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Pard et al.

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(54) **GEARBOX FOR A VEHICLE**

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(58) **Field of Classification Search**

None
See application file for complete search history.

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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 180 days.

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Primary Examiner — Howard J Sanders

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Assistant Examiner — Gregory T Prather

(65) **Prior Publication Data**

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

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Related U.S. Application Data

(57) **ABSTRACT**

(60) Provisional application No. 62/868,516, filed on Jun. 28, 2019.

A gearbox for a vehicle includes: a housing; first and second shafts extending parallel to one another; first transmission gears mounted to the first shaft; and second transmission gears mounted to the second shaft. The transmission gears are helical gears. The first transmission gears are in constant mesh with the second transmission gears to form a plurality of gear pairings engageable to operate the gearbox in different gears. A drive gear is mounted to an input shaft extending into the housing. The input shaft is operatively connected to an engine of the vehicle. A driven gear is mounted to the second shaft and is configured to engage the drive gear. The drive and driven gears are spur gears. A flexible driving member is configured to drivingly connect one of the first shaft and the second shaft to an output shaft. A snowmobile including a gearbox is also contemplated.

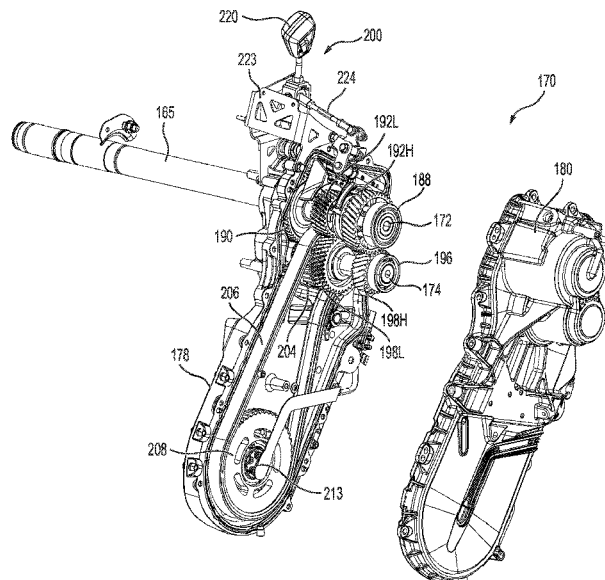
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B62M 11/06	(2006.01)
F16H 57/02	(2012.01)
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F16H 59/04	(2006.01)
B62M 9/04	(2006.01)

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

CPC **F16H 37/021** (2013.01); **B62M 9/04** (2013.01); **B62M 11/06** (2013.01); **B62M 27/02** (2013.01); **F16H 37/065** (2013.01); **F16H 57/02** (2013.01); **F16H 59/04**

20 Claims, 16 Drawing Sheets



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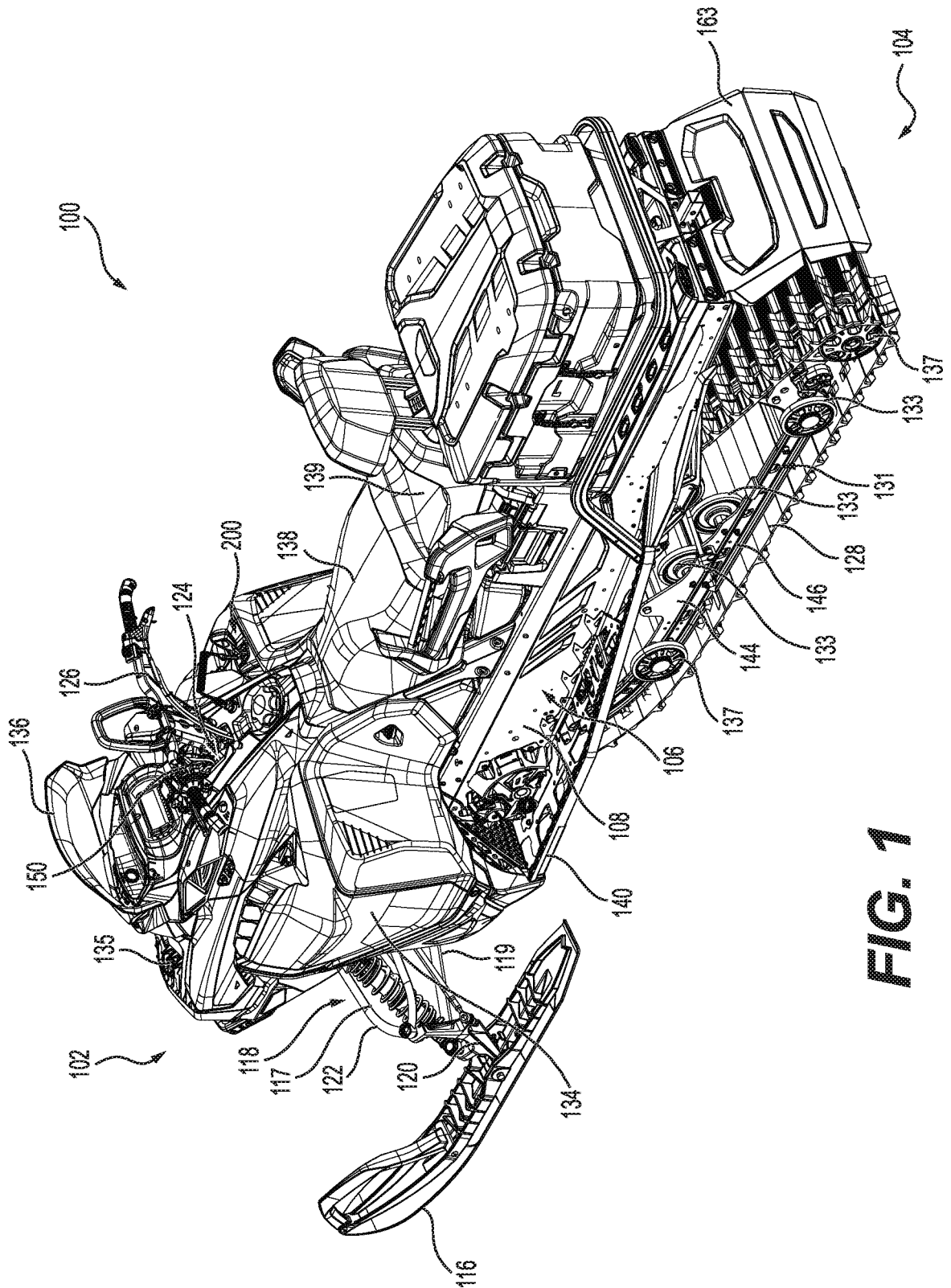


