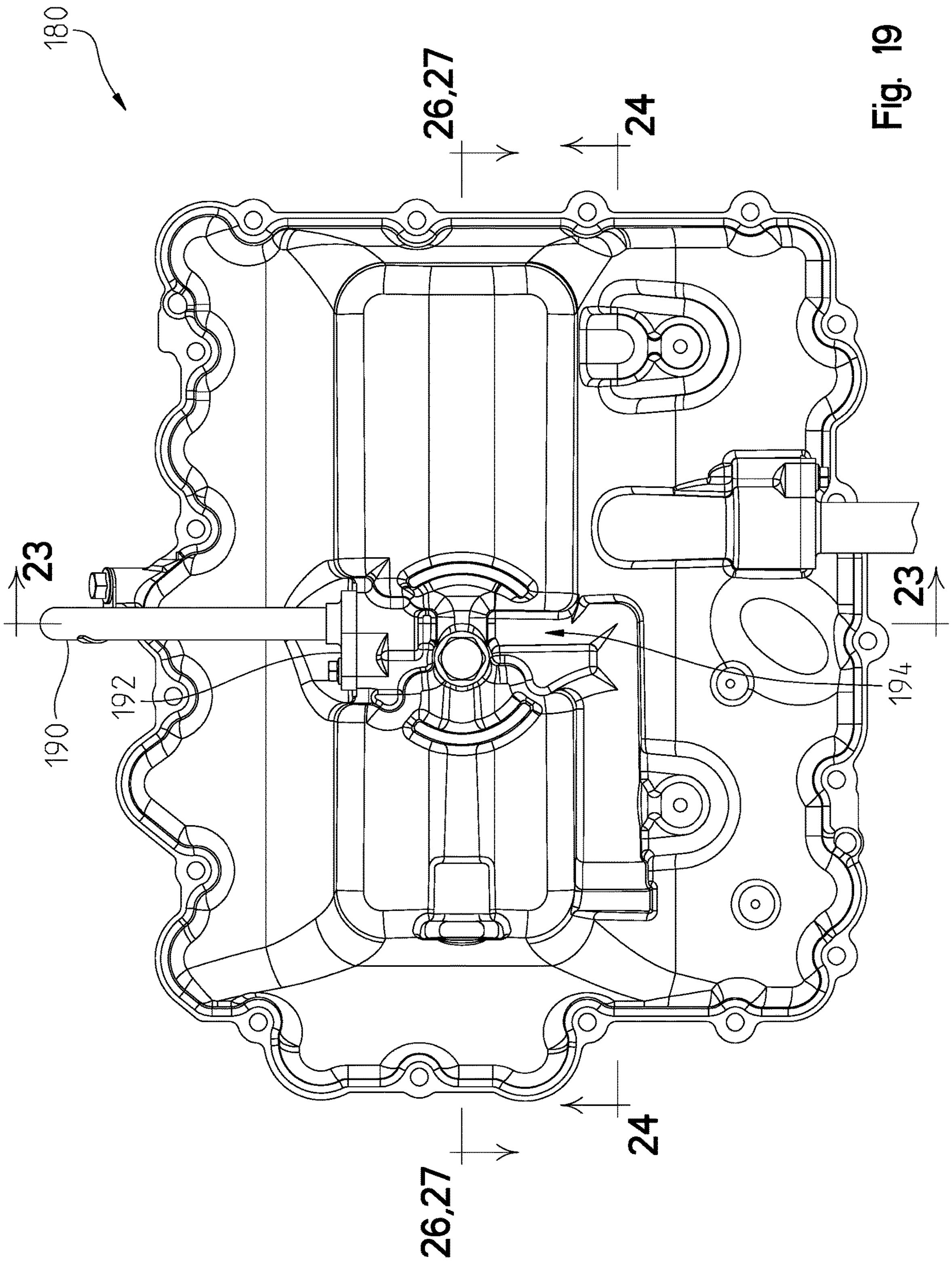

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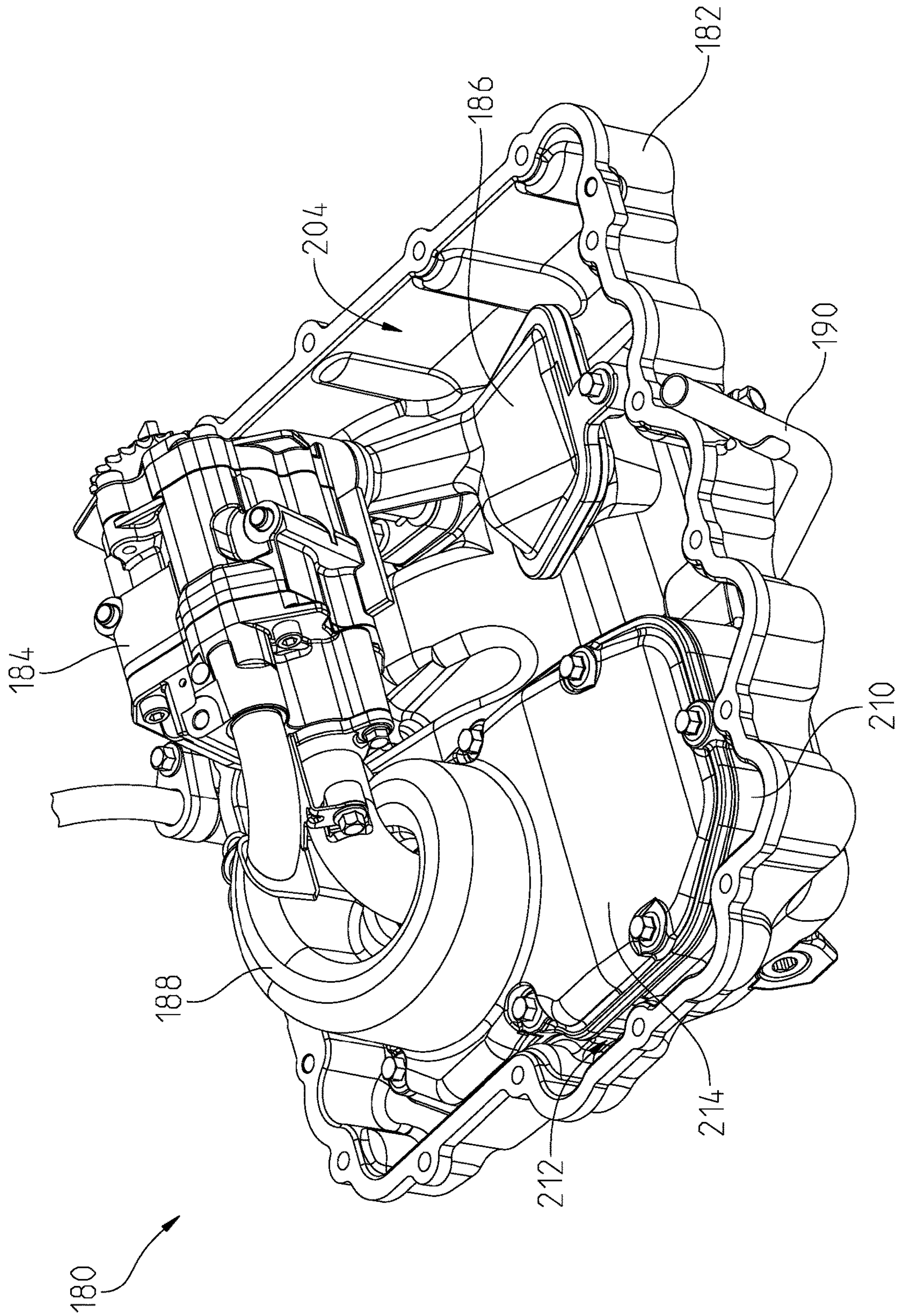

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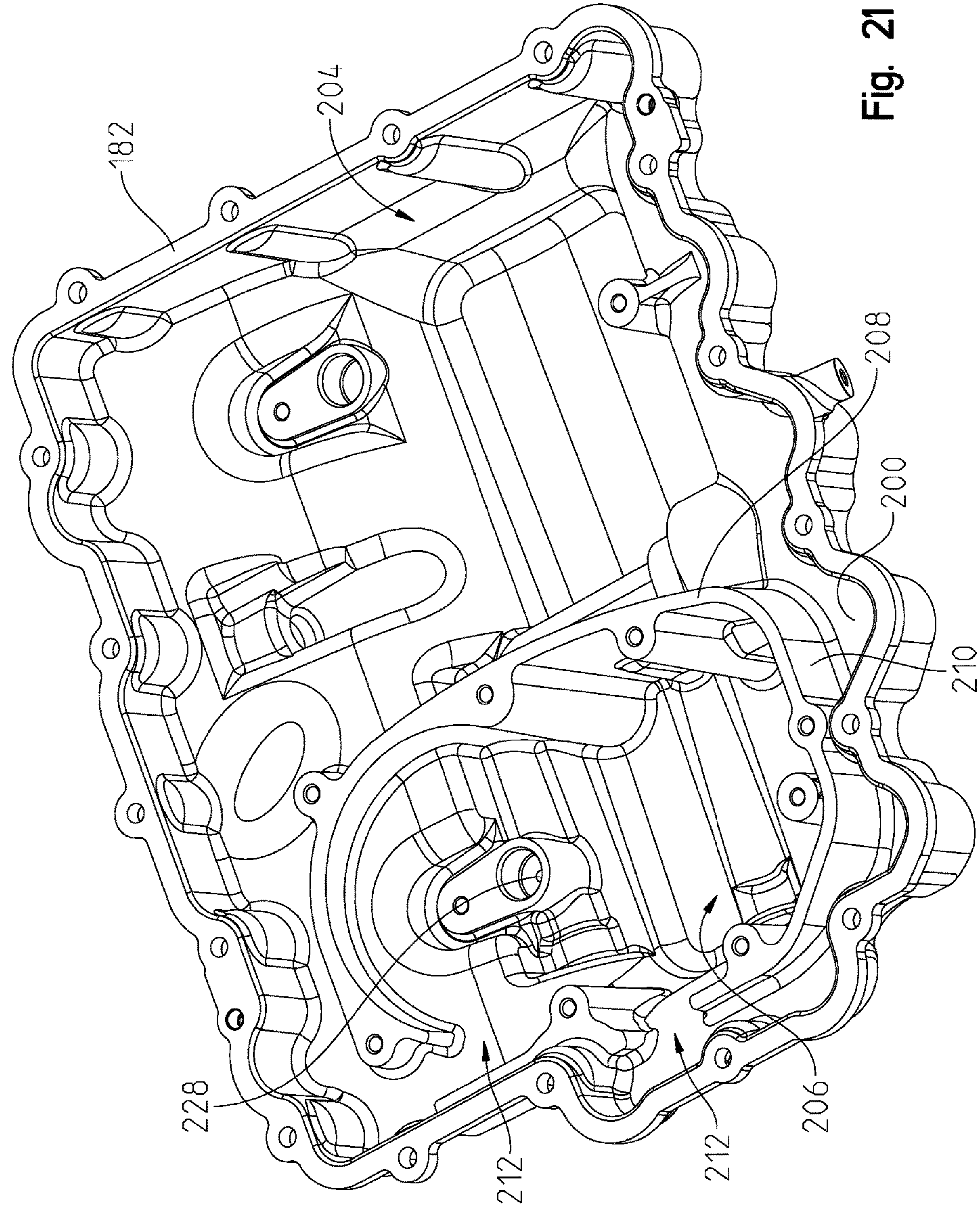