FIG. 1

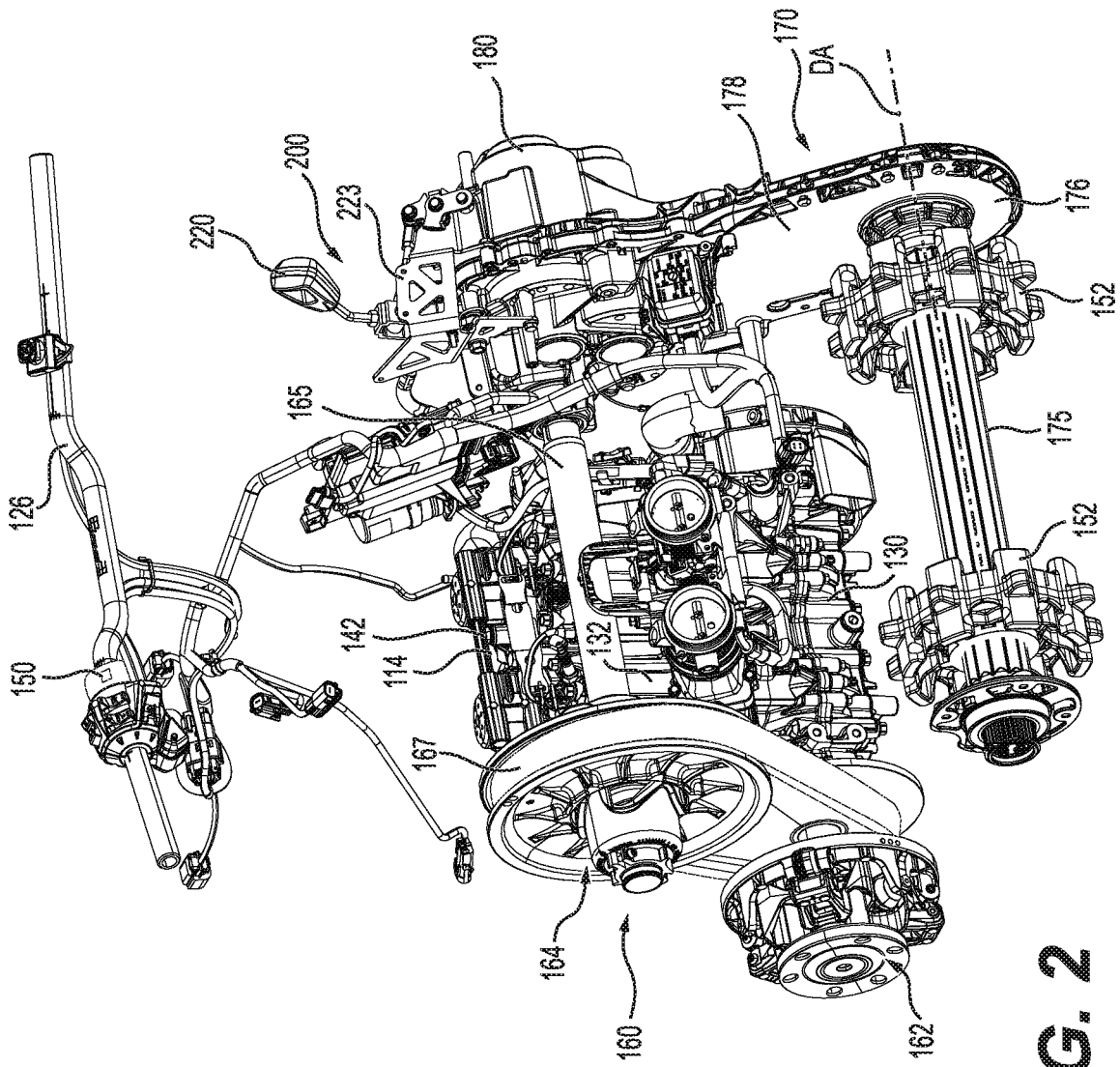


FIG. 2

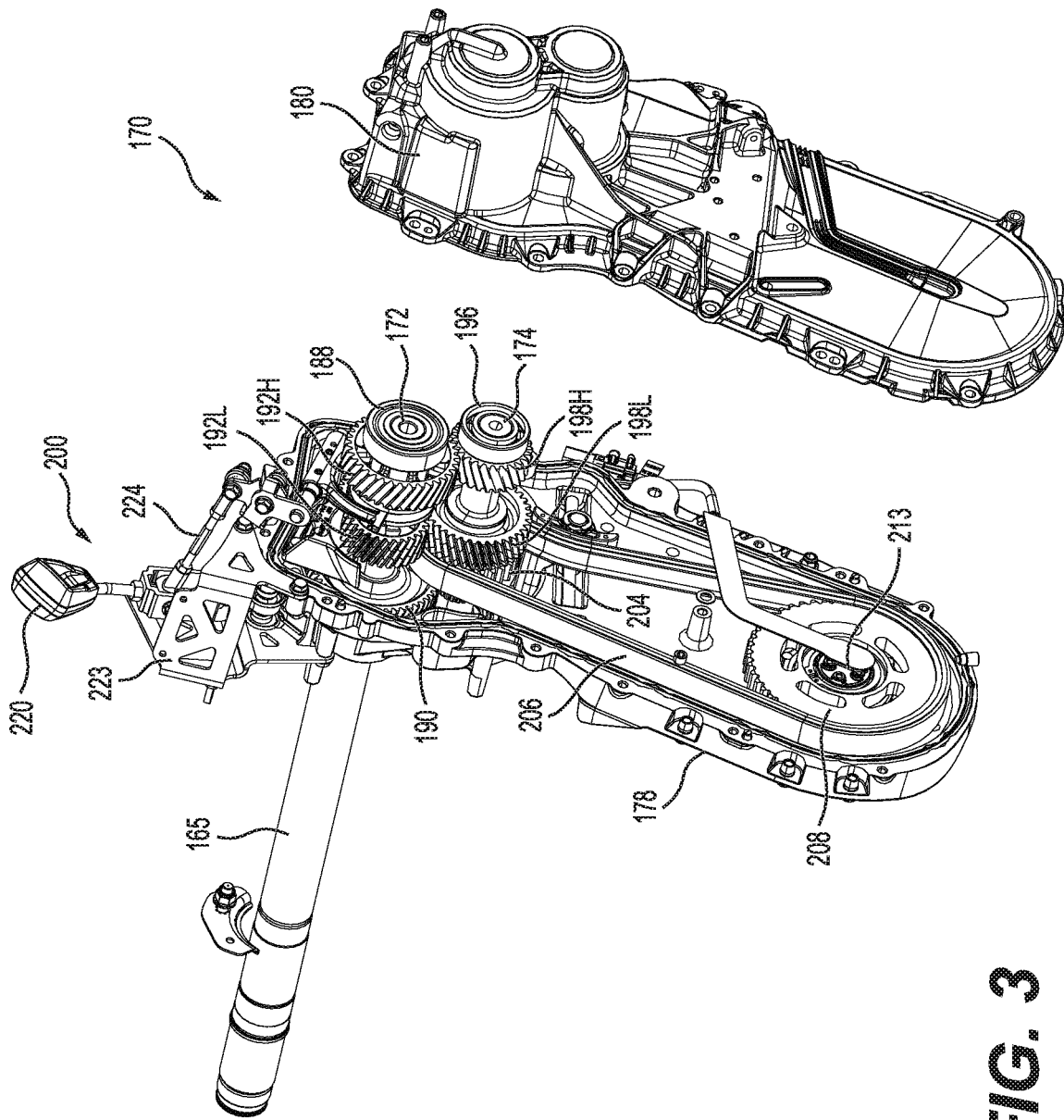


FIG. 3

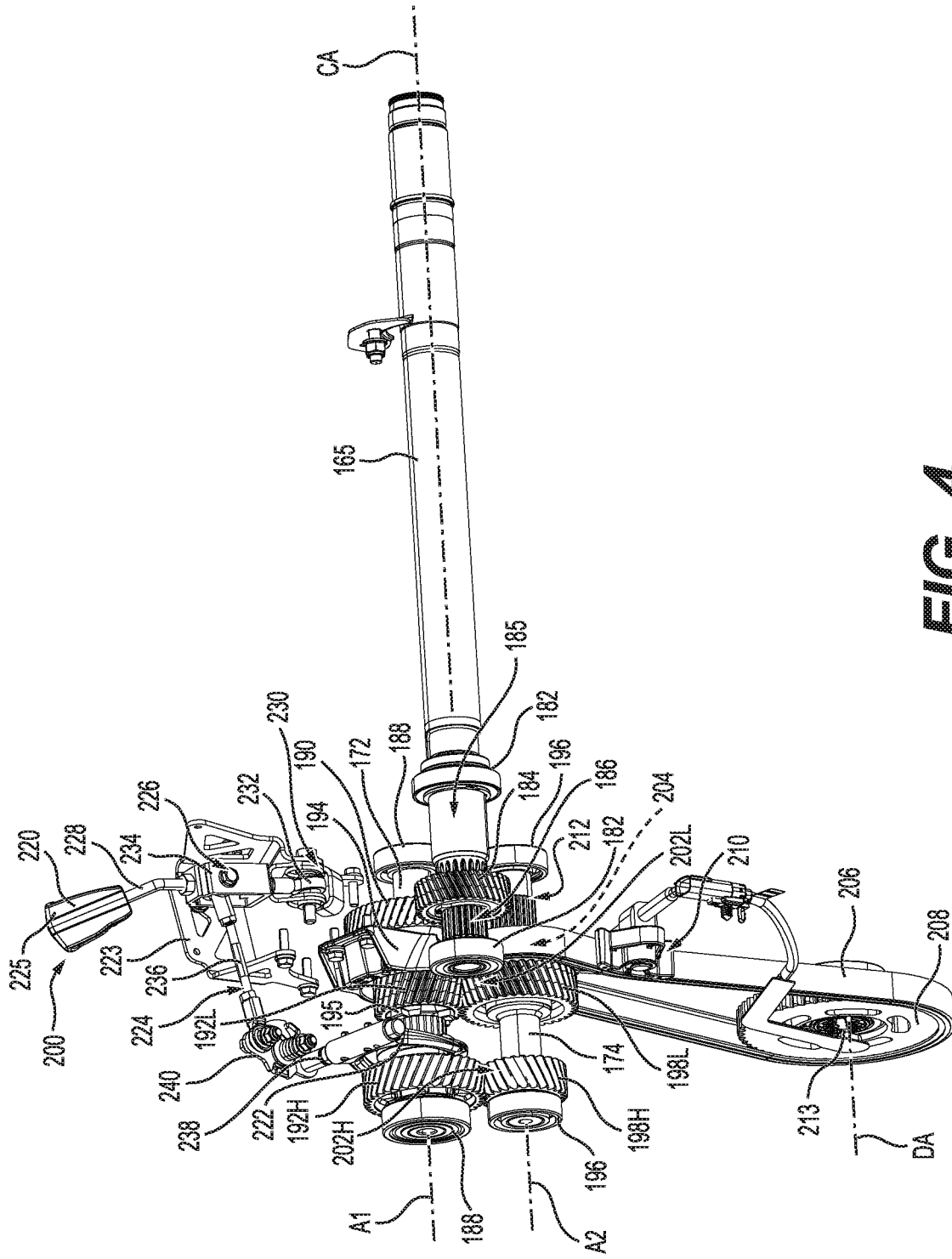


FIG. 4

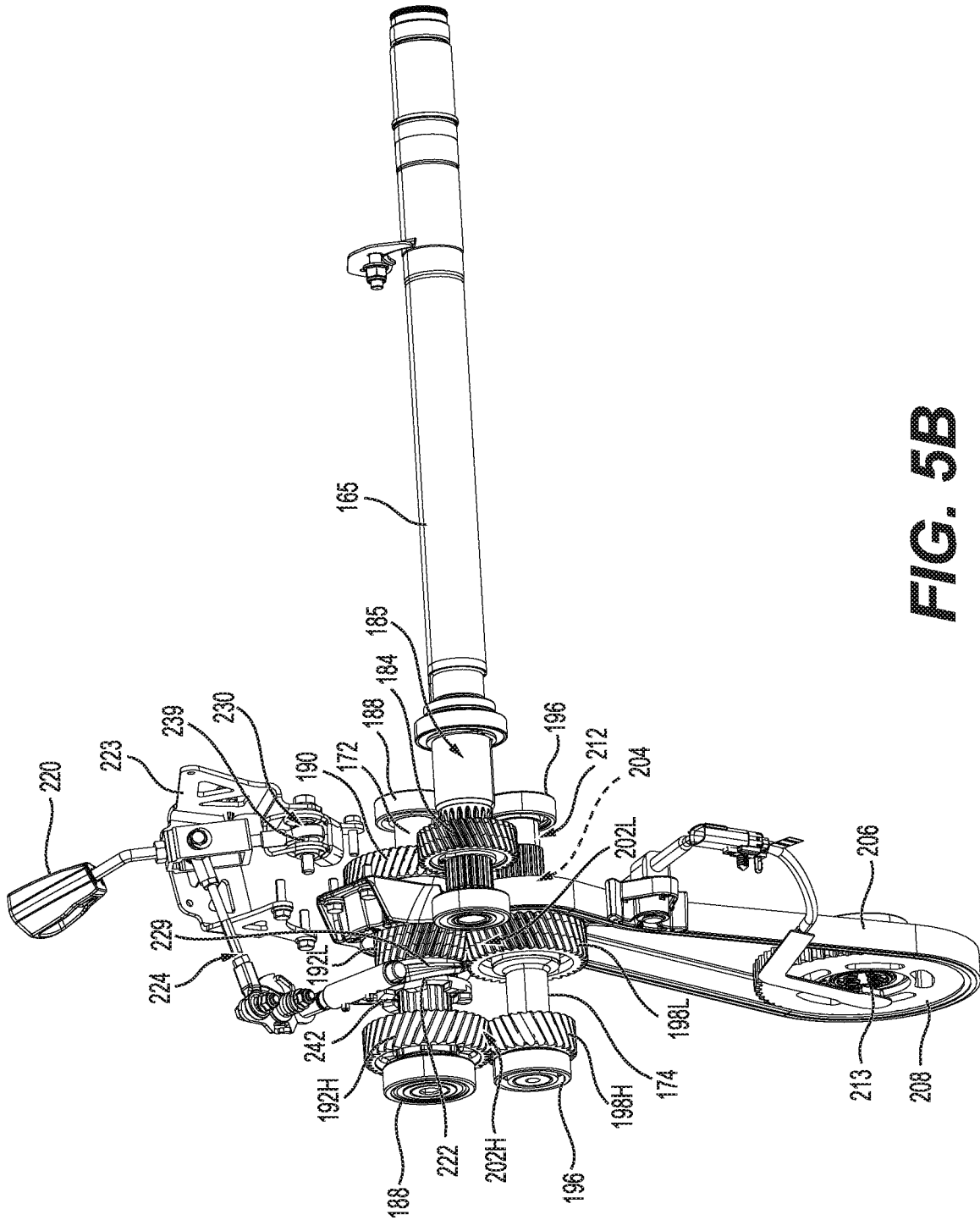


FIG. 5B

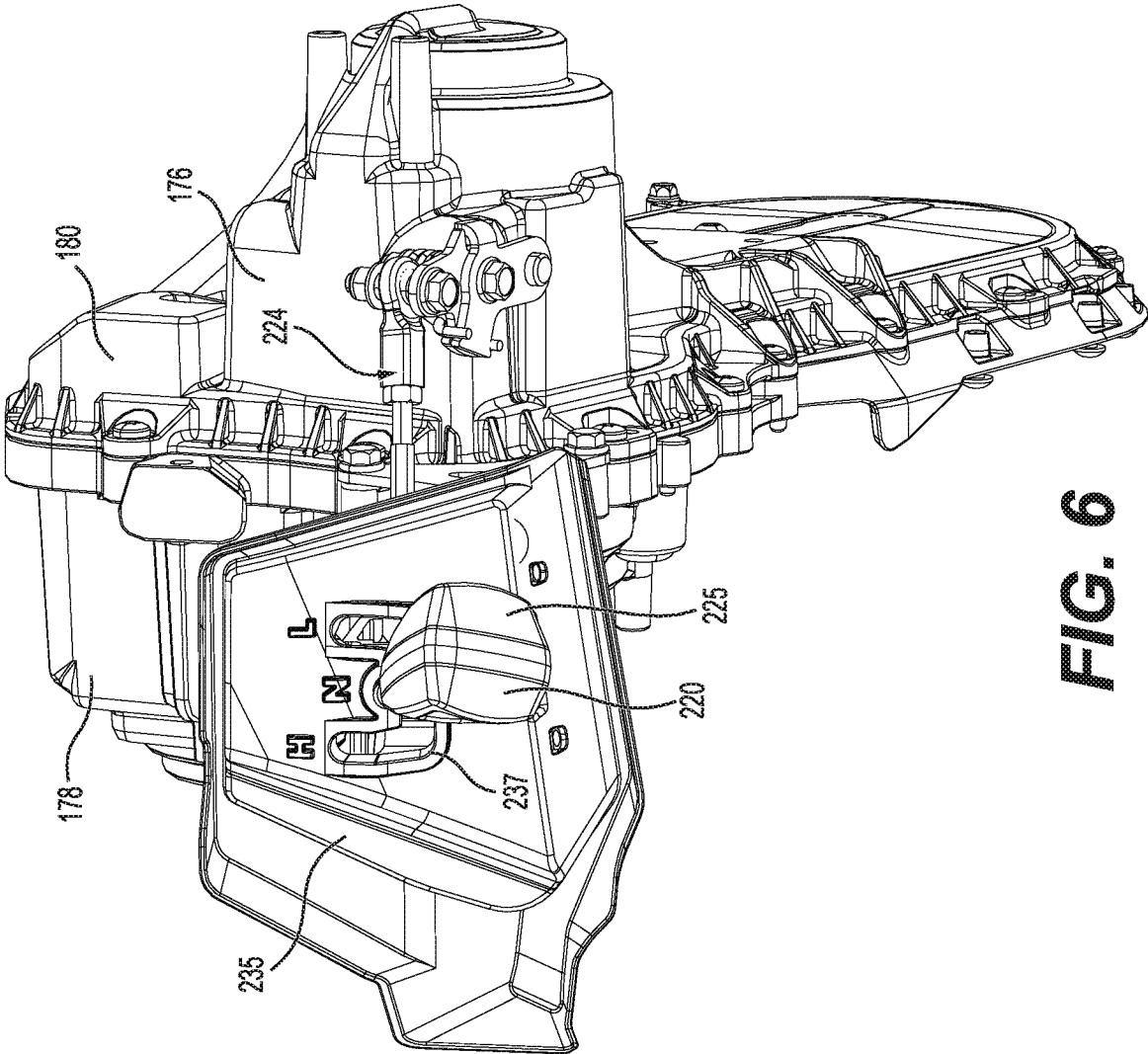


FIG. 6

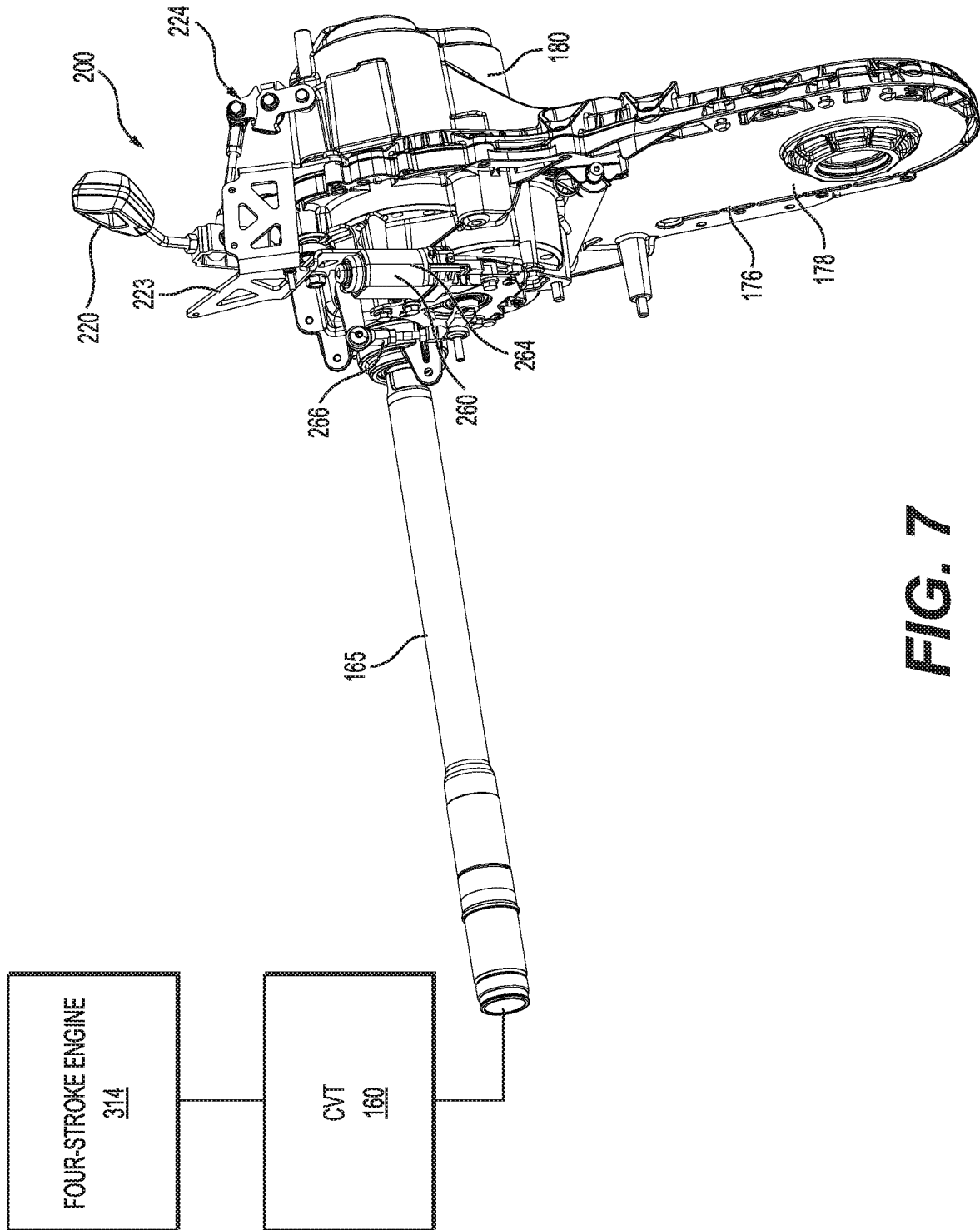


FIG. 7

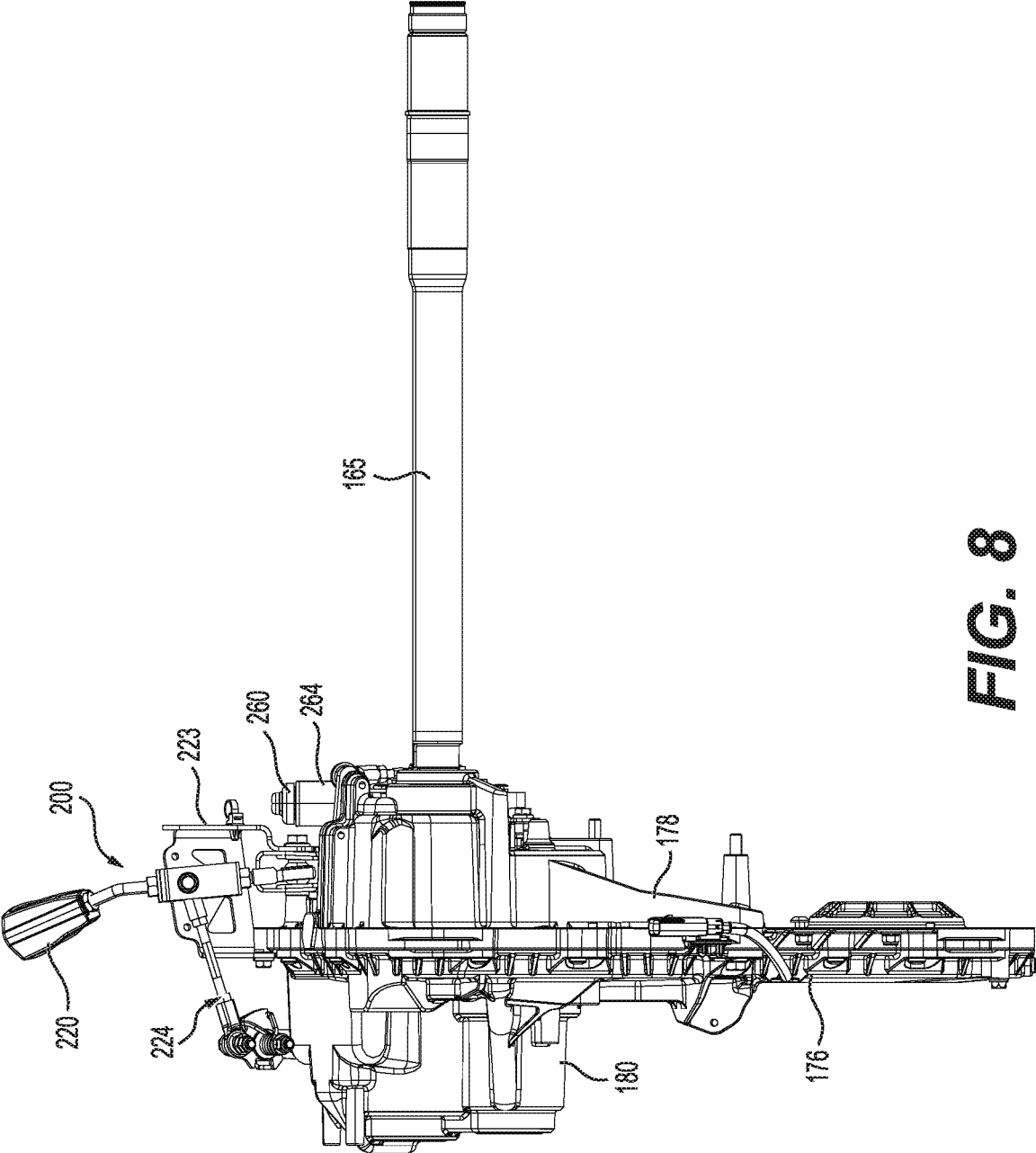


FIG. 8

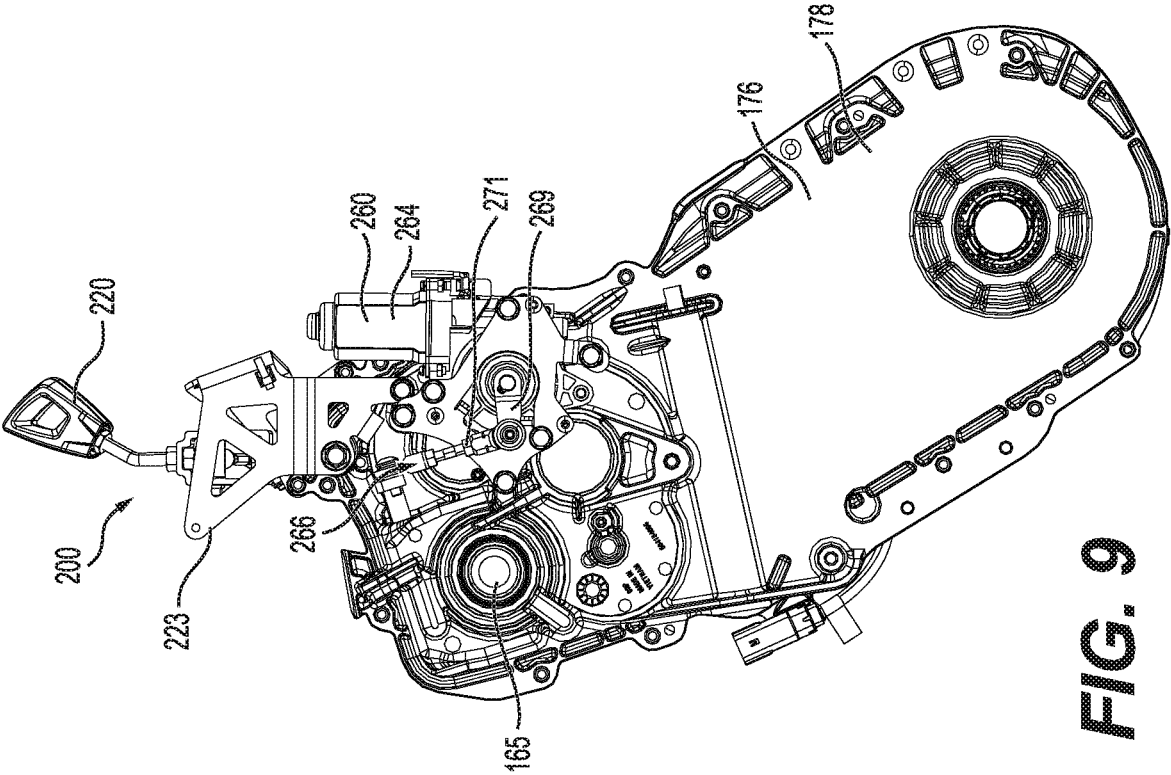


FIG. 9

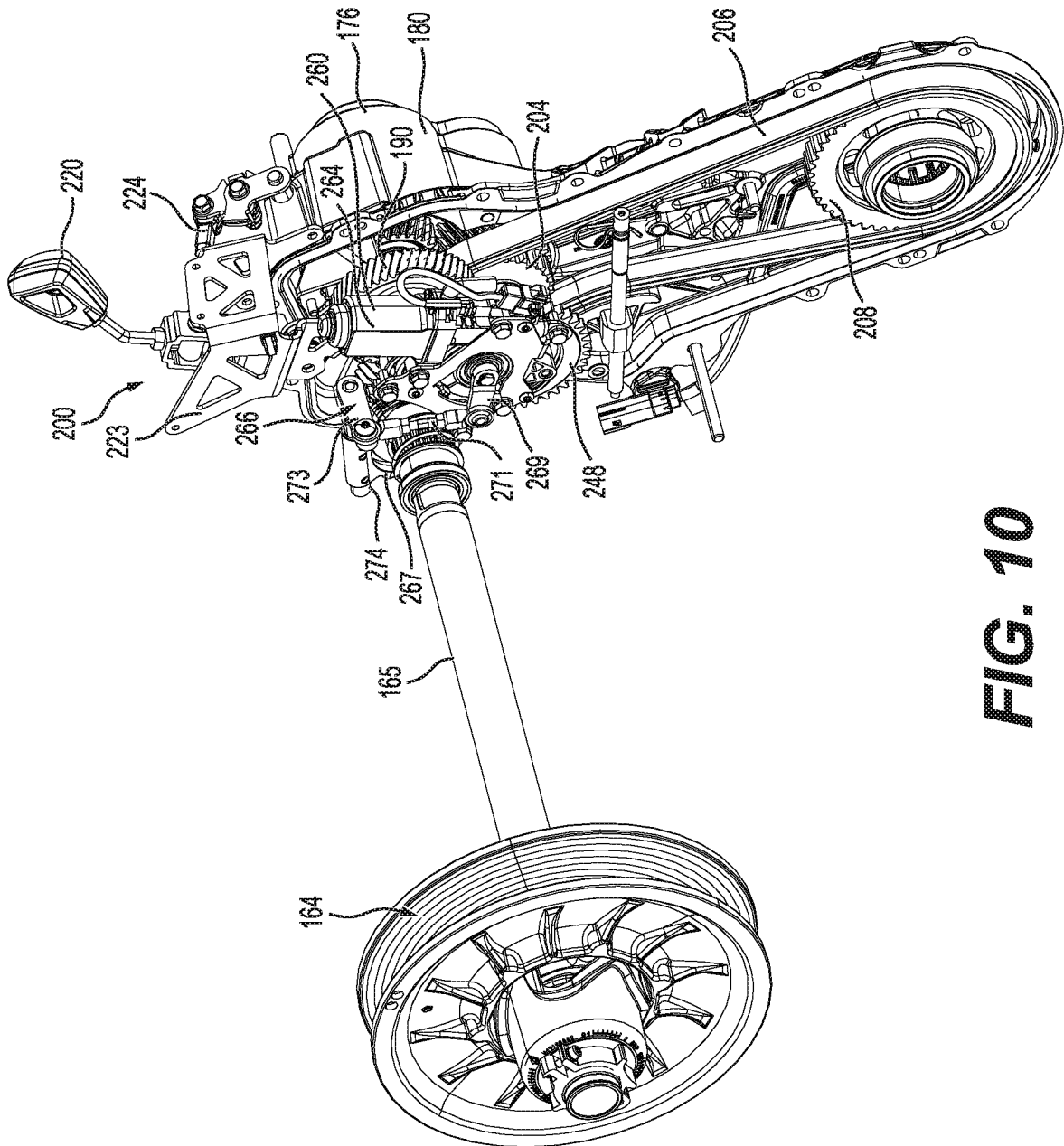


FIG. 10

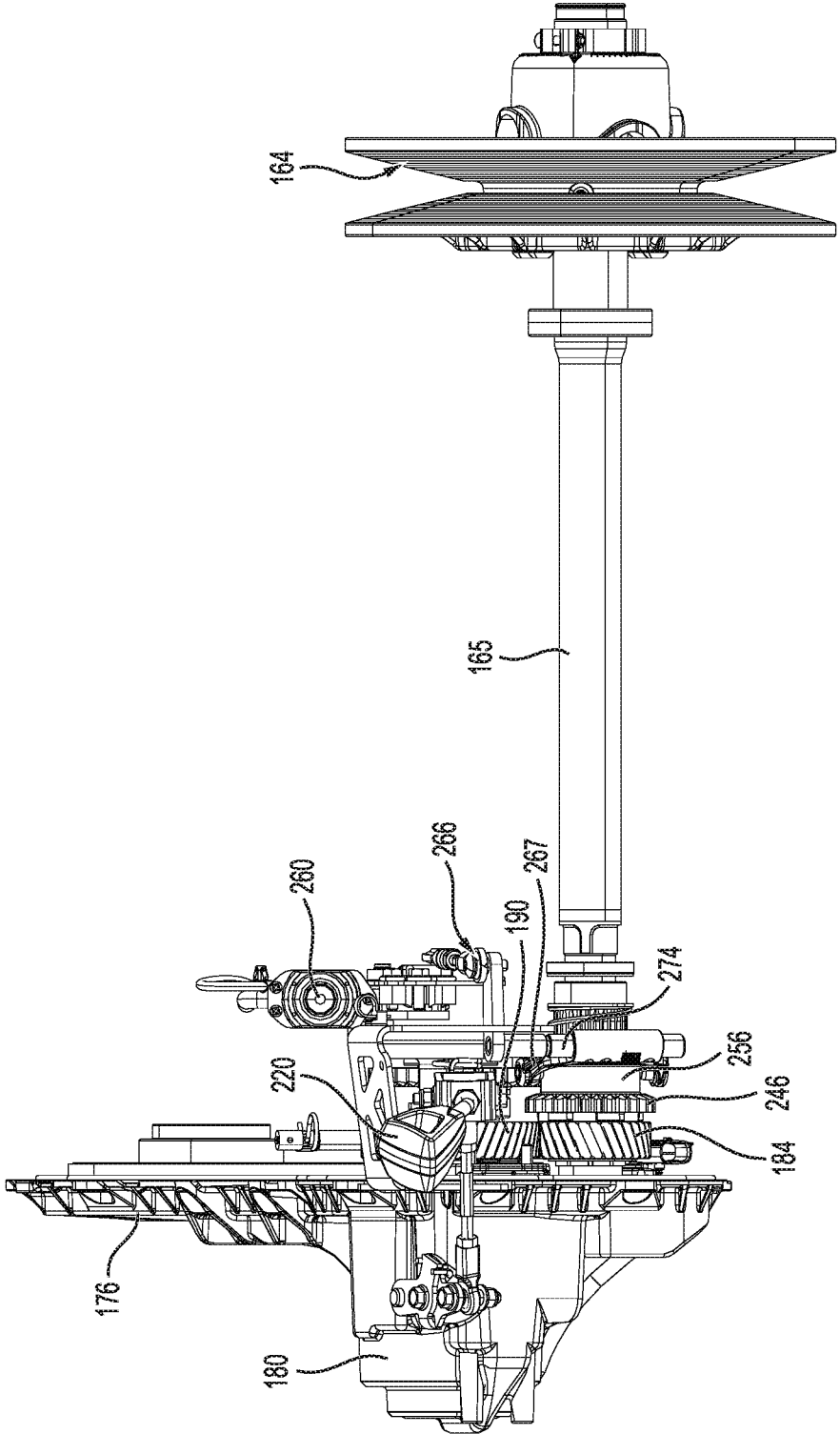


FIG. 11

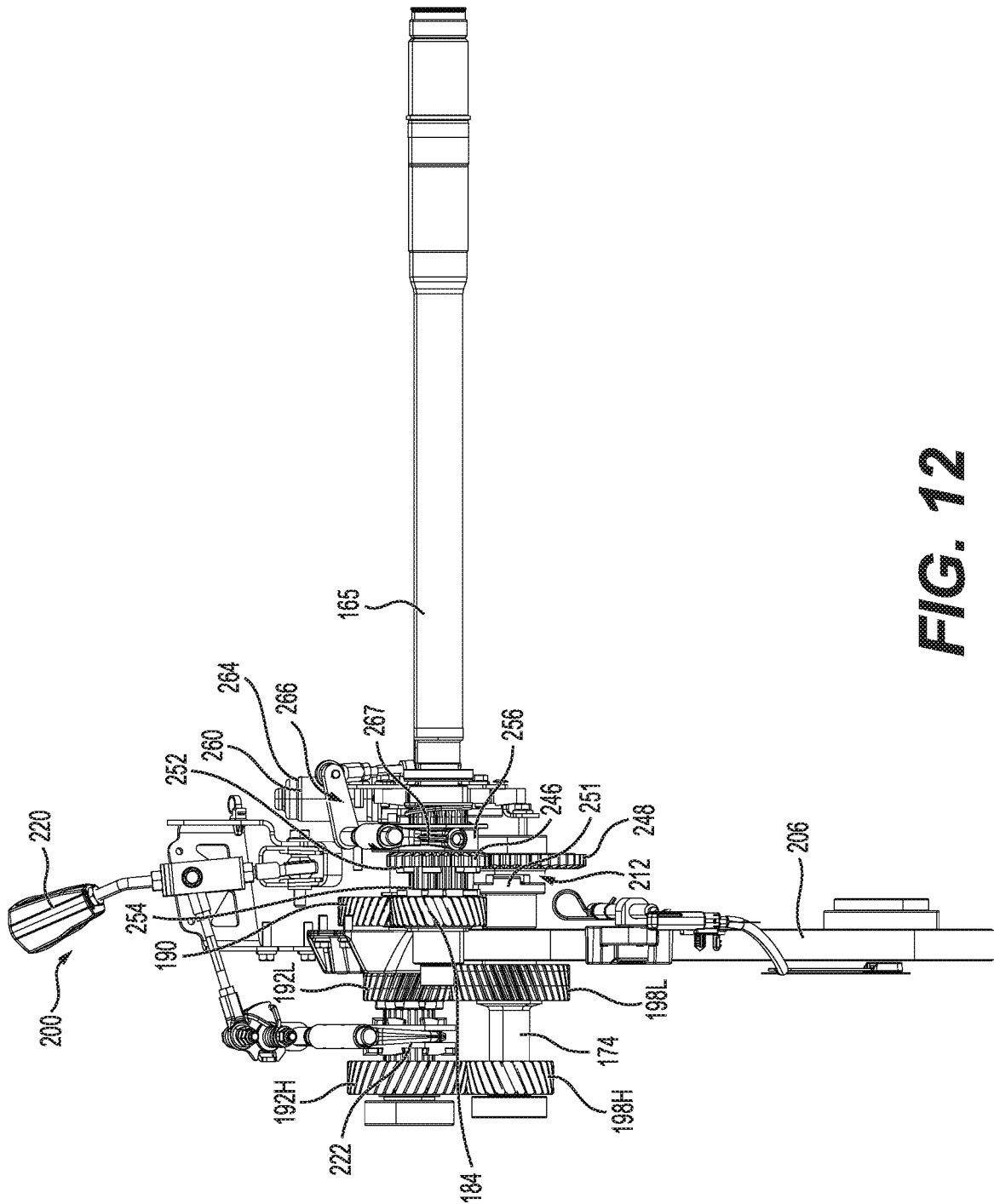


FIG. 12

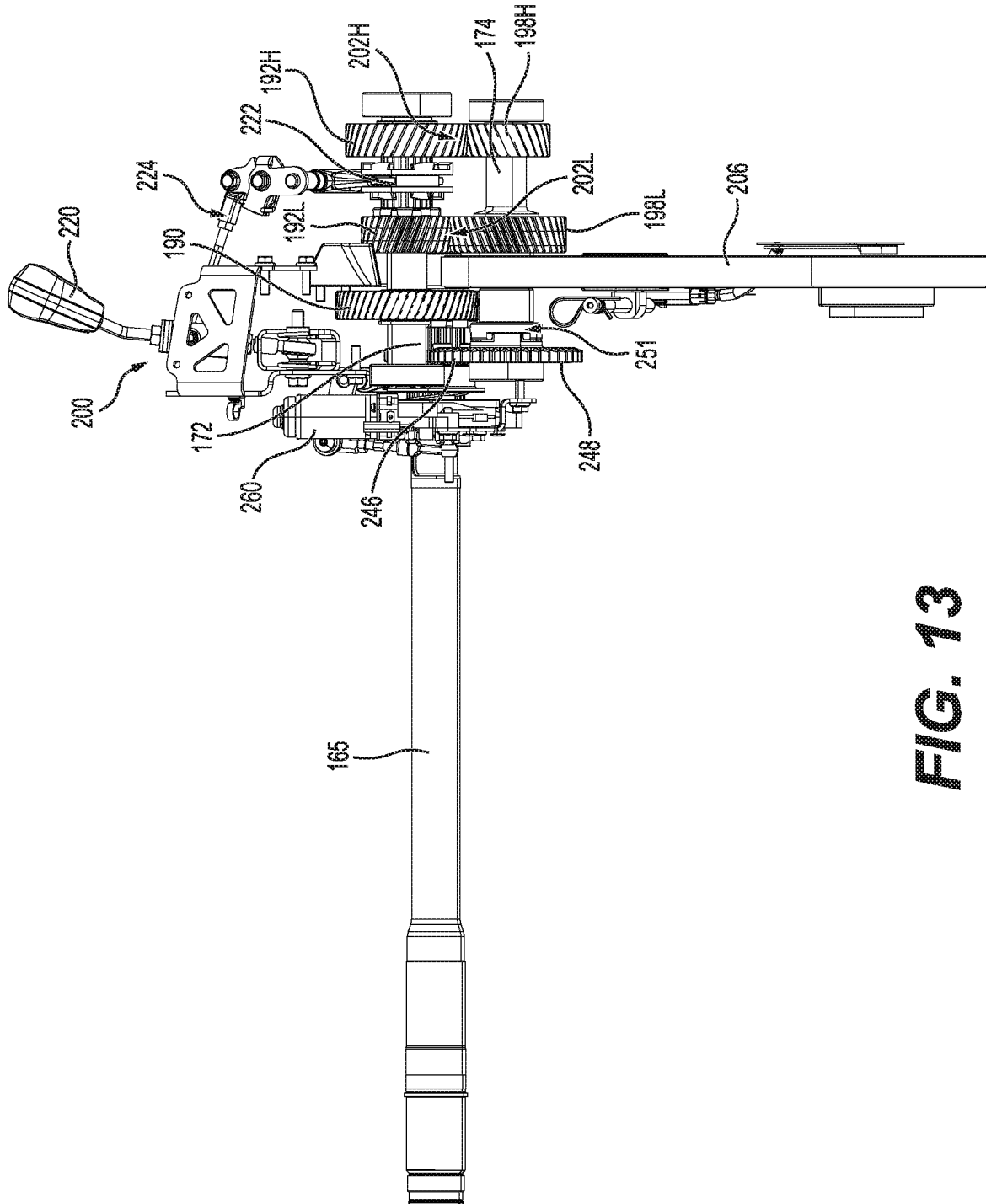


FIG. 13

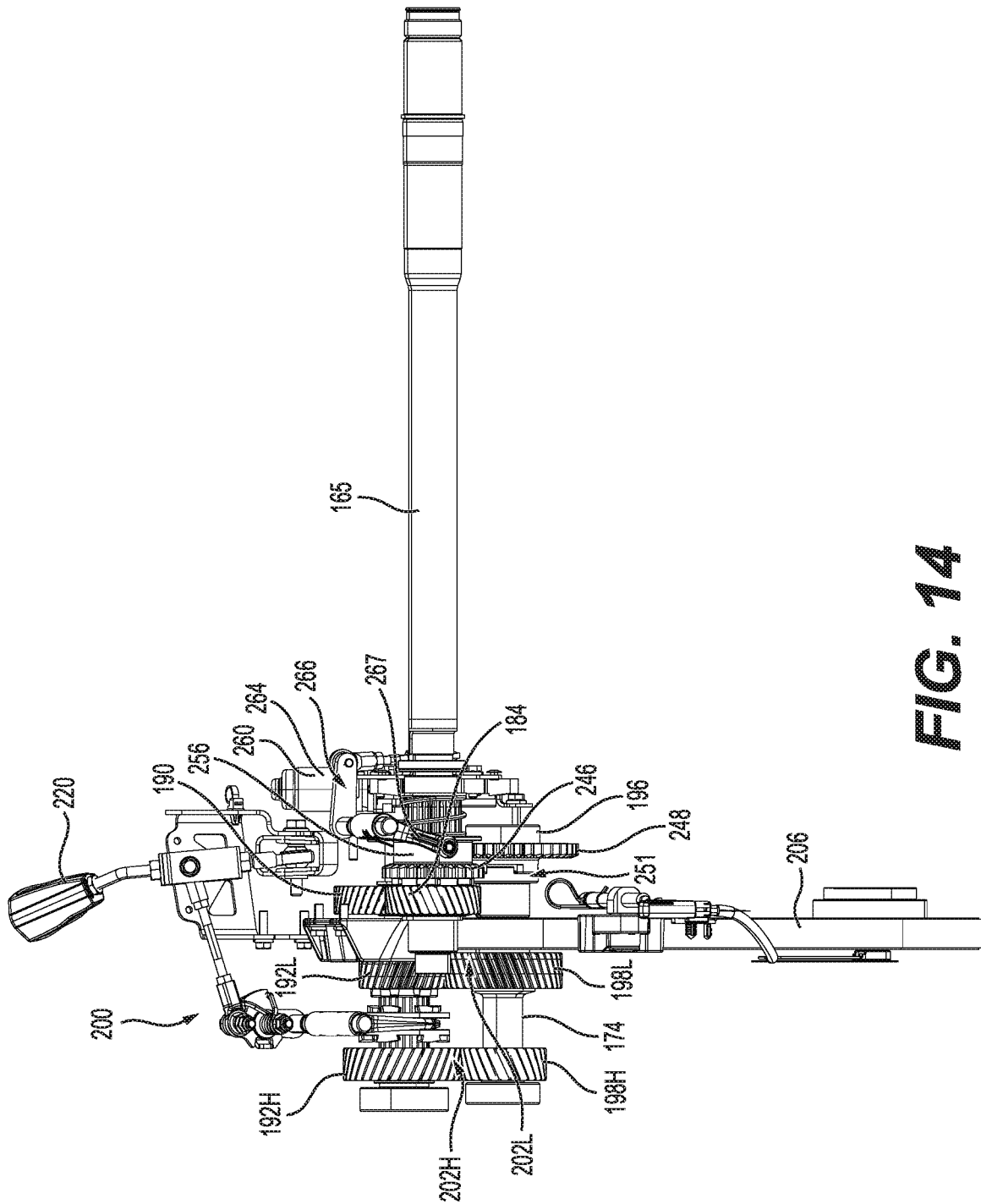


FIG. 14

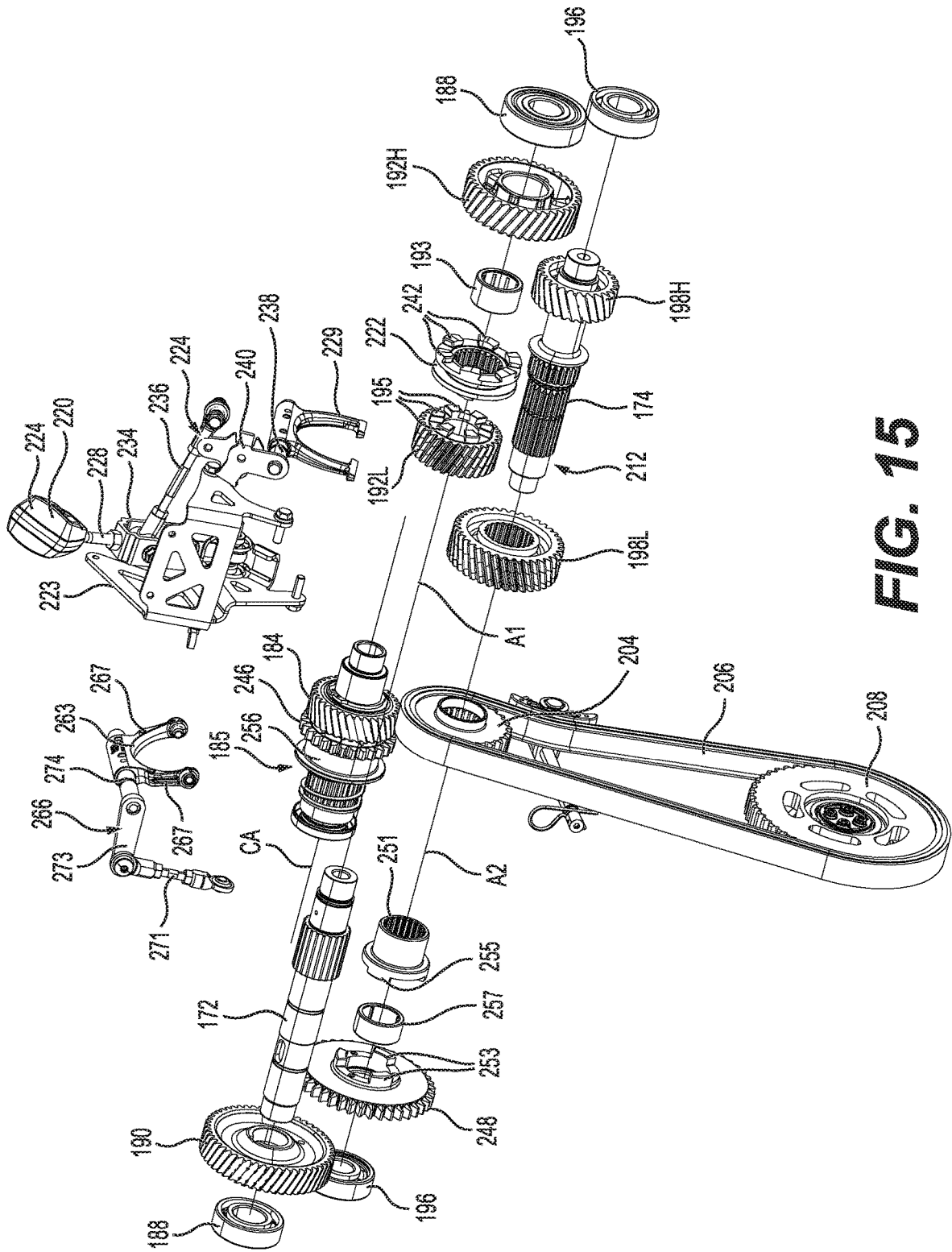


FIG. 15

GEARBOX FOR A VEHICLE

CROSS-REFERENCE

The present application claims priority from U.S. Provisional Patent Application No. 62/868,516, filed on Jun. 28, 2019, the entirety of which is incorporated herein by reference.

TECHNICAL FIELD

The present technology relates to gearboxes for vehicles, and to snowmobile transmissions.

BACKGROUND

A snowmobile's engine is operatively connected to a drive track of the snowmobile to propel the snowmobile. Different transmission components are connected between the engine and the drive track to control a speed and torque applied at the drive track. Namely, a continuous variable transmission (CVT) is typically connected to the engine and provides a variable transmission ratio.

However, while transmission components such as the CVT provide control of the speed and torque at the drive track, a greater degree of control of these parameters may be desired by a user of the snowmobile. Moreover, while some snowmobile engines are provided with a reverse function which allows the engine to operate in reverse, other snowmobiles engines may not be provided with such a reverse function and thus the snowmobile could benefit from other ways of operating in reverse.

Therefore, there is a need for a gearbox and a snowmobile that addresses 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 gearbox for a vehicle. The gearbox includes: a housing; a first shaft rotatably supported by the housing; a second shaft rotatably supported by the housing and extending parallel to the first shaft; a plurality of first transmission gears mounted to the first shaft; and a plurality of second transmission gears mounted to the second shaft. The first and second transmission gears are helical gears. Each of the first transmission gears is in constant mesh with a corresponding one of the second transmission gears to form a plurality of gear pairings engageable to operate the gearbox in different gears. The gearbox also includes: a drive gear configured to be mounted to an input shaft extending into the housing, the input shaft being operatively connected to an engine of the vehicle, the drive gear being a spur gear; a driven gear mounted to the second shaft and configured to engage the drive gear, the driven gear being a spur gear; and a flexible driving member configured to drivingly connect one of the first shaft and the second shaft to an output shaft.