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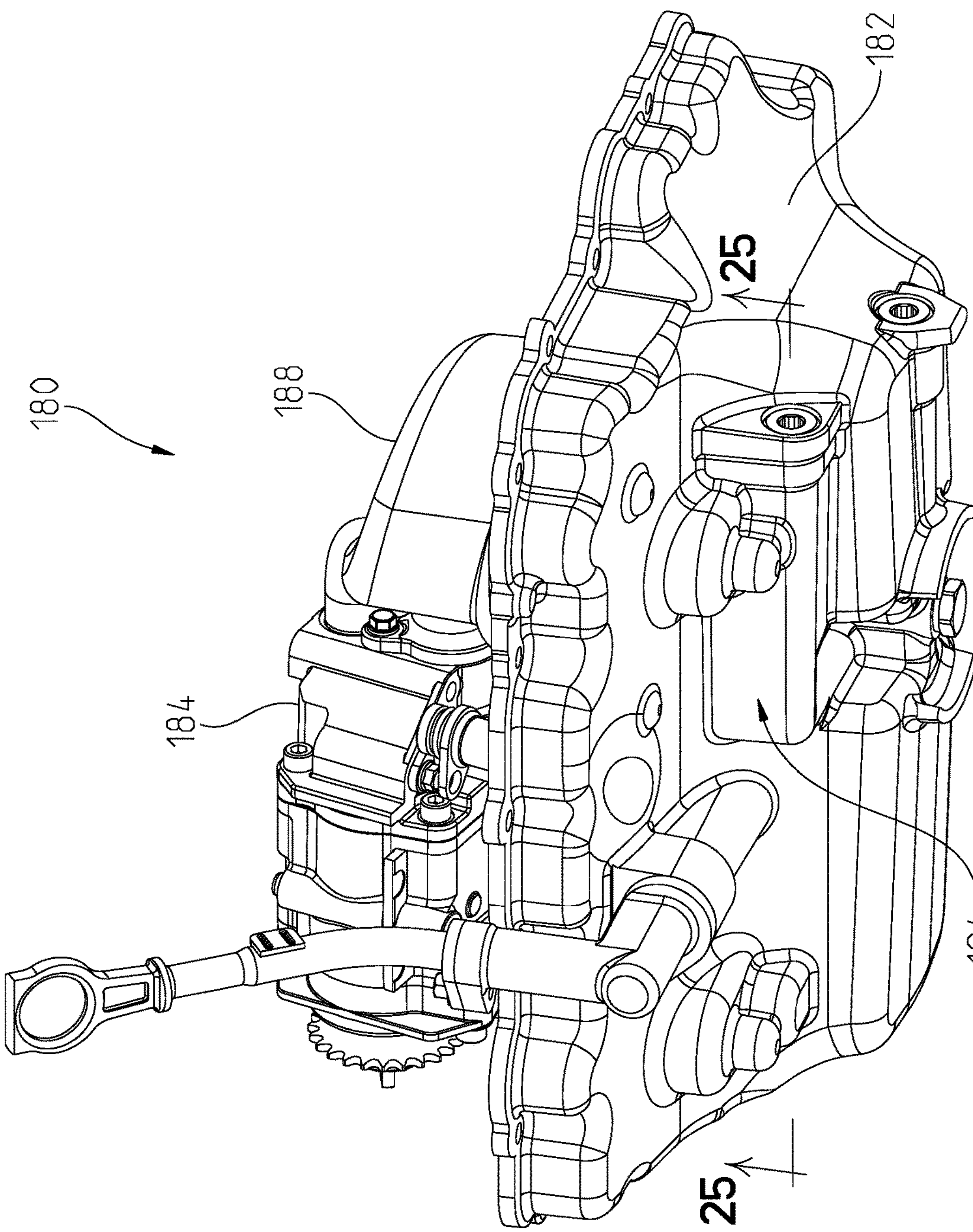

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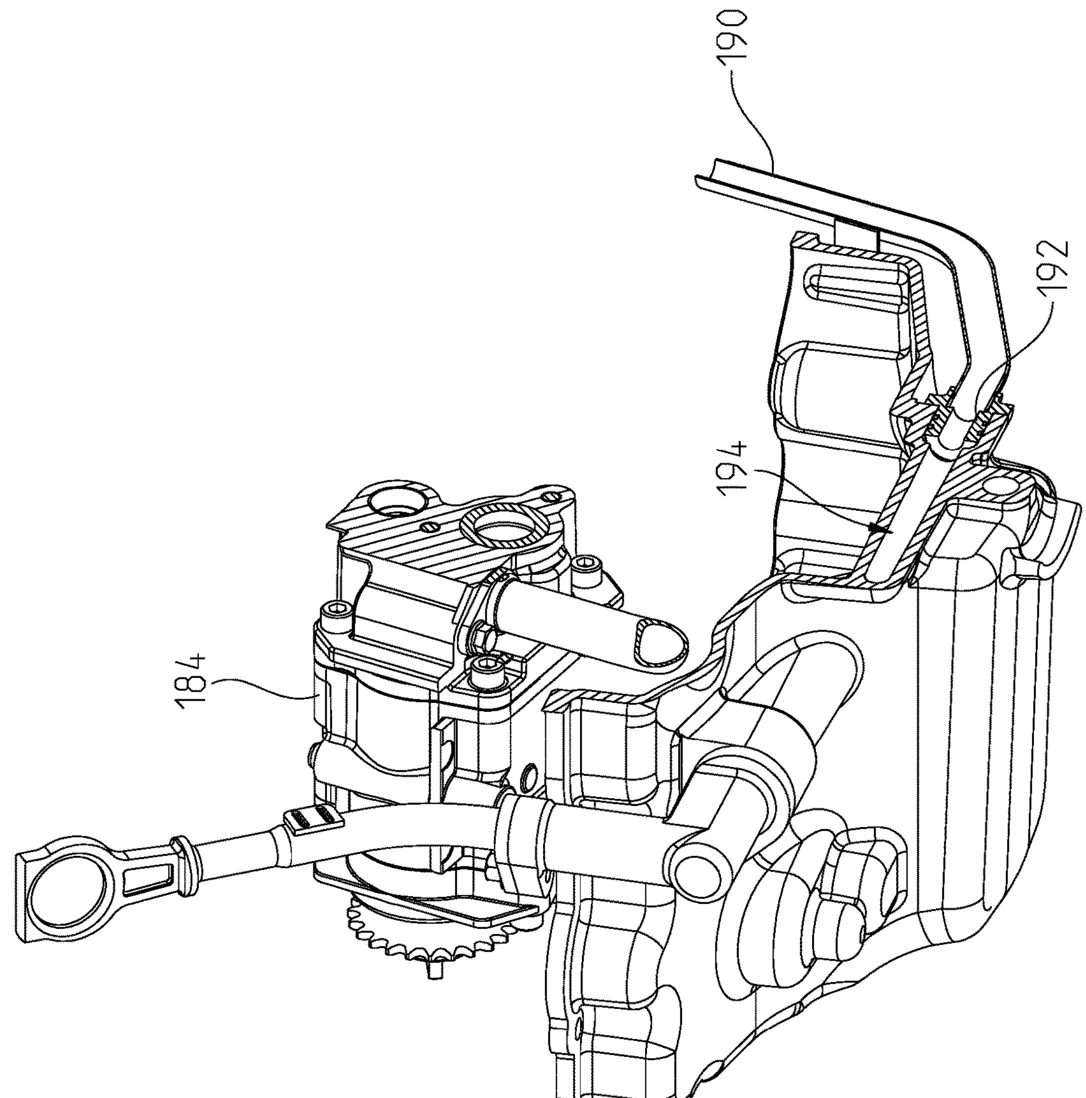

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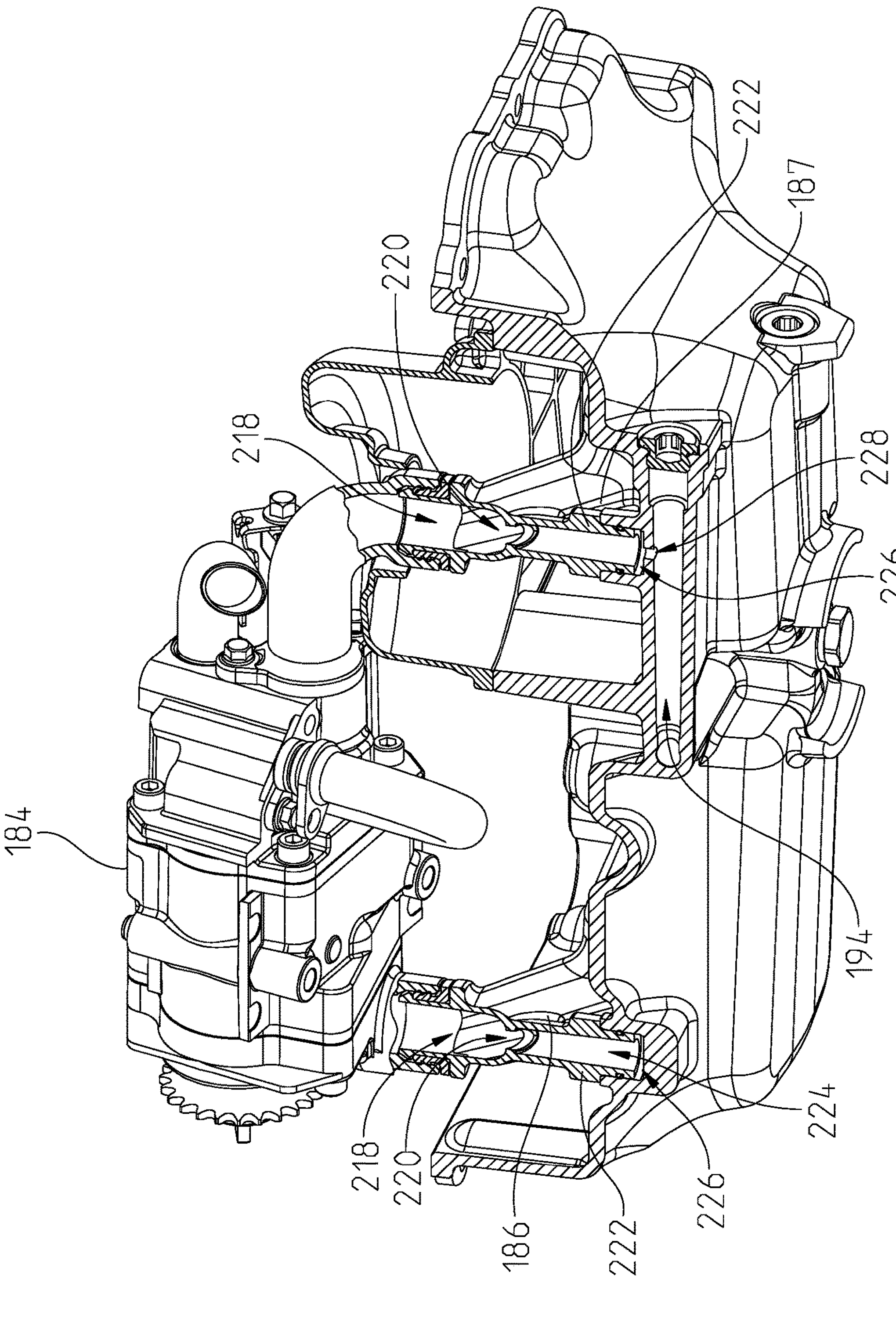
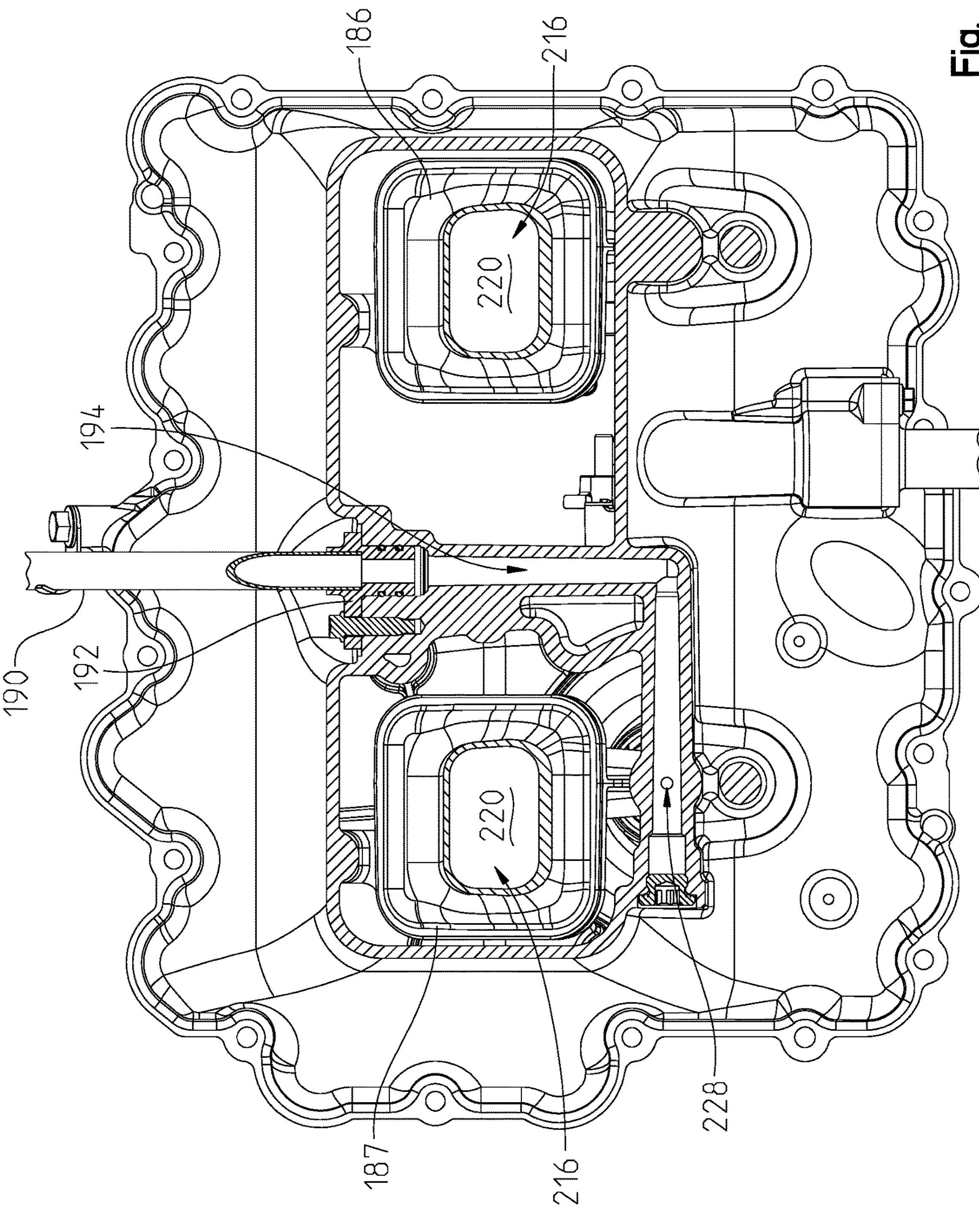