In some embodiments, the drive gear is a reverse drive gear and the driven gear is a reverse driven gear. The gearbox also includes: a forward drive gear configured to be mounted to the input shaft; and a forward driven gear mounted to the first shaft, the forward driven gear engaging the forward drive gear. The gearbox is operable to selectively operate in a forward operation mode and a reverse operation mode. When the gearbox operates in the forward

operation mode, rotary motion is transferred from the input shaft to the first shaft via rotational engagement of the forward drive gear with the forward driven gear; and when the gearbox operates in the reverse operation mode, rotary motion is transferred from the input shaft to the second shaft via rotational engagement of the reverse drive gear with the reverse driven gear.

In some embodiments, the plurality of gear pairings includes a high gear pairing and a low gear pairing.

In some embodiments, the gearbox also includes: a driving sprocket mounted to the second shaft; and an output sprocket configured to be mounted to the output shaft. The flexible driving member drivingly connects the driving sprocket to the output sprocket.

In some embodiments, the flexible driving member is a chain.

In some embodiments, the housing of the gearbox includes a left housing portion and a right housing portion, the left and right housing portions being affixed to one another.

In some embodiments, the first shaft defines a first shaft axis about which the first shaft is rotatable; the second shaft defines a second shaft axis about which the second shaft is rotatable; and the first shaft axis is vertically higher than the second shaft axis.

In some embodiments, the first shaft defines a first shaft axis about which the first shaft is rotatable; the second shaft defines a second shaft axis about which the second shaft is rotatable; the first shaft axis is vertically higher than the second shaft axis; and the output sprocket is rotatable about an output sprocket axis, the second shaft axis being vertically higher than the output sprocket axis.