Fig. 24



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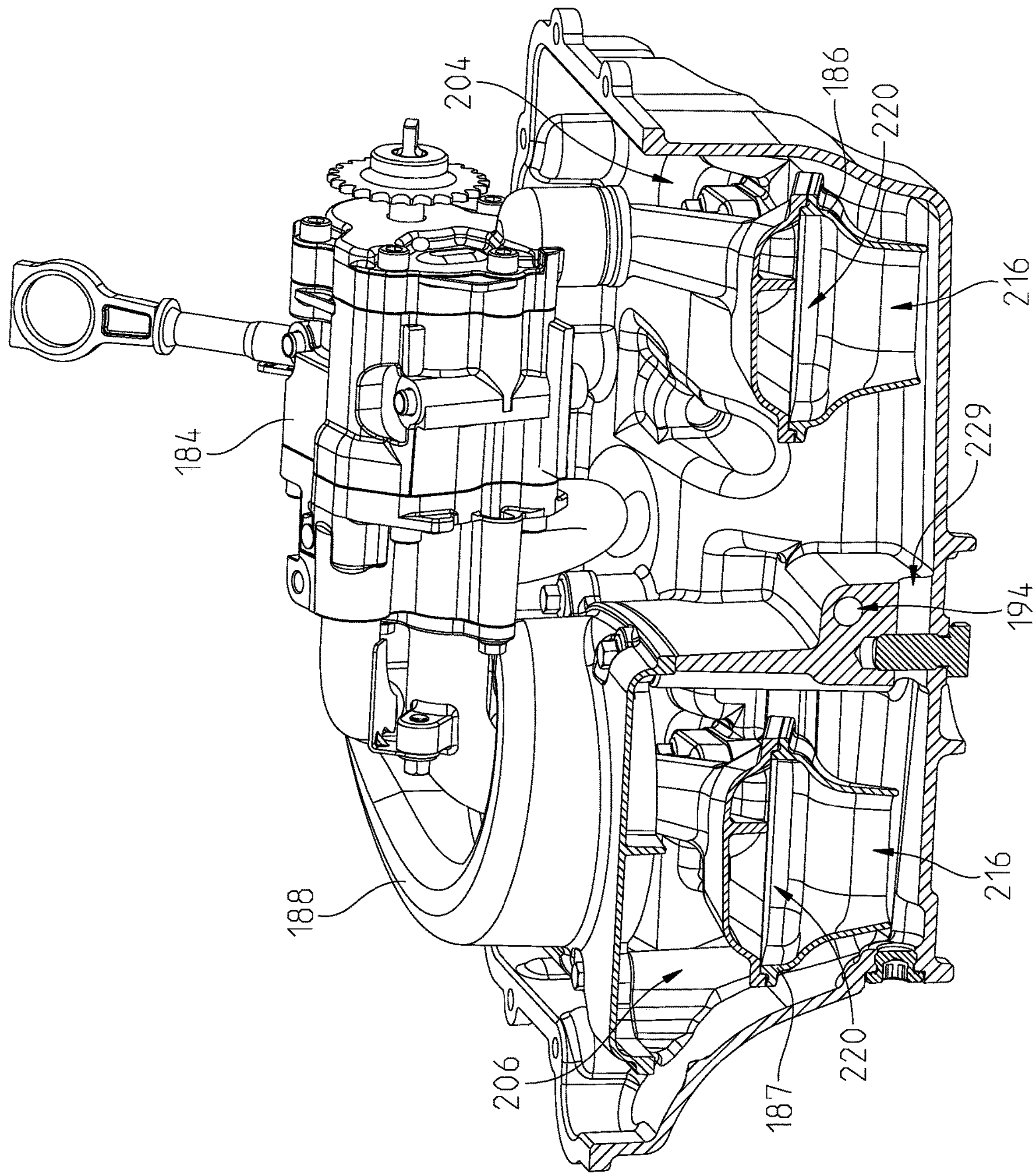

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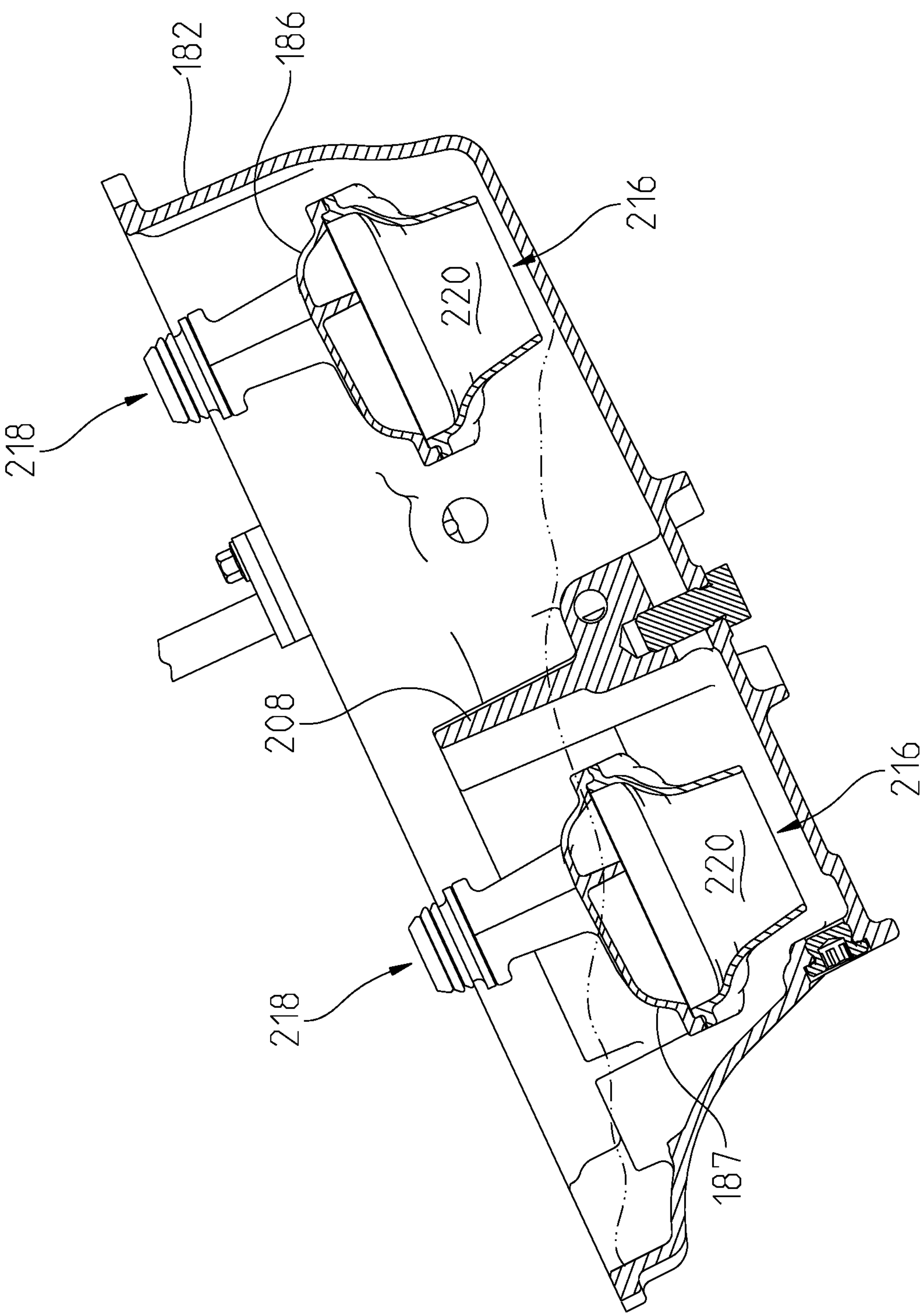


Fig. 27

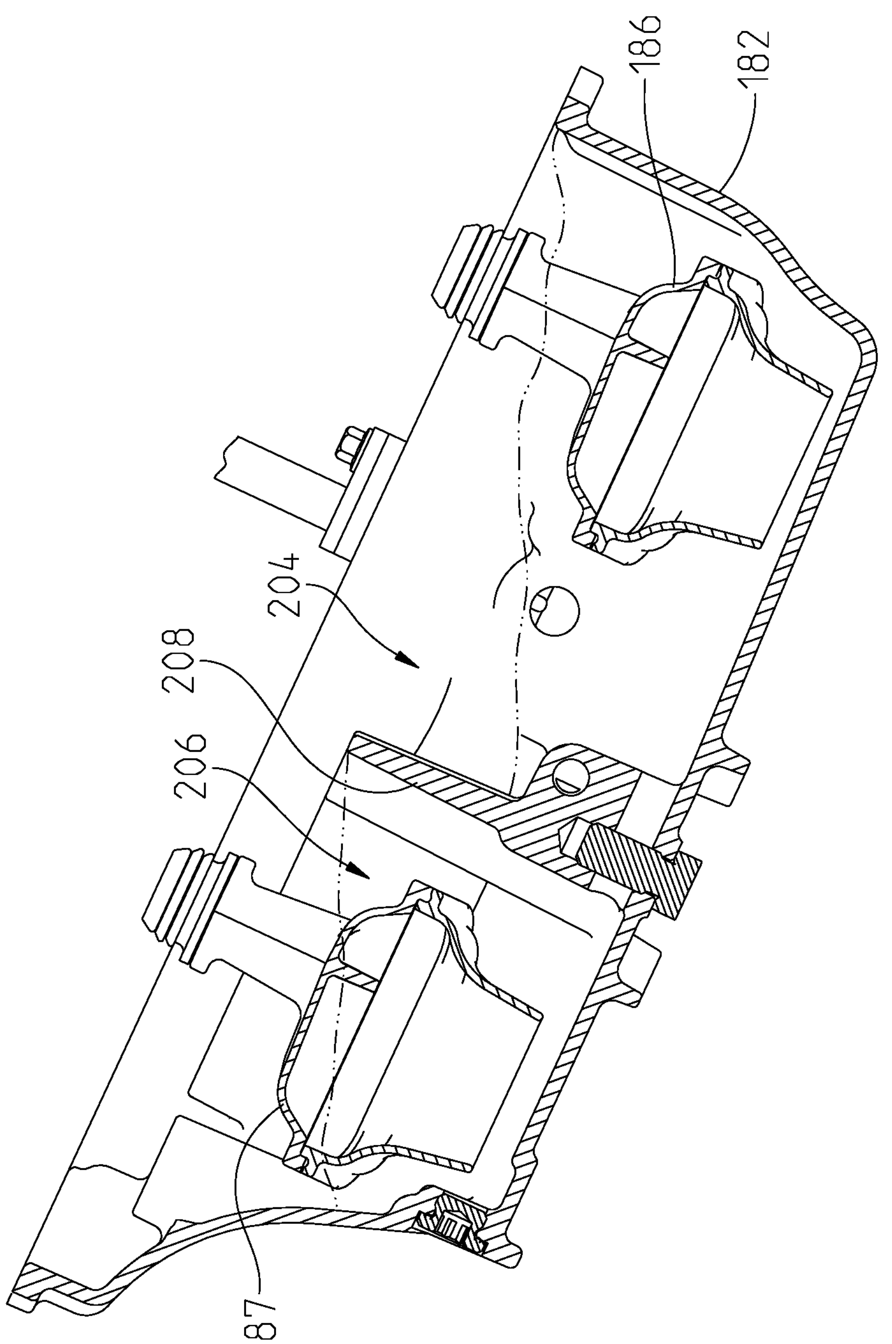


Fig. 28

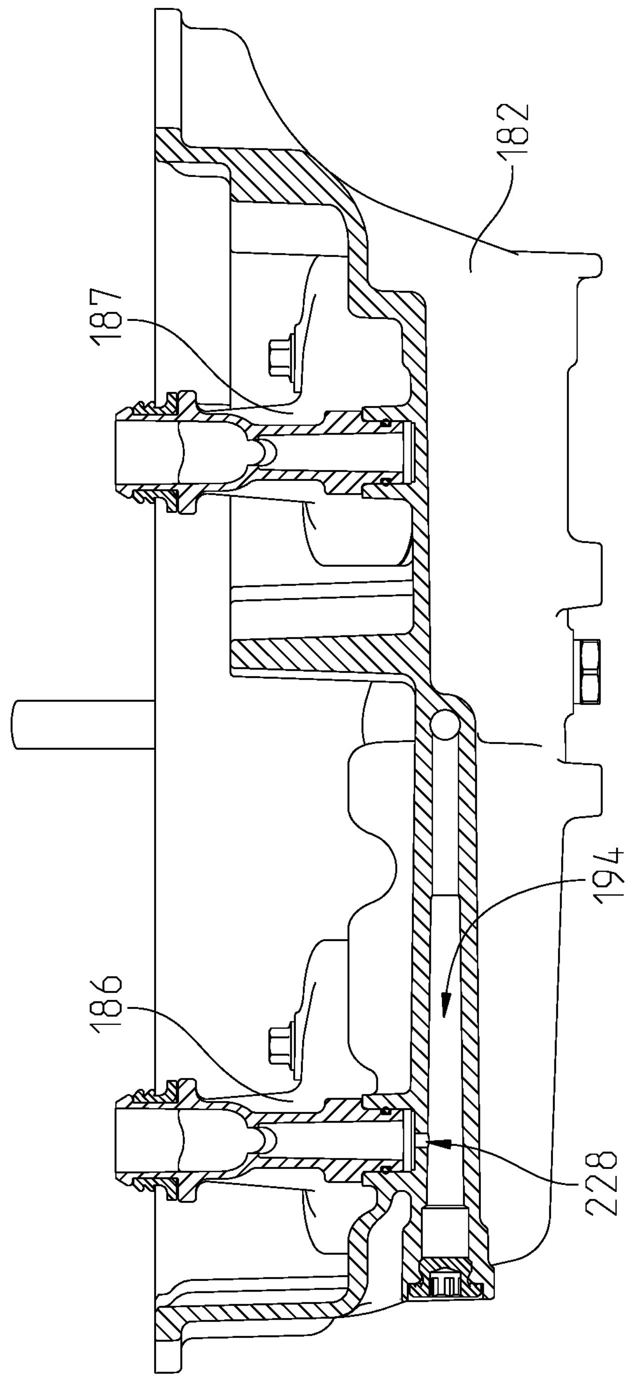


Fig. 29

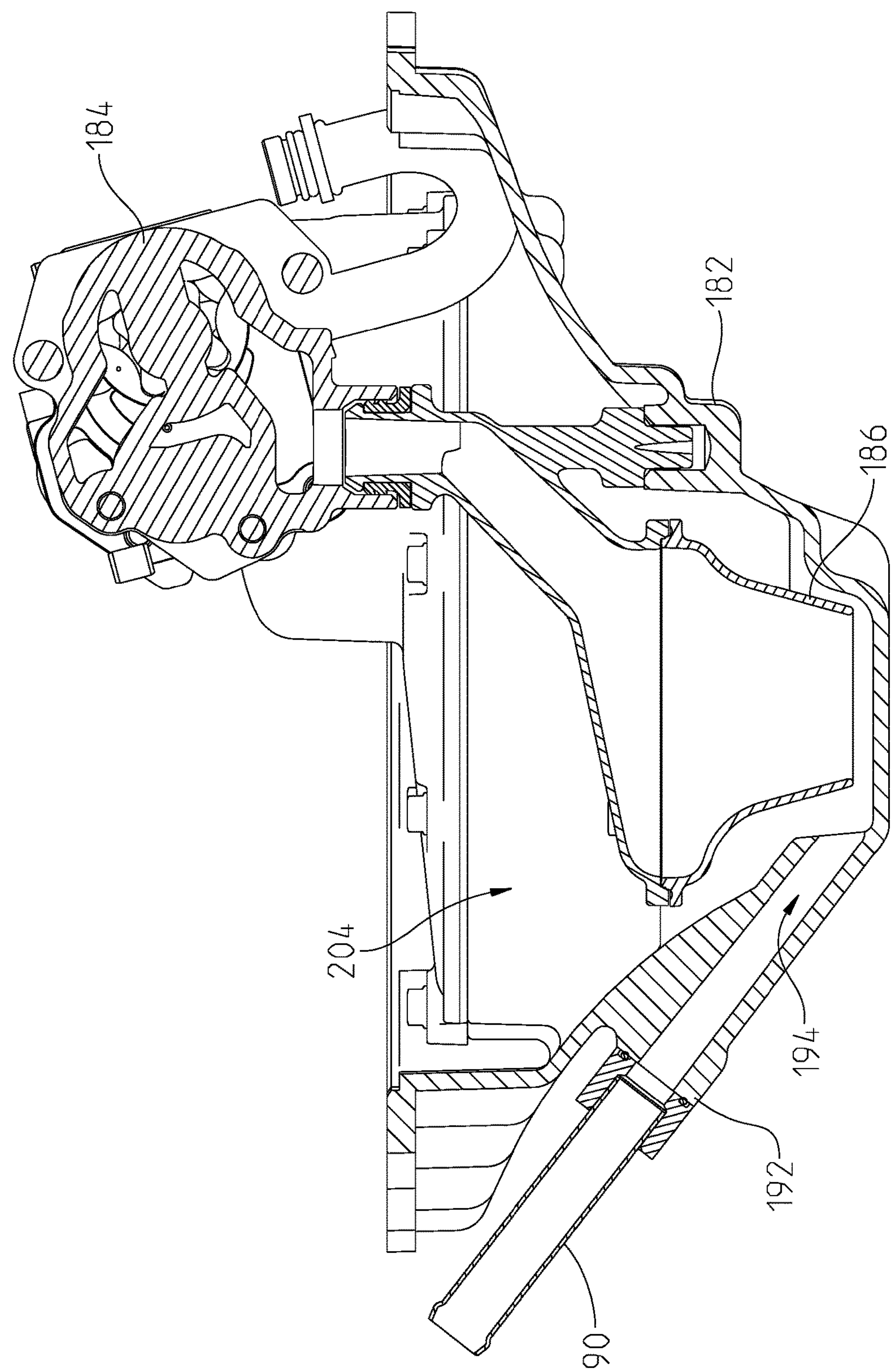


Fig. 30

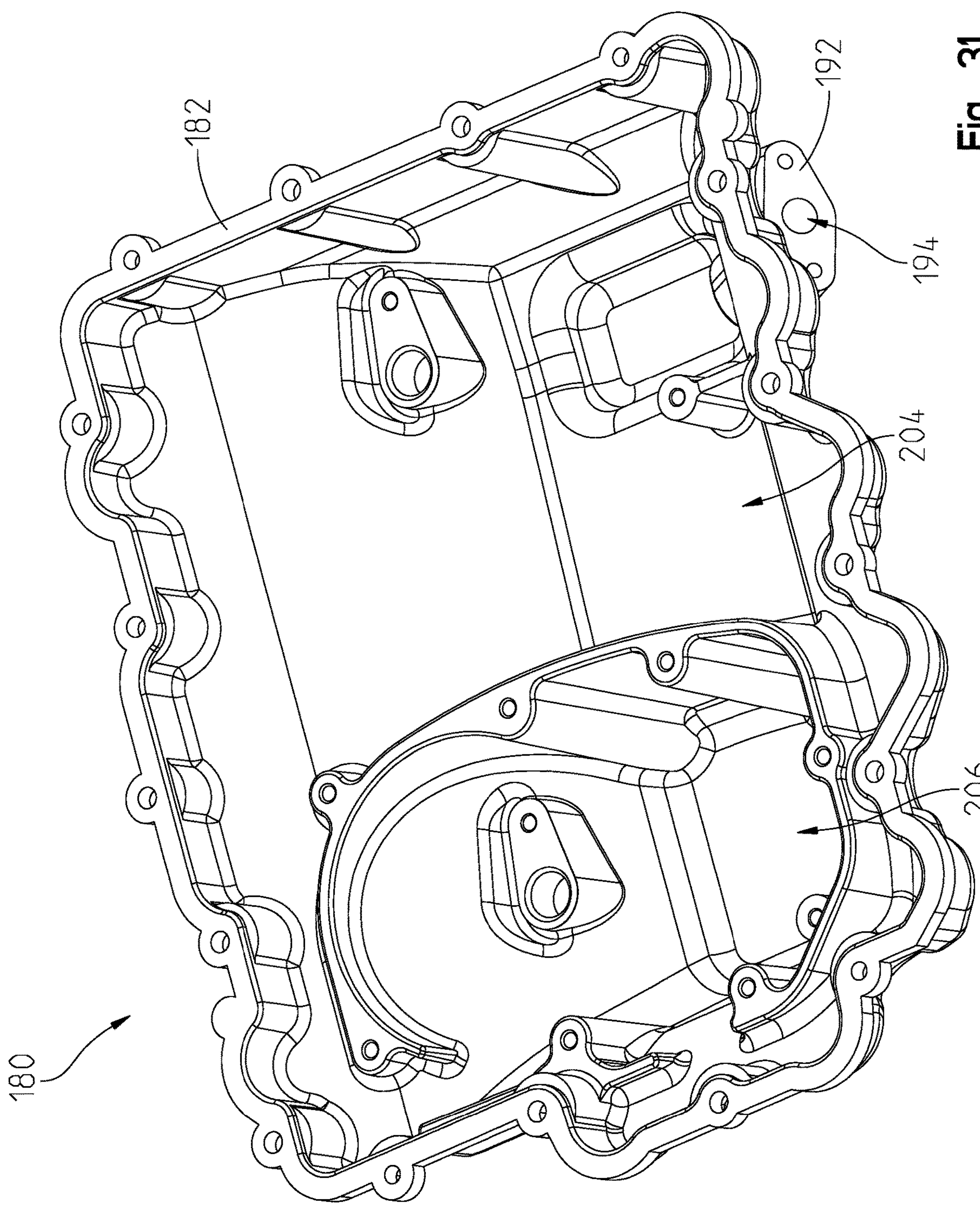
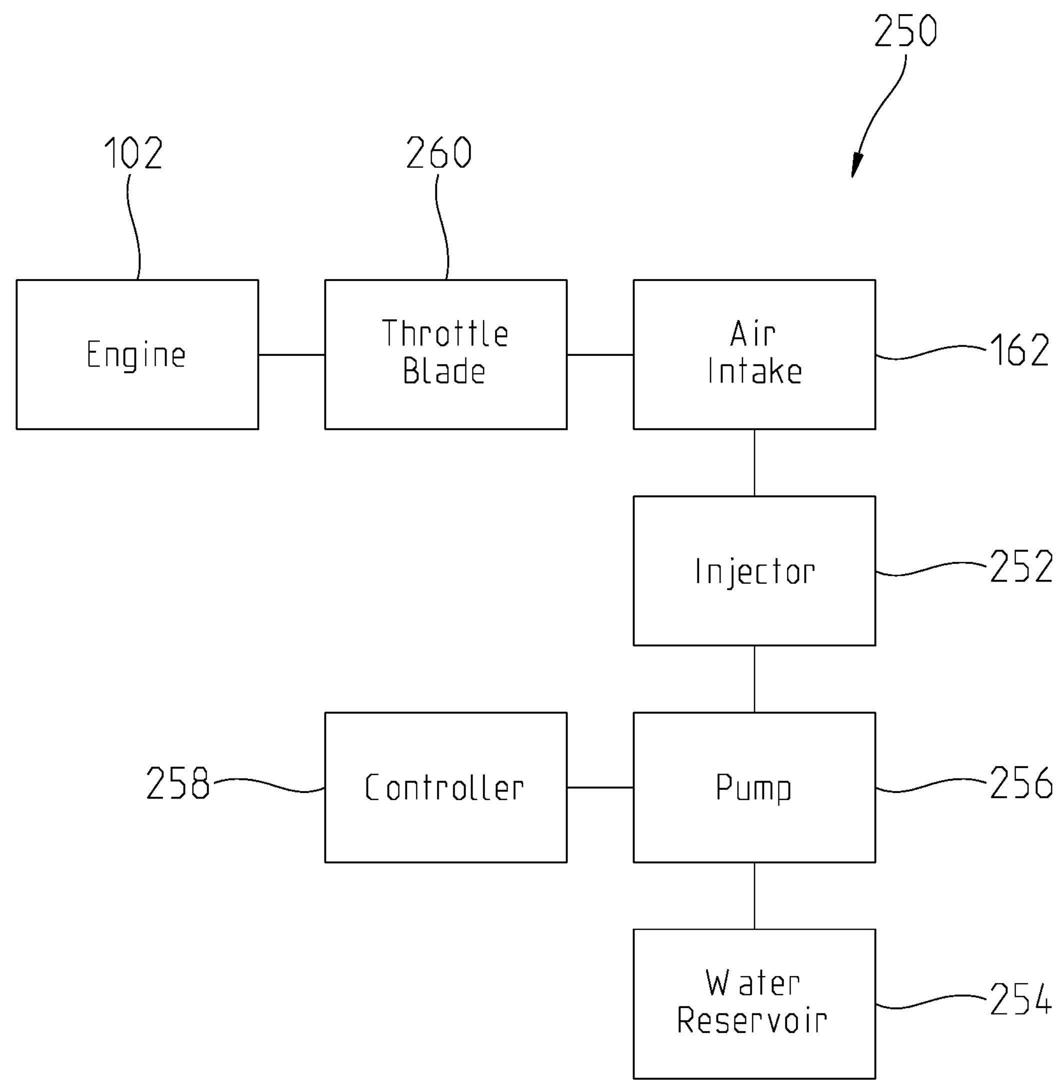