In some embodiments, the vehicle is a snowmobile including: a frame; at least one ski connected to the frame; a rear suspension assembly connected to the frame; a drive track disposed around the rear suspension assembly; an internal combustion engine supported by the frame, the engine comprising a crankshaft; a continuously variable transmission (CVT) operatively connected to the crankshaft. The CVT includes: a drive pulley operatively connected to the crankshaft; a driven pulley; and a transmission belt interconnecting the drive pulley and the driven pulley. The input shaft is a countershaft of the snowmobile connected to the driven pulley of the CVT. The output shaft is a driveshaft of the snowmobile operatively connected to the drive track to propel the snowmobile.

In some embodiments, the plurality of gear pairings includes a high gear pairing and a low gear pairing. For each of the high and low gear pairings: a given one of the first and second transmission gears is in selective free-spin engagement with a corresponding one of the first shaft and the second shaft to which the given one of the first and second transmission gears is mounted; and an other one of the first and second transmission gears is in fixed engagement with a corresponding one of the first shaft and the second shaft to which the other one of the first and second transmission gears is mounted. The snowmobile further includes a shifter operable by a user for selectively operating the gearbox in one of a high gear, a low gear and a neutral gear. When the gearbox operates in the high gear, the given one of the first and second transmission gears corresponding to the high gear pairing is engaged by the shifter to cause driving engagement of the given one of the first and second transmission gears corresponding to the high gear pairing with the corresponding one of the first shaft and the second shaft. When the gearbox operates in the low gear, the given one of the first and second transmission gears corresponding to the

3

low gear pairing is engaged by the shifter to cause driving engagement of the given one of the first and second transmission gears corresponding to the low gear pairing with the corresponding one of the first shaft and the second shaft. When the gearbox operates in the neutral gear, the first and second transmission gears are disengaged from the shifter so that the given one of the first and second transmission gears of each of the high and low gear pairings remains in free-spin engagement with the corresponding one of the first shaft and the second shaft.

In some embodiments, the snowmobile further includes an actuator for selectively transmitting rotary motion from the countershaft to the gearbox via a selected one of the forward drive gear and the reverse drive gear. When the selected one of the forward drive gear and the reverse drive gear is the forward drive gear: when rotating, the driveshaft rotates in the same direction as the countershaft; and the gearbox is operable in one of the high gear, the low gear and the neutral gear. When the selected one of the forward drive gear and the reverse drive gear is the reverse drive gear: when rotating, the driveshaft rotates in a reverse direction opposite to a direction of rotation of the countershaft.