Fig. 31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Air Intake
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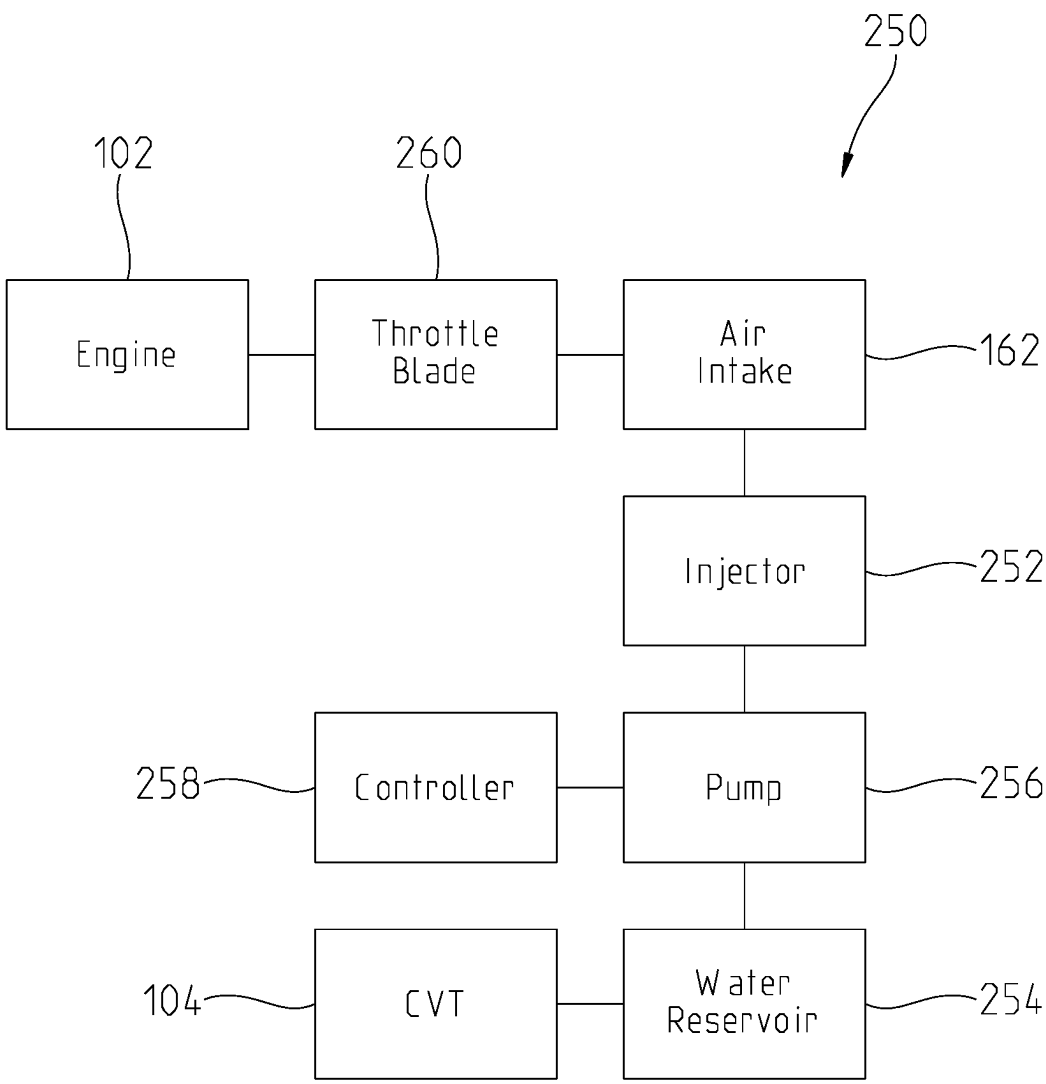
Injector
252
258
Controller
Pump
256
Water Reservoir
254

Fig. 32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Pump
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CVT
Water Reservoir
254

Fig. 33

POWERTRAIN FOR A UTILITY VEHICLE

CROSS-REFERENCE TO RELATED APPLICATION

The present application claims priority to U.S. Patent Application Ser. No. 63/351,574, filed Jun. 13, 2022, the complete disclosure of which is incorporated herein by reference.

FIELD OF THE DISCLOSURE

The present invention relates generally to a vehicle and, in particular, to a vehicle with a turbocharged powertrain assembly.

BACKGROUND THE DISCLOSURE

Generally, all-terrain vehicles ("ATVs") and utility vehicles ("UVs") are used to carry one or more passengers and a small amount of cargo over a variety of terrains.

Power output and the powertrain system is important for providing such vehicles with the ability to move across various terrain. What are needed are improvements to the powertrain system for assuring increased and reliable power.

SUMMARY OF THE DISCLOSURE

A utility vehicle is provided with an engine and turbocharger positioned on the hot side of the engine.

According to one example, a utility vehicle includes a plurality of ground-engaging members, a frame supported by the ground-engaging members, and a powertrain assembly supported by the frame and including an engine supported by the frame, the engine including an exhaust side and a turbocharger operably coupled to the engine, the turbocharger having a turbine housing supporting a turbine and a compressor housing supporting a compressor, the turbocharger being positioned on the exhaust side of the engine and rearward of the engine, a space between the turbocharger and the engine being less than 9 inches.

According to another example, the utility vehicle further includes an operator area and a cargo area supported by the frame, wherein the turbocharger is positioned vertically below at least a portion of the cargo area.

According to another example, the powertrain assembly of the utility vehicle further includes a transmission operably coupled to the engine, wherein the turbocharger is positioned vertically higher than the transmission.

According to another example, the muffler of the utility vehicle is coupled to the engine via an exhaust conduit, the exhaust conduit being less than two feet.

According to another example, the powertrain assembly of the utility vehicle further includes an exhaust conduit positioned fluidically between the engine and the muffler, and wherein the frame defines a frame envelope, the turbocharger being positioned within the frame envelope and the exhaust conduit extending at least partially outside of the frame envelope.

According to another example, the powertrain assembly of the utility vehicle further includes a continuously variable transmission (CVT) operably coupled to the engine, the turbocharger being positioned laterally adjacent to the CVT.

According to another example, the turbocharger of the utility vehicle is outside an envelope defined by the CVT.

According to another example, the powertrain assembly of the utility vehicle further includes an intercooler, the intercooler being positioned laterally adjacent to the turbocharger.

According to another example, the powertrain assembly of the utility vehicle further includes an air intake and an air filter fluidically coupled to the engine via the turbocharger, the air filter being positioned on a non-exhaust side of the engine.

According to another example, a portion of the intercooler of the utility vehicle includes an air intake and an air exhaust, the air exhaust being positioned longitudinally forward of the turbocharger.

According to another example, the powertrain assembly of the utility vehicle further includes an engine intake manifold operably coupled to the engine, and wherein the air exhaust of the intercooler is laterally adjacent at least a portion of the engine intake manifold.

A utility vehicle is provided with an engine and an oil management system.

According to one example, a utility vehicle includes a plurality of ground-engaging members, a frame supported by the ground-engaging members, and a powertrain assembly supported by the frame and including an engine supported by the frame a turbocharger operably coupled to the engine, and an oil management system fluidically coupled to the engine and the turbocharger, the oil management system including an oil pan defining a staging reservoir, a staging oil pick up member including an opening positioned proximate the staging reservoir, an engine oil pump fluidically coupled to the staging oil pick up member and operable to pump oil from the staging reservoir to the engine, and a turbo drain through which oil from the turbocharger is operable to drain from the turbocharger, the turbo drain operable to deliver the oil to be picked up by the staging oil pick up member.

According to another example, the oil management system of the utility vehicle is a wet sump.

According to another example, the staging oil pickup member of the utility vehicle includes an auxiliary opening, the auxiliary opening being fluidically coupled to the turbo drain.

According to another example, the oil management system of the utility vehicle includes a channel in fluid communication with the turbo drain and the staging oil pick up member at the second opening, such that oil is drained from the turbocharger directly to the auxiliary opening of the staging oil pickup member.

According to another example, the oil management system of the utility vehicle includes a delivery reservoir adjacent the staging reservoir and a delivery oil pickup member with an opening proximate the delivery reservoir, wherein the oil pump is operable to deliver oil from the staging reservoir to the delivery reservoir.

According to another example, the oil management system of the utility vehicle includes a de-aerating member fluidically between the staging reservoir and the delivery reservoir.

According to another example, the oil management system of the utility vehicle includes a delivery reservoir cover, wherein the delivery reservoir is a pressurized chamber when the delivery reservoir cover is installed and the oil pump is active.

According to another example, the staging oil pickup member of the utility vehicle is positioned vertically above a portion of the staging reservoir.

According to another example, the portion of the staging reservoir above which the staging oil pickup member of the utility vehicle is positioned defines a low pressure zone during operation.

According to another example, the turbocharger of the utility vehicle drains into the low pressure zone of the staging reservoir.

An off-road recreational vehicle is provided with an engine and a water cooling system.

According to one example, an off-road recreational vehicle includes a plurality of ground-engaging members, a frame supported by the ground-engaging members, and a powertrain assembly supported by the frame and including an engine supported by the frame an air intake system fluidically coupled to the engine to provide air to the engine and including a throttle blade positioned fluidically upstream from the engine, and a water cooling system including a nozzle interfacing with the air intake system upstream from the throttle blade.

According to another example, the nozzle of the off-road recreational vehicle interfaces with the air intake system within 8 inches from the throttle blade upstream from the throttle blade.