In some embodiments, the given one of the first and second transmission gears of each of the high and low gear pairings in selective free-spin engagement with the corresponding one of the first shaft and the second shaft is the first transmission gears such that: the first transmission gears are in selective free-spin engagement with the first shaft; and the second transmission gears are in fixed engagement with the second shaft.

In some embodiments, the shifter of the snowmobile includes: a shifter knob movable between a high gear position, a low gear position and a neutral gear position corresponding to the high gear, the low gear and the neutral gear of the gearbox respectively; a dog mounted on the first shaft and slidable along an axis of the first shaft, the dog comprising dog teeth; and a plurality of links interconnecting the dog to the shifter knob. Each of the first transmission gears has dog teeth configured to match the dog teeth of the dog. When the shifter knob is moved to the high gear position, the dog teeth of the first transmission gear corresponding to the high gear pairing engage the dog. When the shifter knob is moved to the low gear position, the dog teeth of the first transmission gear corresponding to the low gear pairing engage the dog. When the shifter knob is moved to the neutral gear position, the first transmission gears are disengaged from the dog.

In some embodiments, the low gear pairing is configured to be disposed laterally between the high gear pairing and the CVT.

In some embodiments, the plurality of gear pairings includes a high gear pairing and a low gear pairing; and the low gear pairing is disposed laterally between the forward drive gear and the high gear pairing.

In some embodiments, the low gear pairing is disposed laterally between the high gear pairing and the driven gear.

In some embodiments, the driven gear is disposed leftwardly of the low gear pairing.

In some embodiments, the plurality of gear pairings includes a high gear pairing and a low gear pairing. The gearbox also includes: a driving sprocket mounted to the second shaft; and an output sprocket configured to be mounted to the output shaft, the flexible driving member drivingly connecting the driving sprocket to the output sprocket. The driving sprocket is configured to be disposed laterally between the low gear pairing and the CVT.