According to another example, the nozzle of the off-road recreational vehicle is operable to atomize water.

According to another example, the nozzle of the off-road recreational vehicle is positioned perpendicular to flow of air through the air intake system.

According to another example, the water cooling system of the off-road recreational vehicle further includes a controller operable to activate the nozzle in predetermined conditions.

According to another example, the predetermined conditions of the off-road recreational vehicle include one of high temperatures, wide open throttle, and increased power demands.

According to another example, the water cooling system of the off-road recreational vehicle further includes a water reservoir supported by the frame.

According to another example, the off-road recreational vehicle further includes a continuously variable transmission (CVT), wherein the CVT is fluidically coupled to the water reservoir.

BRIEF DESCRIPTION OF THE DRAWINGS

The above mentioned and other features of this invention, and the manner of attaining them, will become more apparent and the invention itself will be better understood by reference to the following description of embodiments of the invention taken in conjunction with the accompanying drawings, where:

FIG. **1** is a front perspective view of a utility vehicle of the present disclosure;

FIG. **2** is a rear perspective view of the utility vehicle of FIG. **1**;

FIG. **3** is a left side view of the utility vehicle of FIG. **1**;

FIG. **4** is a right side view of the utility vehicle of FIG. **1**;

FIG. **5** is a top view of the utility vehicle of FIG. **1**;

FIG. **6** is a front side view of the utility vehicle of FIG. **1**;

FIG. **7** is a rear side view of the utility vehicle of FIG. **1**;

FIG. **8** is a perspective view of a powertrain assembly of the vehicle of FIG. **1**;

FIG. **9** is a side view of the powertrain assembly of FIG. **8**;

FIG. **10** is a top view of the powertrain assembly of FIG. **8**;

FIG. **11** is a view of a powertrain assembly having an engine in an lateral or east-west configuration;

FIG. **12** is a view of a powertrain assembly having an engine in a longitudinal or north-south configuration;

FIG. **13** is a view of an alternative powertrain assembly having an engine in a longitudinal or north-south configuration;

FIG. **14** is a top perspective view of a powertrain assembly with an engine and a turbocharger;

FIG. **15** is a side view of the engine and turbocharger of FIG. **14**;

FIG. **16** is a top view of the engine and turbocharger of FIG. **14**;

FIG. **17** is a bottom perspective view of the engine and turbocharger of FIG. **14**;

FIG. **18** is a bottom perspective view of an oil management system of an engine with a drain line from a turbocharger;

FIG. **19** is a bottom view of the oil management system of FIG. **18**;

FIG. **20** is a top perspective view of the oil management system of FIG. **18**;

FIG. **21** is a top perspective view of an interior of an oil pan of the oil management system of FIG. **18**;

FIG. **22** is a side perspective view of the oil management system of FIG. **18**;

FIG. **23** is a side section view of the oil management system of FIG. **18**;

FIG. **24** is a front section view of the oil management system of FIG. **18**;

FIG. **25** is a top view of the oil management system of FIG. **18**;

FIG. **26** is a front section view of reservoirs and pickup members of the oil management system of FIG. **18**;

FIG. **27** is a section view of the oil management system of FIG. **18** positioned in a condition of high angularity;

FIG. **28** is a section view of the oil management system of FIG. **18** positioned in another condition of high angularity;

FIG. **29** is a view of an alternative embodiment of an oil management system;

FIG. **30** is a section view of another alternative embodiment of an oil management system;

FIG. **31** is a top view of an oil pan of the oil management system of FIG. **30**;

FIG. **32** is a schematic of a water injection system; and

FIG. **33** is an alternative schematic of a water injection system.

Corresponding reference characters indicate corresponding parts throughout the several views. Unless stated otherwise the drawings are proportional.

DETAILED DESCRIPTION OF THE DRAWINGS

The embodiments disclosed below are not intended to be exhaustive or to limit the invention to the precise forms disclosed in the following detailed description. Rather, the embodiments are chosen and described so that others skilled in the art may utilize their teachings. While the present disclosure is primarily directed to a utility vehicle, it should be understood that the features disclosed herein may have application to other types of vehicles such as other all-terrain vehicles, motorcycles, snowmobiles, and golf carts.

With reference first to FIGS. **1-7**, the vehicle of the present invention will be described. As shown, a vehicle **10** is generally depicted which includes front ground-engaging members **12** and rear ground-engaging members **14**. The ground-engaging members **12**, **14** support a vehicle frame **16** (FIG. **3**), which supports an operator or seating area **20** comprised of a driver's seat **22** and a passenger seat **24**. A cab frame **26** generally extends over the seating area **20**. As best shown in FIG. **3**, the vehicle **10** further includes a steering assembly **30** for steering the front ground-engaging members **12** whereby the steering assembly **30** includes a steering wheel **32** which could be both tiltable and longitudinally movable.

In some embodiments, the vehicle **10** is a four-wheel drive vehicle. As shown, the vehicle **10** may also include an outer body **41** including a hood **43**, side panels **44**, doors **45**, a cargo area **46** (e.g., a utility bed), and rear panels **48**, which are illustrated throughout FIGS. **1-7**. The vehicle **10** further includes a front suspension **40** and a rear suspension **42**.

As seen in FIGS. **2-4** and **8-13**, the vehicle **10** include a powertrain assembly **100**. The component parts of the powertrain assembly **100** are discussed hereafter in greater detail with respect to FIGS. **8-10**. Illustratively, the powertrain assembly **100** is comprised of an engine **102**, a transmission **124** (e.g., a continuously variable transmission (CVT) **104**, and/or a shiftable transmission **106**), an exhaust assembly **108**, and a turbocharger **110**. The powertrain assembly **100** is supported by the vehicle frame **16**. The powertrain assembly **100** described herein may be further configured as shown in U.S. patent application Ser. No. 16/875,448 with a filing date of May 15, 2020 and/or U.S. patent application Ser. No. 16/875,494 with a filing date of May 15, 2020, the subject matter of which are incorporated herein by reference in their entireties.

With reference now to FIGS. **8-10**, the powertrain assembly **100** will be described in greater detail. The powertrain assembly **100** provides power to the ground-engaging members **12**, **14** of the vehicle **10** (FIGS. **1-7**). The powertrain assembly **100** is supported on at least longitudinal frame members **17** and an engine mount **18** of the vehicle frame **16**. In one embodiment, the longitudinal frame members **17** are generally parallel to a centerline C_L of the vehicle **10** (FIG. **5**) and the engine mount **18** extends transversely to the centerline C_L and the longitudinal frame members **17**.

Referring to FIGS. **11-13**, the engine **102** is positioned at the rear of the vehicle **10** behind the seating area **20**. The engine **102** includes an engine or cylinder block **112** with at least one cylinder **114** (e.g., including a twin cylinder configuration, three cylinder configuration, other cylinder configurations). Illustratively, the engine **102** is an in-line, three-cylinder engine having a first, second, and a third cylinder **114**. In addition to the engine **102**, the powertrain assembly **100** includes an engine intake manifold assembly **120** providing air to the engine **102**, the exhaust assembly **108** routing exhaust from the engine **102** out of vehicle **10**, the transmission **124** operably coupled to the engine **102**, and a drivetrain having a drive shaft coupled to the transmission **124**. The engine **102** may be oriented either in lateral orientation (FIG. **11**) or in a longitudinal orientation (FIG. **12**). In the lateral orientation of FIG. **11**, a crankshaft (not shown) extends laterally or generally transverse to the centerline C_L, whereas, in the longitudinal orientation of FIG. **12**, the crankshaft (not shown) extends parallel to or colinear with centerline C_L.

The engine **102** of powertrain assembly **100** may be placed in the vehicle **10** in a plurality of different configurations, with the present application illustrating at least two of these different configurations. In the first illustrative configuration, shown in FIG. **11**, the engine **102** is positioned in the vehicle **10** in a lateral orientation, where the cylinders **114** of the engine **102** are aligned from a right side **2** of the vehicle **10** to a left side of the vehicle **10** and the crankshaft (not shown) extends laterally between the right side and left side of the vehicle **10** such that the engine **102** is perpendicular to a centerline C_L of the vehicle **10**. When the engine **102** is in the lateral orientation, the engine intake manifold assembly **120**, which includes an intake manifold **129**, at least one throttle body **130**, and/or intake manifold runners **132**, is positioned generally forward of the engine **102** and rearward of the seating area **20** such that a majority of engine intake manifold assembly **120** is between seating area **20** and a forwardmost point of the engine **102** and all of engine intake manifold assembly **120** is longitudinally between the seating area **20** and a centerline E_L of the engine **102**. The centerline E_L of the engine **102** is defined, in the first illustrative embodiment, as the laterally-extending centerline of the cylinders **114** such that the centerline E_L intersects the midpoint or the vertically-extending reciprocation axis (e.g., reciprocation of a piston (not shown) therein) of each cylinder **114**.

The exhaust assembly **108** of the first illustrative configuration (FIG. **11**), which includes an exhaust manifold **134**, at least one exhaust conduit **136**, and/or a muffler or silencer **138**, is positioned generally rearward of the engine **102** and forward of a rear of the vehicle **10** such that at least the exhaust manifold **134** and muffler **138** of the exhaust assembly **108** are longitudinally between the engine **102** and the rearward most point of the vehicle **10**. It may be appreciated that a portion of a tail pipe of the exhaust assembly **108** may extend rearwardly from the rear of the vehicle **10** without departing from the description and understanding of the exhaust assembly **108** disclosed herein.

The transmission **124** of the first illustrative configuration (FIG. **11**) is laterally positioned between the engine **102** and the right side or left side of the vehicle **10** such that the transmission **124** extends along a right side or a left side of the engine **102**. The transmission **124** also may be positioned rearward of at least a portion of the engine intake manifold assembly **120** and forward of at least a portion of the exhaust assembly **122**. Illustratively, the transmission **124** is positioned laterally between the engine **102** and the left side **4** of the vehicle **10**.

The configuration of the powertrain assembly **100** of the first illustrative configuration (FIG. **11**) allows for the powertrain assembly **100** to have a hot side and a cold side. More particularly, a hot side of the engine **102**, or the side of the engine **102** which contains more heat producing components, is generally defined as the rearward portion of the engine **102** (e.g., may be defined as the portion of at least the engine **102** positioned rearward of the engine centerline E_L). The hot side of the engine **102** includes heat-producing components such as the exhaust manifold **134** which contains hot air exhaust from the engine **102** and other such components that may experience elevated temperatures during operation of the engine **102** compared to other components. Additionally, a cool/cold side of the engine **102**, or the side of the engine **102** which generates less heat, is generally defined as the forward portion of the engine **102** adjacent the seating area **20** (e.g., may be defined as the portion of at least the engine **102** positioned forward of engine centerline E_L). The cool side of the engine **102** includes components that generate no or less heat such as the engine intake manifold assembly **120** which receives ambient air and other such components that do not experience elevated temperatures during operation of the engine **102**. Because the cool side of the engine **102** does not generate heat or generate as much heat as the hot side of the engine **102**, various heat sensitive components of the powertrain assembly **100** and/or the vehicle **10** may be positioned within or adjacent to the cool side of the engine **102**, such as electronics like sensors, controllers, etc. In addition to the strategic positioning of a hot and cold side of the engine **102**, this first illustrative configuration allows for throttle body **130** to be closer to the intake manifold **129** resulting in a shorter engine intake manifold assembly **120**.

In the second illustrative configuration, shown in FIGS. **12** and **13**, the engine **102** is positioned in the vehicle **10** in a longitudinal configuration, where the cylinders **114** of the engine **102** are aligned in the fore/aft direction of the vehicle **10** and the crankshaft **116** extends longitudinally such that engine centerline EL of the engine **102** may be at least parallel to centerline C_L of the vehicle **10**. In other embodiments, the engine centerline E_L may be colinear with the centerline C_L. As shown in FIGS. **12** and **13**, when the engine **102** is in the longitudinal/second illustrative configuration, longitudinal centerline E_L of the engine **102** may be offset to the right of the centerline C_L of the vehicle **10** in order to allow an output shaft (not shown) of shiftable transmission **106** and the drive shaft (not shown) of the drivetrain to be properly aligned. When the engine **102** is in the second or longitudinal configuration, the engine intake manifold assembly **120** is positioned laterally between the right side of the vehicle **10** and the engine **102**, portions of the exhaust assembly **122** extend along the left side of the vehicle **10** to a position rearward of the engine **102**, and the transmission **124** may be positioned longitudinally forward of the engine **102**. In various embodiments, at least a portion of the transmission **124** may be positioned below the seating area **20** and/or rearward of the seating area **20**. As such, the transmission **124** may be longitudinally intermediate a portion of the seating area **20** and a portion of the engine **102**.

In either the first or second illustrative configurations, the powertrain assembly **100** may further include the turbocharger **110**, which may be positioned behind the engine **102** in the transverse configuration of FIG. **11** or behind or to the side of the engine **102** in the longitudinal configuration of FIGS. **12** and **13**. However, in various embodiments, the turbocharger **110** may be positioned at any location along exhaust conduit **136** between the exhaust manifold **134** and muffler **138**. In some embodiments, the turbocharger **110** may be integrated within a portion of the exhaust manifold **134** and/or positioned immediately adjacent the exhaust manifold **134**. The exhaust manifold **134** may include a run that is less than 12 inches, for example, less than 9 inches, less than 6 inches, less than 4 inches, less or than 2 inches. This places the turbocharger **102** in close proximity to the engine **102**, for example the space between the turbocharger **110** and the engine **102** may be less than 9 inches, less than 6 inches, less than 5 inches, less than 4 inches, less than 3 inches, less than 2 inches, or less than 1 inch. Be having the run between the engine **102** and the turbocharger **110** being shortened, the responsiveness of the turbocharger **110** is increased. The configuration of the inlets and outlets of the turbocharger **110** discussed below also facilitates the placement of the turbocharger **110** in such close proximity with the engine **102**.

Referring to FIGS. **14-17**, the turbocharger **110** is positioned on the hot or exhaust side of the engine **102** and is in parallel with the engine **102**. When the engine **102** is provided in the East/West configuration, the turbocharger **110** is positioned rearward of the engine **102**. The turbocharger **110** is coupled to the engine block **112**. It is understood that the turbocharger **110** may be provided as a single integral unit with the exhaust manifold **134** or may be provided as a separate component that can be coupled to the exhaust manifold **134**. Accordingly, in some embodiments, the turbocharger **110** is coupled to the engine block **112** via the exhaust manifold **134** which is separate from the turbocharger **110** or in some embodiments is coupled to the engine block **112** via the exhaust manifold **134** that is integral with the turbocharger **110**. The turbocharger **110** is in fluid communication with the exhaust ports **123** of the engine **102**. Various turbochargers may be implemented, including but not limited to those shown in U.S. Pat. No. 10,300,786 issued May 28, 2019 and entitled "Utility Vehicle", the subject matter of which is incorporated herein by reference in its entirety. In some embodiments, the exhaust manifold **134** includes a short run from the engine **102** to the turbocharger **110** (e.g., less than one foot, such as less than 8 inches or less than 6 inches). By having a shorter run from between the turbocharger **110** and the engine **102**, other air delivery components such as the second and third conduits **168**, **172** (which are discussed hereafter) have shorter segments exposed to the hot side of the engine **102** and therefore heat transfer is limited to those components which deliver air to the engine for combustion.

The turbocharger **110** includes a turbine portion **140** and a compressor portion **150**. The turbine portion **140** includes a turbine housing **142**, a turbine (not shown), a turbine inlet **146**, and a turbine outlet **148**. In some embodiments, the turbine inlet **146** receives exhaust from the exhaust manifold **134** (e.g., the turbine inlet **146** is coupled to the exhaust manifold **134** or is integral with the exhaust manifold **134**). The compressor portion **150** includes a compressor housing **152**, a compressor (not shown), a compressor inlet **156**, and a compressor outlet **158**. A shaft (not shown) extends between turbine and the compressor.

As shown in FIG. **16**, the compressor outlet **158** is aligned parallel to the engine centerline E_L. The compressor inlet **156** is also aligned parallel to the engine centerline E_L. By aligning the compressor inlet and outlet **156**, **158**, the turbocharger **110** includes a narrower profile extending away from the engine **102**. For example, when the engine **102** has an East/West configuration, the turbocharger **110** includes the compressor inlet and outlet **156**, **158** each facing towards the left side of the vehicle **10** (FIG. **8**). This reduces the profile of the turbocharger **110** in the longitudinal direction of the vehicle **10** when installed. The compressor inlet and outlet **156**, **158** are positioned on the same side of the compressor housing **152**. For example, the compressor inlet **156** may be positioned along or near a center of a side of the compressor housing **152** (e.g., along a compressor axis C_A of the compressor **154**, see FIG. **16**) and the compressor outlet **158** is positioned at the periphery of the side of the compressor housing **152** (e.g., at an outer edge of the compressor **154** having an outlet axis O_A that is substantially parallel to the compressor axis C_A). Furthermore, by placing the compressor inlet and outlet **156**, **158** as described, thermal transfer of the turbocharger **110** and its corresponding components (e.g., conduits) is reduced. By having the compressor inlet **156** and the compressor outlet **158** parallel to each other, both the compressor inlet and outlet **156**, **158** extend laterally away from the engine **102** and therefore are oriented to limit heat transfer to the conduits which couple to each of the compressor inlet and outlet **156**, **158**. This also facilitates the close placement of the turbocharger **110** with the engine **102** as described above.

More specifically, by placing the compressor inlet and outlet **154**, **156** as shown and described (e.g., FIGS. **10** and **16**), the conduits through which the air is travelling have a shortened length and their exposure to the hot side of the engine **102** is reduced. Referring to FIGS. **8-10**, for example, the vehicle **10** may include an air intake system **160** that includes an air intake inlet **162**, an air filter **164**, a first conduit **166** extending between the air intake inlet **162** and the air filter **164**, a second conduit **168** extending between the air filter **164** and the compressor inlet **156**, an intercooler **170**, a third conduit **172** extending between the compressor outlet **158**, and a fourth conduit **174** extending between the intercooler **170** and the engine intake manifold assembly **120**. The second and third conduits **168**, **172** are short segments on the hot side of the engine **102** in order to reduce thermal transfer to the air that moves through those conduits. For example, the portions of the second and third conduits **168**, **172** that are positioned on the hot side of the engine **102** are less than two to three feet, including less than one foot. Because the turbocharger **110** includes shorter conduits (e.g., first, second, third, and fourth conduits **166**, **168**, **172**, **174**), and because the turbocharger **110** is arranged to include a compact profile (e.g., the alignment of the compressor inlet and outlet **156**, **158**), the turbocharger **110** is able to limit thermal transfer and therefore increase the thermal efficiency of the turbocharger **110** and the powertrain assembly **100**, generally.

Referring again to FIGS. **8-10**, the turbocharger **110** is packaged within the vehicle **10** in order to optimize the ability of the powertrain assembly **100** to deliver power to the ground-engaging members **12**, **14**. As illustrated in FIG. **9**, the turbocharger **110** is positioned longitudinally rearward of the engine **102**, vertically below the cargo area **46**, longitudinally forward of the muffler **138**, vertically above at least a portion of the transmission **124**, laterally adjacent to the CVT **106** (see FIG. **11**), and laterally between rear frame members **19**. The turbocharger **110** is positioned below and spaced from the cargo area **46** such that it is not contacting or directly adjacent to the cargo area **46** to limit heat transfer to the cargo area **46** (e.g., when a utility bed includes a plastic body) and outside of an envelope formed by the CVT **106**. The turbocharger **110** is protected between the rear frame members **19** and is also positioned spaced from the rear ground-engaging members **14** and an envelope defined by the rear ground-engaging members **14**. As illustrated, the exhaust conduit **136** is coupled to the turbine outlet **148** and extends to the muffler **138**. In some embodiments, the exhaust conduit **136** is routed to the muffler **138** such that at least a portion of the exhaust conduit **136** extends beyond (e.g., outboard of) one of the rear frame members **19**. Thus, the turbocharger **110** is positioned within a frame envelope defined by the rear frame members **19** envelope and the exhaust conduit **136** extends at least partially outside of the frame envelope. In some embodiments, the turbocharger **110** is within 4 feet (e.g., within 2 feet) of the rear suspension **42**. The turbocharger **110** may be packaged inboard of the rear suspension **42**, the positioning being operable to mitigate heat transfer to the components of the rear frame members **19** and the rear suspension **42**.

Referring now to FIGS. **17-29**, the powertrain assembly **100** also includes an oil management system **180**. The oil management system **180** includes an oil pan **182** coupled to the engine **102** (FIGS. **17-20**), an oil pump **184** (FIG. **20**), at least one oil pickup member **186** (FIG. **20**), and a deaerator **188** (FIG. **20**). The oil pan **182** defines at least one reservoir into which oil is drained. Oil that is in the reservoir is pumped from the reservoir, through the oil pickup member **186** via the oil pump **184**, and into the engine **102** (e.g., a wet sump). The reservoir is also operable to receive oil drained from the turbocharger **110**. For example, the turbocharger **110** may include a drain **111** that is coupled to an oil drain line **190** that coupled to an oil drain line connector **192** on the oil pan **182** (FIG. **20**). The drain line connector **192** includes a channel **194** through which oil drains from the turbocharger **110** into the reservoir of the oil management system **180**.

The oil pan **182** with the turbo drain line connector **192** allows the turbocharger **110** to continue to operate in conditions of high vehicle angularity. For example, the turbocharger **110** will continue to drain in conditions of 50 degree and greater angularity of the vehicle **10**, which can be caused in certain operating conditions of the vehicle **10** including climbing, rock crawling, accelerations, and so forth. The turbocharger **110** will continue to drain into the oil pan **182** in the high angularity conditions because a low pressure zone is formed where the oil from the turbocharger **110** is drained in the oil management system **180**. In some embodiments, the oil pan **182** includes a deep profile that is facilitated, in part, by the raising of the engine **102** from the frame **16**, which is discussed more fully in U.S. patent application Ser. No. 16/875,494, which is incorporated by reference herein. By having a deeper profile, the oil pan **182** and reservoir are able to hold oil even when the vehicle **10** is in high angularity and/or high acceleration situations (e.g., longitudinal, lateral, and compound angularity). The angle of the drain lines (i.e., the drain line connector **192** and channel for the turbocharger **110**) may be angled relative to a vertical axis such that even at high angularity or acceleration, oil does not travel backward through the oil management system **180**.

Referring to FIG. **21**, the oil management system **180** including the oil pan **182** includes a pan bottom **200** and outer side walls **202**. The oil pan **182** defines a staging reservoir **204** and a delivery reservoir **206** and are separated from each other by a wall **208**. The oil pan **182** is formed such that oil from the engine **102** drains into and pools in the staging and delivery reservoirs **204**, **206**. In some embodiments, the oil pan **182** is formed to direct oil substantially to the staging reservoir **204** by including an interior side wall **210** that extends substantially around the delivery reservoir **206**. The pan bottom **200** and the interior side wall **210** are formed to facilitate oil draining and pooling to the staging reservoir **204**. The interior side walls **210** may include gaps **212** that allow the oil to drain or enter into the delivery reservoir **206**, however, the majority of the oil draining into the oil pan **182** from the engine **102** will be directed to the staging reservoir **204** when the engine **102** is in a neutral orientation (i.e., not on an incline, etc.). Referring to FIG. **20**, the delivery reservoir **206** is covered with a covering member **214** which allows the delivery reservoir **206** to retain oil supply to the engine **102** during certain angularity operations. The covering member **214** couples to the interior side wall **210** to form the partially pressurized chamber. It is noted that the gaps **212** in the interior side walls **210** are not sealed by the covering member **214**, thus allowing oil to enter or exit the delivery reservoir **206** through the gaps **212**. In some embodiments, the gaps **212** are positioned on one side of the interior side walls **210** which facilitates the delivery reservoir **206** to retain oil supply to the engine **102** during certain angularity operations (e.g., when the vehicle **10** is angled in such a way that the gaps **212** are vertically higher than other portions of the interior side walls **210**).