4

In some embodiments, the plurality of gear pairings includes a high gear pairing and a low gear pairing. The gearbox also includes: a driving sprocket mounted to the second shaft; and an output sprocket configured to be mounted to the output shaft, the flexible driving member drivingly connecting the driving sprocket to the output sprocket. The low gear pairing is disposed laterally between the high gear pairing and the driving sprocket.

In some embodiments, the plurality of gear pairings includes a high gear pairing and a low gear pairing. The gearbox also includes: a driving sprocket mounted to the second shaft; and an output sprocket configured to be mounted to the output shaft, the flexible driving member drivingly connecting the driving sprocket to the output sprocket. The driving sprocket is disposed laterally between the forward drive gear and the low gear pairing.

According to another aspect of the present technology, there is provided a snowmobile. The snowmobile includes: a frame; at least one ski connected to the frame; a rear suspension assembly connected to the frame; a drive track disposed around the rear suspension assembly; an internal combustion engine supported by the frame, the engine having a crankshaft; a continuously variable transmission (CVT) operatively connected to the crankshaft. The CVT includes: a drive pulley operatively connected to the crankshaft; a driven pulley; and a transmission belt interconnecting the drive pulley and the driven pulley. The snowmobile also includes a countershaft connected to the driven pulley of the CVT. The snowmobile also includes a plurality of countershaft gears mounted to the countershaft, including: a forward drive gear in selective free-spin engagement with the countershaft; and a reverse drive gear in rotational engagement with the countershaft. The snowmobile also includes a gearbox. The gearbox includes: a first shaft; a second shaft extending parallel to the first shaft; a plurality of gears mounted to the first shaft; and a plurality of gears mounted to the second shaft. The plurality of gears mounted to the first shaft includes: a plurality of first transmission gears; and a forward driven gear engaging the forward drive gear. The plurality of gears mounted to the second shaft includes: a plurality of second transmission gears; and a reverse driven gear configured to selectively engage the reverse drive gear, the reverse driven gear and the reverse drive gear being spur gears. Each of the first transmission gears is in constant mesh with a corresponding one of the second transmission gears to form a plurality of gear pairings including a high gear pairing and a low gear pairing. The first and second transmission gears are helical gears. For each of the high and low gear pairings: a given one of the first and second transmission gears is in selective free-spin engagement with a corresponding one of the first shaft and the second shaft to which the given one of the first and second transmission gears is mounted; and an other one of first and second transmission gears is in fixed engagement with a corresponding one of the first shaft and the second shaft to which the other one of the first and second transmission gears is mounted. The gearbox also includes: a driving sprocket fixedly mounted to the second shaft; an output sprocket operatively connected to the driving sprocket; a flexible driving member drivingly connecting the driving sprocket to the output sprocket; and a housing enclosing: the plurality of gears mounted to the first shaft, the plurality of gears mounted to the second shaft, the driving sprocket, the output sprocket and the flexible driving member. The housing rotatably supports the first shaft and the second shaft, the countershaft partly extending within the housing and being rotatably supported thereby. The

5

snowmobile also includes a driveshaft coupled to the output sprocket, and a shifter operable by a user for selectively operating the gearbox in one of a high gear, a low gear and a neutral gear. The driveshaft is operatively connected to the drive track to propel the snowmobile. When the gearbox operates in the high gear, the shifter engages the given one of the first and second transmission gears corresponding to the high gear pairing to cause driving engagement thereof with the corresponding one of the first shaft and the second shaft. When the gearbox operates in the low gear, the shifter engages the given one of the first and second transmission gears corresponding to the low gear pairing to cause driving engagement thereof with the corresponding one of the first shaft and the second shaft. When the gearbox operates in the neutral gear, the shifter is disengaged from the first and second transmission gears so that the given one of the first and second transmission gears of each of the high and low gear pairings remains in free-spin engagement with the corresponding one of the first shaft and the second shaft. The snowmobile also includes an actuator for selectively transmitting rotary motion from the countershaft to the gearbox via a selected one of the forward drive gear and the reverse drive gear. When the selected one of the forward drive gear and the reverse drive gear is the forward drive gear: when rotating, the driveshaft rotates in the same direction as the countershaft; and the gearbox is operable in one of the high gear, the low gear and the neutral gear. When the selected one of the forward drive gear and the reverse drive gear is the reverse drive gear: when rotating, the driveshaft rotates in a reverse direction opposite to a direction of rotation of the countershaft.

In some embodiments, the flexible driving member is a chain.

In some embodiments, the given one of the first and second transmission gears of each of the high and low gear pairings in selective free-spin engagement with a corresponding one of the first shaft and the second shaft is the first transmission gears such that: the first transmission gears are in selective free-spin engagement with the first shaft; and the second transmission gears are in fixed engagement with the second shaft.

In some embodiments, the shifter includes: a shifter knob movable between a high gear position, a low gear position and a neutral gear position corresponding to the high gear, the low gear and the neutral gear of the gearbox respectively; a dog mounted on the first shaft and slidable along an axis of the first shaft, the dog comprising dog teeth; and a plurality of links interconnecting the dog to the shifter knob. Each of the first transmission gears has dog teeth matching the dog teeth of the dog. When the shifter knob is moved to the high gear position, the dog engages the dog teeth of the first transmission gear corresponding to the high gear pairing. When the shifter knob is moved to the low gear position, the dog engages the dog teeth of the first transmission gear corresponding to the low gear pairing. When the shifter knob is moved to the neutral gear position, the dog is disengaged from the first transmission gears.

In some embodiments, in the neutral gear position of the shifter knob, the dog is mounted on the first shaft between the first transmission gear corresponding to the high gear pairing and the first transmission gear corresponding to the low gear pairing.

In some embodiments, the shifter also includes a support bracket for supporting the shifter knob, the support bracket being fastened to the housing of the gearbox.

6

In some embodiments, the housing of the gearbox includes a left housing portion and a right housing portion, the left and right housing portions being affixed to one another.

In some embodiments, the first shaft defines a first shaft axis about which the first shaft is rotatable; the second shaft defines a second shaft axis about which the second shaft is rotatable; and the first shaft axis is vertically higher than the second shaft axis.

In some embodiments, the driveshaft defines a driveshaft axis about which the driveshaft is rotatable, the second shaft axis being vertically higher than the driveshaft axis.

In some embodiments, the gearbox is disposed on a right side of the engine.

In some embodiments, the CVT is disposed on a left side of the engine.

In some embodiments, the countershaft extends from the left side of the engine to the right side of the engine.

In some embodiments, the snowmobile also includes a pair of drive sprockets mounted to the driveshaft, the drive sprockets being in driving engagement with the drive track.

In some embodiments, the low gear pairing is disposed laterally between the high gear pairing and the CVT.

In some embodiments, the low gear pairing is disposed laterally between the forward drive gear and the high gear pairing.

In some embodiments, the low gear pairing is disposed laterally between the high gear pairing and the driven gear.

In some embodiments, the driven gear is disposed leftwardly of the low gear pairing.

In some embodiments, the driving sprocket is disposed laterally between the low gear pairing and the CVT.

In some embodiments, the low gear pairing is disposed laterally between the high gear pairing and the driving sprocket.

In some embodiments, the driving sprocket is disposed laterally between the forward drive gear and the low gear pairing.

In some embodiments, the actuator is operatively connected to the reverse drive gear; the reverse drive gear has dog teeth extending from a lateral side thereof the forward drive gear has dog teeth configured for matching the dog teeth of the reverse drive gear, the dog teeth of the forward drive gear extending from a lateral side thereof; and when the selected one of the forward drive gear and the reverse drive gear is the forward drive gear, the actuator moves the reverse drive gear along the countershaft such that the dog teeth of the forward and reverse drive gears are engaged with one another thereby transmitting rotary motion from the reverse drive gear to the forward drive gear.

In some embodiments, when the selected one of the forward drive gear and the reverse drive gear is the reverse drive gear, the actuator moves the reverse drive gear along the countershaft such that the reverse drive gear is in rotational engagement with the reverse driven gear thereby transmitting rotary motion from the reverse drive gear to the reverse driven gear.

In some embodiments, the reverse drive gear is leftwardly of the forward drive gear.

In some embodiments, the reverse driven gear is disposed laterally between the plurality of second transmission gears and an inner wall of the housing.

In some embodiments, the reverse driven gear is leftwardly of the plurality of second transmission gears.

In some embodiments, the actuator is an electric actuator.

In some embodiments, the engine is a two-stroke engine.

In some embodiments, the engine is a four-stroke engine.

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, left side, of a snowmobile;

FIG. 2 is a perspective view, taken from a rear, left side, of part of the snowmobile of FIG. 1, including an engine, a continuous variable transmission (CVT), a gearbox, and a driveshaft;

FIG. 3 is a perspective view, taken from a rear, right side, of the gearbox and a countershaft of the snowmobile of FIG. 1, with a housing of the gearbox being open to expose various components of the gearbox;

FIG. 4 is a perspective view, taken from a front, right side, of part of the gearbox and the countershaft of the snowmobile of FIG. 1, with the gearbox being operated in a high gear;

FIG. 5A is a perspective view, taken from a front, right side, of the part of the gearbox and the countershaft of FIG. 4, with the gearbox being operated in a neutral gear;

FIG. 5B is a perspective view, taken from a front, right side, of the part of the gearbox and a countershaft FIG. 4, with the gearbox being operated in a low gear;

FIG. 6 is a top plan view of the gearbox and of a shifter of the snowmobile of FIG. 1;

FIG. 7 is a perspective view, taken from a rear, left side, of the gearbox and the countershaft in accordance with another configuration of the snowmobile;

FIG. 8 is a front elevation view of the gearbox and the countershaft of the configuration of the snowmobile of FIG. 7;

FIG. 9 is a left side elevation view of the gearbox and the countershaft of the configuration of the snowmobile of FIG. 7;

FIG. 10 is a perspective view, taken from a rear, left side, of part of the CVT, the countershaft and the gearbox of the configuration of the snowmobile of FIG. 7, with a left portion of the housing of the gearbox removed to expose internal components of the gearbox;

FIG. 11 is a top plan view of the components of the snowmobile of FIG. 10;

FIG. 12 is a front elevation view of part of the gearbox and the countershaft in accordance the configuration of the snowmobile of FIG. 7, in which the gearbox is in a reverse operation mode;

FIG. 13 is a rear elevation view of the part of the gearbox and the countershaft of FIG. 10, in which the gearbox is in the reverse operation mode;

FIG. 14 is a front elevation view of the part of the gearbox and of the countershaft of FIG. 7, in which the gearbox is in a forward operation mode;

FIG. 15 is an exploded view, taken from a rear, right side, of part of the gearbox, part of the countershaft of the configuration of the snowmobile of FIG. 7.

DETAILED DESCRIPTION

With reference to FIG. 1, a snowmobile 100 will be described herein. The snowmobile 100 has a front end 102 and a rear end 104, which are defined consistently with the forward travel direction of the vehicle. The snowmobile 100 includes a frame 106 which includes a tunnel 108.

A ski and steering assembly is provided, in which two skis 116 (only one of which is shown in FIG. 1) are positioned at the front end 102 of the snowmobile 100, and are attached to a front portion of the frame 106 through a front suspension assembly 118.

The front suspension assembly 118 includes ski legs 120, supporting arms 122, spindles and ball joints for operatively joining the respective ski legs 120, supporting arms 122 and a steering column 124. The supporting arms 122 include left and right upper A-arms 117 and left and right lower A-arms 119 (only left upper and lower A-arms 117, 119 being shown in FIG. 1). It is contemplated that the front suspension assembly 118 could be different from the double A-arm suspension described above. At its upper end, the steering column 124 is attached to a handlebar 126 which is positioned forward of a user to rotate the ski legs 120 and thus the skis 116, in order to steer the snowmobile 100.

A straddle seat 138 is disposed rearward of the handlebar 126. A rear portion 139 of the straddle seat 138 provides a passenger seat. Two footrests 140 (only one of which is shown in FIG. 1) extend along opposite lateral sides of the snowmobile 100 below the straddle seat 138 to accommodate the riders' feet.

An engine 114 (FIG. 2) is supported by the frame 106. In this embodiment, the engine 114 operates on a two-stroke engine cycle such that the engine 114 completes a power cycle with two strokes (an upstroke and a downstroke) of the engine's pistons (not shown). The engine 114 can thus be referred to as a two-stroke engine. With reference to FIG. 2, the engine 114 has a crankcase 130, a cylinder block 132 defining two cylinders (not shown) connected on top of the crankcase 130 and a cylinder head 142 connected on top of the cylinder block 132. The engine 114 also has a crankshaft (not shown) disposed in the crankcase 130 and driven by the motion of the pistons.

The engine 114 has an electronic reverse function for operating the engine 114 in reverse so that the crankshaft can be selectively rotated in a forward rotation direction and a reverse rotation direction. This is achieved by controlling the fuel injection and ignition within the cylinders of the engine 114. For instance, U.S. Pat. No. 5,036,802, issued Aug. 6, 1991, which is incorporated herein by reference, describes in detail a manner in which this electronic reverse function can be achieved. The electronic reverse function can be selectively activated via an electronic reverse function control element 150 (FIGS. 1, 2) disposed on the handlebar 126 of the snowmobile 100. In this embodiment, the electronic reverse function control element 150 is a push button which is selectively actuated by the user to engage or disengage the electronic reverse function of the engine 114.