Referring to FIG. **20**, the oil management system **180** includes a first pickup member **186** that is positioned with the staging reservoir **204** and a second pickup member **187** positioned with the delivery reservoir **206** (see FIG. **25**). The first and second pickup members **186**, **187** are operable to uptake oil that is positioned in the respective reservoirs **204**, **206**. Each of the oil pickup members **186**, **187** may include a first opening **216** and a second opening **218** and a main lumen **220** defined within the oil pickup members **186**, **187** (see FIG. **26**). Oil is picked up by the oil pickup members **186**, **187** at the first opening **216** by creating a lower pressure zone in the lumen of the oil pickup members **186**, **187** (e.g., via the oil pump **184** which is in fluid communication with the oil pickup members **186**, **187** by way of the second opening **218**). The oil picked up by the first pickup member **186** is ejected from the oil pump **184** into the deaerator **188** which includes a spiral profile. The deaerator **188** removes air that may have been introduced into the oil collected in the staging reservoir **204** when taken up by the first oil pickup member **186**. This may also occur when the first opening **216** of the oil pickup member **186** is not submerged in oil (e.g., when the vehicle **10** is in configurations of high angularity such as when climbing, etc.) (see FIG. **27**). The deaerator **188** receives oil from the oil pump **184** and the oil travels through the deaerator **188** around a spiral portion **189** which forces air from the oil, and the deaerated oil is dumped into the delivery reservoir **206**. Oil can then be picked up by the second pickup member **187** and cycled back through the appropriate mechanical systems of the powertrain assembly **100** (e.g., the engine **102** and turbocharger **110**).

Referring to FIGS. **27** and **28**, the oil management system **180** is shown in positions of high angularity. FIG. **27** depicts the oil management system **180** in a position such that the delivery reservoir **206** is in a vertically lower position than the staging reservoir **204**. When this occurs, the first opening **216** of the first oil pickup member **186** may not be submerged in oil and thus may pick up both oil and air from the staging reservoir **204**. Oil from the staging reservoir **204** is transferred to the delivery reservoir **206** via the deaerator **188**. Oil is picked up from the delivery reservoir **206** via the second pickup member **187** and delivered to the engine **102**. When the vehicle **10** is in a position that places the oil management system **180** in the configuration shown in FIG. **28**, the first opening **216** of the first oil pickup member **186** is submerged in oil and picks up oil from the staging reservoir **204** and transfers it to the delivery reservoir **206**. The first opening **216** of the second pickup member **187** remains submerged in oil because the oil being transferred from the staging reservoir **204** to the delivery reservoir **206**.

Referring again to FIGS. **23** and **24**, the oil pickup members **186**, **187** may include an auxiliary arm **222**. The auxiliary arm **222** includes an auxiliary lumen **224** and an auxiliary opening **226**. The auxiliary lumen **224** is in fluid communication with the main lumen **220**. Oil drained from the turbocharger **110** is operable to be drained to a position proximate the auxiliary opening **226** of the oil pickup members **186**, **187** such that the oil is picked up at the auxiliary opening **226** and travels through the auxiliary lumen **224** into the main lumen **220**. This allows oil to be drained directly from the turbocharger **110** and picked up without pooling in the reservoirs **204**, **206**. The low pressure zone formed at the auxiliary opening **226** of the oil pickup members **186**, **187** pulls the oil through and reduces clogging or backup of oil in the oil drain line **190** and channel **194** of the drain line connector **192**. For example, in one embodiment, the channel **194** of the drain line connector **192** can extend through the oil pan **182** (or in other embodiments through another conduit separate from the oil pan **182**) to a position proximate the auxiliary opening **226** of the oil pickup members **186**, **187**. In another embodiment the channel **194** of the drain line connector **192** may drain into one of the reservoirs **204**, **206**. These embodiments are discussed in more detail herein.

Referring to the embodiment in which the channel **194** of the drain line connector **192** extend through the oil pan **182**, the channel **194** is integrally formed in the oil pan **182**. For example, FIGS. **23-25** depict the channel **194** extending through the pan bottom **200**. An orifice **228** is provided proximate the channel **194**. Oil in the channel **194** can exit the channel **194** at the orifice **228**. The auxiliary opening **226** of one of the oil pickup members **186**, **187** is positioned at or proximate the orifice **228** such that oil is taken up directly into the oil pickup member. The orifice **228** may be sized to include various diameters, which can result in various velocity of oil being pulled through the orifice **228** and various volumes per unit time being pulled through the orifice **228**. In the embodiment depicted, the channel **194** is a pressurized system which allows oil to be pulled through the channel **194** and limits oil from backing up in the oil drain line **190**. This is important when the vehicle **10** is in positions of high angularity where a gravity turbo drain system would be backed up and oil would not be able to drain from the turbocharger **110**. It is understood that the channel **194** may be formed to fluidly connect with the auxiliary opening **226** of either the first oil pickup member **186** (see FIG. **29**) or the second oil pickup member **187** (see FIG. **24**).

Referring to FIG. **26**, a drain channel **229** may be formed through the wall **208** which connects the staging reservoir **204** and the delivery reservoir **206**, the drain channel **229** also extending down through the pan bottom **200**. This allows for a single access point when changing the oil of the powertrain assembly **100**. As is further depicted in FIG. **26**, the channel **194** for the turbo drain line connector **192** extends through the wall **208**.

Referring to embodiments in which the channel **194** drains directly into one of the reservoirs **204**, **206**, in order to reduce clogging or backup of oil in the oil drain line **190** and channel **194** of the drain line connector **192**, the oil pickup member **186** is positioned proximate the opening to the channel **194** at the staging reservoir **204** of the oil pan **182** (see FIGS. **30-31**). The oil pickup member **186** is in fluid communication with the oil pump **184**. Because the opening of the pickup member **186** which receives oil from the staging reservoir **204** is positioned proximate the opening to the channel **194** of the drain line connector **192**, a low pressure zone is created in the reservoir **204** which causes oil to be pulled from the channel **194** and into the reservoir **204**, from the staging reservoir **204** into the oil pickup member **186**, and up into the oil pump **184**. This keeps the opening of the channel **194** clear (or maintains movement of oil through the channel **194**) and reduces the occurrence of oil backups or clogs from oil draining from the turbocharger **110**.

Once the oil from the staging reservoir **204** is picked up, the oil can be recirculated into the engine **102** (e.g., via the deaerator **188**). The oil pickup member **186** can be integral with the oil pan **182** or can be a separate member that is coupled to the oil pan **182**. For example, is some embodiments, the oil pickup members **186**, **187** are formed from a stable polymer that is coupled to the oil pan **182** (e.g., via bolts).

Referring now to FIGS. **32-33**, a water injection system **250** is provided with the powertrain assembly **100**. More specifically, the water injection system **250** is operable to cool the air intake tract, e.g., the air intake inlet **162**. The water injection system **250** includes an injector **252**, a water reservoir **254**, a pump **256**, and a controller **258**. The water injection system **250** cools the air intake **162** fluidically prior to a throttle blade **260** of the throttle body **130** (see FIG. **11**). In some embodiments, the water injection system **250** interfaces with the air intake **162** (e.g., the injection **252** is positioned with the air intake **162**) at a distance of about 5 inches or less from the throttle blade **252** (e.g., 3-4 inches pre-throttle blade). The injector **252** is mounted to the air intake **162** at about a 90 degree angle such that that injector **252** is substantially perpendicular to the flow of air through the air intake **162**. The injector **252** is optimized to atomize the water to provide increased surface area for cooling the air intake **162**.

By cooling the air prior to the throttle blade **260**, only one interface with the air intake inlet **162** is required as the cooled air is distributed to each of the cylinders while allowing the throttle blade **260** to remain close to the cylinders to provide a responsive engagement. The lower intake air temperatures increase the octane rating of the fuel and help sustain the target horsepower. The water injection system **250** is operable to remove heat from the air to provide about a 10-15 degree Celsius temperature drop. The water injection system **250** may be mounted on the frame **16** of the vehicle **10** (e.g., an off road vehicle). The water injection system **250** is positioned on the CVT-side of the powertrain assembly **100**.

The water cooling system **250** may be activated in various conditions. For example, the controller **258** may activate based on sensed conditions such as certain operating temperature, increased power demands, and so forth. For example, when the vehicle **10** is being operated in wide open throttle, a predetermined boost threshold is met, the water cooling system **250** is activated and water is pumped through to the injector **252** intake and the water contacting the air intake **162** is operable to remove heat from the air (10-15° C. of temperature drop) flowing into the engine **102**. The water is operable to add a high octane level and changes the knock propensity. That decreases the occurrence of the engine **102** de-rating and allows the engine **102** to continue to make power. In some embodiment, the water injection system **250** is operable to initialize in de-rate conditions. This allows the powertrain assembly **100** to maintain higher levels of performance in high temperature internal engine conditions.

In some embodiments, the water injection system **250** and the CVT **104** may be at least partially integrated. For example, controller **258** may be operable to control the operation of the water injection system **250** and operation of the CVT **104**. Furthermore, the CVT and the water injection system **250** may be fluidically coupled to the water reservoir **254** (e.g., a common reservoir).

While this invention has been described as having an exemplary design, the present invention may be further modified within the spirit and scope of this disclosure. This application is therefore intended to cover any variations, uses, or adaptations of the invention using its general principles. Further, this application is intended to cover such departures from the present disclosure as come within known or customary practice in the art to which this invention pertains.

What is claimed is:

1. A utility vehicle, comprising:

a forward portion of the vehicle, a rearward portion of the vehicle, and a longitudinal direction of the vehicle extending between the forward portion and the rearward portion;

a plurality of ground-engaging members;

a frame supported by the ground-engaging members, the frame including a cab frame;

an operator area and a cargo area supported by the frame, wherein the cargo area is rearward of the operator area in the longitudinal direction of the vehicle and vertically lower than an upper portion of the cab frame, the cargo area including at least a first upstanding wall and a second upstanding wall positioned laterally opposite each other forming a partially enclosed compartment with a floor extending between the first and the second upstanding walls; and

a powertrain assembly supported by the frame and including:

an engine supported by the frame, the engine including an exhaust side, the engine being positioned rearward of the operator area in the longitudinal direction of the vehicle;

a turbocharger operably coupled to the engine, the turbocharger having a turbine housing supporting a turbine and a compressor housing supporting a compressor, the turbocharger being positioned on the exhaust side of the engine and rearward of the engine in the longitudinal direction of the vehicle, a space between the turbocharger and the engine being less than 9 inches;

wherein the powertrain assembly includes a muffler coupled to the engine via an exhaust conduit, the exhaust conduit being less than two feet; and

wherein the exhaust conduit is positioned fluidically between the engine and the muffler, and wherein the frame defines a frame envelope, the turbocharger being positioned within the frame envelope and the exhaust conduit extending at least partially outside of the frame envelope.

2. The utility vehicle of claim **1**, wherein the powertrain assembly further comprises a transmission operably coupled to the engine, wherein the turbocharger is positioned vertically higher than the transmission.

3. The utility vehicle of claim **1**, wherein the powertrain assembly further includes a continuously variable transmission (CVT) operably coupled to the engine, the turbocharger being positioned laterally adjacent in a lateral direction to the CVT.

4. The utility vehicle of claim **3**, wherein the turbocharger is outside an envelope defined by the CVT.

5. The utility vehicle of claim **1**, wherein the powertrain assembly further includes an intercooler, the intercooler being positioned laterally adjacent in a lateral direction to the turbocharger.

6. The utility vehicle of claim **5**, wherein the powertrain assembly further includes an air intake and an air filter fluidically coupled to the engine via the turbocharger, the air filter being positioned on a non-exhaust side of the engine.

7. The utility vehicle of claim **6**, wherein a portion of the intercooler includes an intercooler air intake and an air exhaust, the air exhaust being positioned longitudinally forward of the turbocharger.

8. The utility vehicle of claim **7**, wherein the powertrain assembly further includes an engine intake manifold operably coupled to the engine, and wherein the air exhaust of the intercooler is laterally adjacent in a lateral direction to at least a portion of the engine intake manifold.

9. The utility vehicle of claim **1**, further comprising a steering assembly including a steering wheel, wherein the plurality of ground engaging members includes a plurality of front wheels, and wherein the steering assembly is configured to steer the plurality of front wheels.

10. The utility vehicle of claim **1**, wherein the space between the turbocharger and the engine is greater than one inch.

11. The utility vehicle of claim **1**, wherein an exhaust conduit is greater than one inch.

12. The utility vehicle of claim **1**, further comprising a suspension system including a trailing arm hingedly coupled to the frame.

13. The utility vehicle of claim **12**, wherein rear ground engaging members of the plurality of ground engaging members are coupled to the trailing arm.

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