As shown in FIG. 2, the engine 114 is connected to a continuously variable transmission (CVT) 160 disposed on a left side of the engine 114. The CVT 160 includes a drive

pulley 162 operatively connected to the crankshaft of the engine 114, a driven pulley 164 disposed on a countershaft 165 for rotation therewith, and a transmission belt 167 disposed around both pulleys 162, 164 to transmit torque from the drive pulley 162 to the driven pulley 164. The driven pulley 164 is rearward and upward of the drive pulley 162 such that the countershaft 165 is located rearward and upward of the crankshaft of the engine 114. A cover (not shown) covers the pulleys 162, 164 and the transmission belt 167.

Each of the pulleys 162, 164 includes a movable sheave that can move axially relative to a fixed sheave to modify an effective diameter of the corresponding pulley 162, 164. The drive pulley 162 is a centrifugal pulley in that the sheaves thereof move in response to a centrifugal force applied thereon. The effective diameters of the pulleys 162, 164 are in inverse relationship. In the illustrated embodiment, the CVT 160 is a purely mechanical CVT 160, in which the diameter of the drive pulley 162 increases with increasing rotational speed of the drive pulley 162 (i.e., with increasing engine speed). The diameter of the driven pulley 164 therefore decreases when the torque required at the countershaft 165 increases. The CVT 160 may thus be referred to as an “unassisted” CVT in that a gear ratio of the CVT 160 (i.e., an effective diameter of the driven pulley 164 over the effective diameter of the drive pulley 162) is automatically mechanically adjusted in accordance with the speed of the engine 114 and the torque requirement at the countershaft 165.

It is contemplated that, in other embodiments, the CVT 160 could be an assisted CVT such as a hydraulic CVT.

A gearbox 170 disposed on the right side of the engine 114 is connected to the CVT 160 via the countershaft 165 such that the countershaft 165 extends from the left side to the right side of the engine 114. The gearbox 170, which will be described in greater detail below, provides a gearing system which allows the driver of the snowmobile 100 to change a “gear” in which the gearbox 170 is operated. Moreover, as will be described below, in some embodiments, the gearbox 170 can be operated in “reverse”.

It is contemplated that, in other embodiments, the positions of the CVT 160 and the gearbox 170 could be switched such that the CVT 160 is disposed on the right side of the engine 114 and the gearbox 170 is disposed on the left side of the engine 114.

Returning to FIG. 1, at the front end 102 of the snowmobile 100, fairings 134 are provided that enclose the engine 114, the CVT 160, and the gearbox 170, thereby providing an external shell that not only protects these components of the snowmobile 100, but also make the snowmobile 100 more aesthetically pleasing. The fairings 134 include a hood 135 and one or more side panels which can be opened to allow access to the engine 114, the CVT 160 and the gearbox 170 when this is required, for example for inspection or maintenance thereof. A windshield 136 is connected to the fairings 134 in front of the handlebar 126. Alternatively, the windshield 136 can be attached directly to the handlebar 126. The windshield 136 acts as a windscreen to lessen the force of the air on the user while the snowmobile 100 is moving forward.

An endless drive track 128 is disposed under the tunnel 108. The endless drive track 128 is operatively connected to the engine 114 through the CVT 160 and the gearbox 170. The endless drive track 128 is driven to run about a rear suspension assembly 131 for propulsion of the snowmobile 100.

The rear suspension assembly 131 comprises front and rear shock absorbers (not shown). The front shock absorber extends rearwardly and downwardly from a front portion of the tunnel 108, and is disposed between the tunnel 108 and a slide frame assembly 144, partially forward of front suspension arms of the rear suspension assembly 131. The rear shock absorber extends forwardly and downwardly from a rear portion of the tunnel 108, and is disposed at least in part rearwardly of the front suspension arms. The slide frame assembly 144 includes a pair of spaced apart slide rails 146 that engage the inner side of the ground-engaging portion of the endless drive track 128. The slide frame assembly 144 journals a plurality of backup rollers 133 and four idler rollers 137. In addition, further rollers are carried by the tunnel 108, in order to define the path over which the endless drive track 128 travels. Other types of rear suspension assemblies are contemplated.

The endless drive track 128 is engaged with and driven by two drive sprockets 152 (FIG. 2) which are journaled by the tunnel 108 and are driven by the engine 114 via the CVT 160 and the gearbox 170. More specifically, the drive sprockets 152 are mounted to a driveshaft 175 which is operatively connected to the gearbox 170.

At the rear end 104 of the snowmobile 100, a snow flap 163 is connected to a rear end of the tunnel 108. The snow flap 163 protects against snow, ice, dirt or other debris that could be projected from the drive track 128 when driving. In some embodiments, the snow flap 163 also redirects snow and ice projected by the drive track 128 on the underside of the tunnel 108 where an engine heat exchanger (not shown) is provided. It is contemplated that the snow flap 163 could be omitted.

The snowmobile 100 includes other elements well known in the art, and as such they will not be described in detail herein.

The gearbox 170 and related components of the snowmobile 100 will now be described with reference to FIGS. 3 to 6.

The gearbox 170 includes a primary shaft 172, a secondary shaft 174, and a plurality of gears mounted to a respective one of the primary and the secondary shafts 172, 174. A housing 176 of the gearbox 170 encloses the primary and secondary shafts 172, 174 and their respective gears therein. The housing 176 includes a left portion 178 and a right portion 180 which are affixed to one another to enclose the components of the gearbox 170.

As briefly mentioned above, the countershaft 165 operatively connects the CVT 160 to the gearbox 170. In this embodiment, the countershaft 165 extends partly within the housing 176 of the gearbox 170 to drivingly engage the gearing of the gearbox 170. In particular, the countershaft 165 extends through a left portion 178 of the housing 176 and is rotatably supported by the housing 176 via two bearings 182 (FIG. 4) mounted to the countershaft 165, one of which is mounted to an end of the countershaft 165. The bearing 182 mounted to the end of the countershaft 165 is supported by the right portion 180 of the housing 176 and the other bearing 182 is supported by the left portion 178 of the housing 176. In order to drive the gearbox 170, a forward drive gear 184 is mounted to the countershaft 165 and rotates therewith. Notably, in this embodiment, the forward drive gear 184 is in driving engagement with a splined portion 186 of the countershaft 165. Furthermore, in this embodiment, the forward drive gear 184 is a single gear mounted to the countershaft 165 to drive the gearbox 170.

The countershaft 165 may alternatively be referred to as an “input shaft” as it transmits the input rotary motion into

the gearbox 170. Similarly, the driveshaft 175 may alternatively be referred to as an “output shaft” as it transmits the output rotary motion from the gearbox 170.

The primary shaft 172 defines a primary shaft axis A1 extending laterally (i.e., parallel to the countershaft axis CA) about which the primary shaft 172 is rotatable. In particular, the primary shaft 172 is rotatably mounted to the housing 176 via bearings 188 mounted to the ends of the primary shaft 172. Notably, one of the bearings 188 mounted to a right end of the primary shaft 172 is supported by the right portion 180 of the housing 176 and the other bearing 188 mounted to a left end of the primary shaft 172 is supported by the left portion 178 of the housing 176. The primary shaft 172 is positioned rearward of the countershaft 165 such that the primary shaft axis A1 is rearward of the countershaft axis CA. Moreover, the primary shaft axis A1 is vertically higher than the countershaft axis CA. A forward driven gear 190 is mounted to the primary shaft 172 and rotates therewith. A splined connection is implemented between the forward driven gear 190 and a splined portion of the primary shaft 172. In this embodiment, the gearbox 170 is driven by the countershaft 165 via the forward driven gear 190. More specifically, the forward driven gear 190 is in rotational engagement with the forward drive gear 184 so that the primary shaft 172 is coupled to the countershaft 165.

Two primary transmission gears 192L, 192H are mounted to the primary shaft 172 and are spaced from one another. The primary transmission gears 192L, 192H are used to transmit motion from the primary shaft 172 to the secondary shaft 174. In particular, as will be described below, one of the primary transmission gears 192L, 192H is selected to transmit motion to the secondary shaft 174 in accordance with a desired torque and speed. To that end, the primary transmission gears 192L, 192H are configured differently. Notably, the primary transmission gear 192L is smaller in diameter than the primary transmission gear 192H.

In this embodiment, the primary transmission gears 192L, 192H are in selective free-spin engagement with the primary shaft 172. In particular, the primary transmission gear 192L is loosely fitted to the primary shaft 172, while the primary transmission gear 192H is mounted to the primary shaft 172 via a needle bearing 193 (FIG. 15). As such, on their own, the primary transmission gears 192L, 192H and the primary shaft 172 are drivingly disengaged. It is contemplated that, in other embodiments, the primary transmission gear 192L could be rotatably mounted to the primary shaft 172 via a bearing, or the primary transmission gear 192H could be loosely fitted to the primary shaft 172. As will be described in greater detail below, a shifter 200 is used to select which of the primary transmission gears 192L, 192H, if any, to place into driving engagement with the primary shaft 172. In order to engage the shifter 200, each of the primary transmission gears 192L, 192H has dog teeth 195 (shown for the primary transmission gear 192L in FIG. 4) which are engaged by the shifter 200 when one of the primary transmission gears 192L, 192H is selected to be placed into driving engagement with the primary shaft 172. In particular, the primary transmission gear 192L has the dog teeth 195 on its right side (i.e., facing the primary transmission gear 192H) while the primary transmission gear 192H has the dog teeth 195 on its left side (i.e., facing the primary transmission gear 192L).

A deflector 194 is fastened to the housing 176 and partially surrounds a part of the primary shaft 172. The deflector 194 is configured to deflect lubricant (i.e., oil) which is projected from a flexible driving member 206 towards the primary transmission gears 192L, 192H. The

forward driven gear 190 and the primary transmission gears 192L, 192H are disposed on opposite sides of the deflector 194.

The secondary shaft 174 defines a secondary shaft axis A2 extending parallel to the primary shaft axis A1 (i.e., laterally) and about which the secondary shaft 174 is rotatable. In particular, the secondary shaft 174 is rotatably mounted to the housing 176 via bearings 196 mounted to the ends of the secondary shaft 174. Notably, one of the bearings 196 mounted to a right end of the secondary shaft 174 is supported by the right portion 180 of the housing 176 and the other bearing 196 mounted to a left end of the secondary shaft 174 is supported by the left portion 178 of the housing 176. As can be seen in FIG. 4, the primary shaft axis A1 is vertically higher than the secondary shaft axis A2. The secondary shaft axis A2 is also vertically lower than the countershaft axis CA. Moreover, the secondary shaft axis A2 is disposed rearwardly of the primary shaft axis A1 and rearwardly of the countershaft axis CA.

Two secondary transmission gears 198L, 198H are mounted to the secondary shaft 174 and are spaced from one another. In this embodiment, the secondary transmission gears 198L, 198H are in fixed engagement with the secondary shaft 174 (i.e., the secondary transmission gears 198L, 198H are drivingly engaged by the secondary shaft 174). The secondary transmission gear 198L has a greater diameter than the secondary transmission gear 198H.

In this embodiment, the primary and secondary transmission gears 192L, 192H, 198L, 198H are helical gears.

It is contemplated that, in other embodiments, the secondary transmission gears 198L, 198H could be in selective free-spin engagement with the secondary shaft 174 while the primary transmission gears 192L, 192H are in fixed engagement with the primary shaft 172. For example, in such embodiments, the secondary transmission gears 198L, 198H are provided with the dog teeth instead of the primary transmission gears 192L, 192H, and the shifter 200 is connected to the secondary shaft 174 to selectively engage one of the secondary transmission gears 198L, 198H.

The primary and secondary transmission gears 192L, 198L, are in constant mesh with one another to form a low gear pairing 202L. The primary and secondary transmission gears 192H, 198H, are in constant mesh with one another to form a high gear pairing 202H. These gear pairings 202L, 202H can be selectively chosen, via the shifter 200, to transmit rotary motion from the countershaft 165 to the driveshaft 175 in order to affect the speed and torque at the driveshaft 175. Notably, as will be understood, the gear pairings 202L, 202H offer different gear ratios for transmitting motion from the primary shaft 172 to the secondary shaft 174. For instance, the low gear pairing 202L is selected to transmit motion from the primary shaft 172 to the secondary shaft 174 when a greater torque is desired, whereas the high gear pairing 202H is selected to transmit motion from the primary shaft 172 to the secondary shaft 174 when a greater speed is desired. As such, the high gear pairing 202H is associated with a “high gear” of the gearbox 170 while the low gear pairing 202L is associated with a “low gear” of the gearbox 170. The gearbox 170 is thus described as operating in high gear when the shifter 200 engages the high gear pairing 202H (FIG. 4) and as operating in low gear when the shifter 200 engages the low gear pairing 202L (FIG. 5B). As will be described in more detail below, the gearbox 170 can also be operated in “neutral gear” whereby none of the gear pairings 202L, 202H are

engaged by the shifter **200** (i.e., the primary transmission gears **172L**, **172H** are disengaged by the shifter **200**) (FIG. 5A).

It is contemplated that the gearbox **170** could be operated in additional gears (e.g., a second high gear, a second low gear) by providing additional gear pairings.

The shifter **200** can thus be operated by the user to place one of the primary transmission gears **192L**, **192H** of a selected one (or none) of the gear pairings **202L**, **202H** into driving engagement with the primary shaft **172** (via the matching dog teeth **195**, **242** as described above) which in turn engages the corresponding secondary transmission gear **198L**, **198H**.

In this embodiment, the high gear pairing **202H** is disposed rightwardly of the low gear pairing **202L**. As such, the low gear pairing **202L** is disposed laterally between the high gear pairing **202H** and the CVT **160**. The low gear pairing **202L** is also disposed laterally between the forward drive gear **184** and the high gear pairing **202H**. Similarly, the low gear pairing **202L** is disposed laterally between the high gear pairing **202H** and the forward driven gear **190**. As such, the forward driven gear **190** is disposed leftwardly of the low gear pairing **202L**.

As shown in FIG. 3, a driving sprocket **204** is fixedly mounted to the secondary shaft **174** and enclosed within the housing **176**. The driving sprocket **204** is disposed leftwardly of the secondary transmission gears **198L**, **198H** and is generally laterally aligned with the divider **194**. In particular, the driving sprocket **204** is disposed laterally between the low gear pairing **202L** and the CVT **160**. As such, the low gear pairing **202L** is disposed laterally between the high gear pairing **202H** and the driving sprocket **204**.

The driving sprocket **204** is operatively connected to the driveshaft **175**. Notably, the flexible driving member **206** drivably connects the driving sprocket **204** to an output sprocket **208** fixedly mounted to the driveshaft **175** and enclosed within the housing **176**. As such, rotary motion is transmitted from the secondary shaft **174** to the driveshaft **175** via the driving and output sprockets **204**, **208** and the flexible driving member **206**. The driveshaft **175** is thus coupled to the secondary shaft **174**.

The driveshaft **175** defines a driveshaft axis DA about which the driveshaft **175** and the output sprocket **208** are rotatable. The driveshaft axis DA is vertically lower than and rearward of the secondary shaft axis A2 about which the driving sprocket **204** rotates.

The flexible driving member **206** may be any suitable type of flexible driving member. In this embodiment, the flexible driving member **206** is a chain which engages the teeth of the sprockets **204**, **208**. In other embodiments, the flexible driving member **206** may be a rubber belt for example. Moreover, an adjustable tensioner **210** (FIG. 4) is provided to regulate tension in the flexible driving member **206**. In this embodiment, the tensioner **210** applies pressure on an outer side of the flexible driving member **206**. The tensioner **210** is supported by the housing **176**.

As shown in FIGS. 3 to 5B, a speed sensor **213** is supported by the housing **176** and is configured to measure the speed of the driveshaft **175**.

As shown in FIG. 4, a configurable portion **212** of the secondary shaft **174** extends leftwardly from the driving sprocket **204** (and thus leftwardly of the second transmission gears **198L**, **198H**). In particular, the configurable portion **212** extends laterally between the forward drive gear **184** and an inner wall of the housing **176** defined by the left portion **178** of the housing **176**. In this configuration of the snowmobile **100**, the configurable portion **212** of the sec-

ondary shaft **174** is free of any gears mounted thereto. As will be discussed in greater detail below, in another configuration of the snowmobile **100**, a gear is mounted to the configurable portion **212** of the secondary shaft **174** for transmitting rotary motion to the secondary shaft **174** otherwise than through the primary shaft **172** (i.e., without going through the primary shaft **172**). Likewise, the countershaft **165** has a configurable portion **185** extending laterally between the forward drive gear **184** and an inner wall of the housing **176** defined by the left portion **178** of the housing **176**. As such, the configurable portion **185** extends leftwardly of the forward drive gear **184**. Similarly to the configurable portion **212** of the secondary shaft **174**, in this configuration of the snowmobile **100**, the configurable portion **185** of the countershaft **165** is free of any gears mounted thereto. The configurable portions **185**, **212** of the countershaft **165** and the secondary shaft **174** are laterally aligned with one another.

The shifter **200** is operable by the user of the snowmobile **100** for selectively operating the gearbox in one of the high gear, the low gear and a neutral gear. With reference to FIGS. 4 to 5B, the shifter **200** includes a shifter knob **220**, a dog **222**, and a link assembly **224** interconnecting the dog **222** to the shifter knob **220**. The shifter **200** also has a support bracket **223** for supporting the shifter knob **220**. The support bracket **223** is fastened to the housing **176**.

With reference to FIG. 6, the shifter knob **220** is movable between different positions to select a gear in which to operate the gearbox **170**. More specifically, the shifter knob **220** is movable between a high gear position, a low gear position and a neutral gear position corresponding to the high gear, the low gear and the neutral gear of the gearbox **170** respectively. As shown in FIG. 4, the shifter knob **220** has a knob portion **225**, a base portion **226** and a shaft **228** interconnecting the knob portion **225** to the base portion **226**. The knob portion **225** is configured to be handled by the user's hand. A connector **234** of the base portion **226** is connected to the dog **222** via the link assembly **224**. The base portion **226** defines a pivot **230** at its bottom end, implemented via a rod end **232**. The shifter knob **220** is pivotable frontwardly and rearwardly about the pivot **230**. The shifter knob **220** is moved leftwardly or rightwardly to a selected one of the high gear, low gear and neutral gear positions. Notably, as can be seen in FIG. 6, a path of the shifter knob **220** is from left to right as it moves from the high gear position, to the neutral gear position and to the low gear position in order to cause the dog **222** to move accordingly laterally along the primary shaft **172**. A shifter cover **235** (FIG. 6) covers part of the shifter **200**, with the knob portion **225** and the shaft **228** protruding through an aperture **237** of the shifter cover **235**. The aperture **237** defines the path of the shifter knob **220** as it is moved through the different gear positions. As can be seen from the aperture **237**, once the shifter knob **220** is in the correct position for the desired gear, the shifter knob **220** is moved forwardly along a corresponding longitudinally-extending portion of the aperture **237** so that the gearbox **170** stays engaged in the selected gear. To that end, a spring **239** (FIGS. 5A, 5B) is provided at the pivot **230** to bias the shifter knob **220** forwardly and into the longitudinally-extending portion of the aperture **237** corresponding to the selected gear. In order to change gears, the shifter knob **220** is thus moved rearwardly (against the biasing force of the spring **239**) to disengage the corresponding longitudinally-extending portion of the aperture **237** and then moved laterally to another gear position.

The link assembly 224 includes a generally laterally-extending link 236, a generally longitudinally-extending link 238 and an interconnecting bracket 240 to which each of the links 236, 238 is connected. The laterally-extending link 236 has one end fastened to the connector 234 of the base portion 226 of the shifter knob 220. Another end of the laterally-extending link 236 is fastened to the interconnecting bracket 240. The longitudinally-extending link 238 has one end fastened to the interconnecting bracket 240 and the other end fastened to the dog 222.

The dog 222 is mounted on the primary shaft 172 and is slidable along the primary shaft axis A1. An inner part of the dog 222 is drivingly engaged with the primary shaft 172 and thus rotates therewith. Notably, an inner periphery of the dog 222 is splined to engage the splines on the primary shaft 172. A fork 229 (FIGS. 5A, 5B) of the low gear 222 is rotatable relative to the inner part of the dog 222 and is connected to the link 238. As shown in FIGS. 5A and 5B, the dog 222 has dog teeth 242 on the left and right sides of the dog 222 which match the dog teeth 195 of the primary transmission gears 192L, 192H. The dog teeth 242 of the dog 222 are configured to engage and thereby drive the primary transmission gears 192L, 192H via the dog teeth 195 thereof.

Notably, when the shifter knob 220 is moved to the high gear position (FIG. 4), the dog 222 slides right and engages the dog teeth 195 of the primary transmission gear 192H corresponding to the high gear pairing 202H. When the shifter knob 220 is moved to the low gear position (FIG. 5B), the dog 222 slides left and engages the dog teeth 195 of the primary transmission gear 192L corresponding to the low gear pairing 202L. When the shifter knob 220 is moved to the neutral gear position (FIG. 5A), the dog 222 slides to a position between the primary transmission gears 192L, 192H and is disengaged from the primary transmission gears 192L, 192H.

By operating the gearbox 170 via the shifter 220 and controlling the rotation direction of the crankshaft of the engine 114 via the reverse function control element 150, the user of the snowmobile 100 can choose to operate the gearbox 170 in any of the high, low and neutral gears while the crankshaft of the engine 114 rotates in the forward rotation direction or the reverse rotation direction. As such, the user may have a greater degree of control of the speed and torque delivered to the drive track 128 when the snowmobile 100 moves in reverse. The gearbox 170 is said to be in "reverse operation" when the crankshaft of the engine 114 rotates in the reverse rotation direction, namely since the driveshaft 175, when rotating, rotates in a direction that is associated with rearward driving direction of the snowmobile 100 (when the handlebar 126 is oriented to steer the skis 116 straight). In some embodiments, when the crankshaft of the engine 114 rotates in reverse, the gearbox 170 may be limited to operating in one or two of the high, low and neutral gears. For example, in some embodiments, when the crankshaft of the engine 114 rotates in reverse, the gearbox 170 may be limited to operating in the low gear.

It is contemplated that the shifter knob 220 of the shifter 200 could be replaced by an electric actuator which is operated by the user via buttons (e.g., provided on the handlebar 126) such as to provide electric shifting.

As will be described in greater detail below, the snowmobile 100 can be configured according to two different configurations. The two different configurations of the snowmobile 100 implement different ways in which the reverse operation of the gearbox 170 can be achieved. An example of the first configuration of the snowmobile 100 is described above with respect to FIGS. 3 to 6, whereby the reverse

operation of the gearbox 170 is achieved by operating the engine 114 in the reverse rotation direction.

The second configuration of the snowmobile 100 that allows reverse operation of the gearbox 170 will now be described below with respect to FIGS. 7 to 14. In the second configuration of the snowmobile 100, the snowmobile 100 has an engine 314 (schematically illustrated in FIG. 7) which, unlike the engine 114, does not have an electronic reverse function and thus the reverse operation of the gearbox 170 is provided by driving components of the snowmobile 100 other than the engine 314, namely including the gearbox 170. In this embodiment, in the second configuration of the snowmobile 100, the engine 314 is a four-stroke engine operating on a four-stroke engine cycle such that the engine 314 completes a power cycle with four strokes (two upstrokes and two downstrokes) of the engine's piston(s). Indeed, the second configuration of the snowmobile 100 may be particularly useful for four-stroke engines as their crankshafts can only be rotated in a single rotation direction. Alternatively, the engine 314 in the second configuration of the snowmobile 100 could be a two-stroke engine which does not implement the electronic reverse function described above.

As shown in FIG. 7, the engine 314 is operatively connected to the countershaft 165 via the CVT 160 described above.

As shown in FIGS. 12 to 14, in the second configuration of the snowmobile 100, the forward drive gear 184 is in selective free-spin engagement with the countershaft 165. As such, the forward drive gear 184 drives the primary shaft 172 only when it is selected to do so.

Moreover, in the second configuration of the snowmobile 100, the snowmobile 100 includes a reverse drive gear 246 mounted to the countershaft 165 at the configurable portion 185 of the countershaft 165 and in driving engagement with the countershaft 165. In particular, the reverse drive gear 246 is drivingly connected to the countershaft 165 via a splined connection therebetween. The reverse drive gear 246 is enclosed within the housing 176 and, as will be described in greater detail below, is slidable along the countershaft 165. The reverse drive gear 246 also has dog teeth 252 extending from a right side thereof. Notably, in this second configuration of the snowmobile 100, the forward drive gear 184 has dog teeth 254 which are configured for matching the dog teeth 252 of the reverse drive gear 246. The dog teeth 254 of the forward drive gear 184 extend from a left side thereof (i.e., facing the reverse drive gear 246).

As can be seen in FIGS. 11, 12 and 14, a support collar 256 is rotatably connected to the reverse drive gear 246 on a left side thereof. That is, the support collar 256 can rotate relative to the reverse drive gear 246 such that, when the reverse drive gear 246 rotates with the countershaft 165, the support collar 256 remains in the same rotational position about the countershaft 165. As will be described in greater detail below, the support collar 256 allows connection of the reverse drive gear 246 to an actuator.

Furthermore, in the second configuration of the snowmobile 100, the gearbox 170 includes a reverse driven gear 248 mounted to the secondary shaft 174 at the configurable portion 212 of the secondary shaft 174. More specifically, as shown in FIG. 15, the reverse driven gear 248 is mounted to the secondary shaft 174 via a needle bearing 257. However, an adapter 251 mounted to the secondary shaft 274 is splined to engage the splines of the secondary shaft 174 and is drivingly connected to the reverse driven gear 248 via dog teeth 255 extending from a left side of the adapter 251. In particular, the reverse driven gear 248 has dog teeth 253

extending from a right side thereof and which match the dog teeth 255 of the adapter 251. The reverse driven gear 248 is configured to mesh with the reverse drive gear 246. The reverse driven gear 248 is enclosed within the housing 176.

In this embodiment, the reverse drive gear 246 and the reverse driven gear 248 are spur gears.

In the second configuration of the snowmobile 100, an actuator 260 is provided for selectively transmitting rotary motion from the countershaft 165 to the gearbox 170 via a selected one of the forward drive gear 184 and the reverse drive gear 246. That is, the actuator 260 is controlled by an input from the user to drive the gearbox 170 in a forward rotation direction (corresponding to rotational engagement of the forward drive gear 184) or in a reverse rotation direction (corresponding to rotational engagement of the reverse driven gear 248). To that end, in the second configuration, the reverse function control element 150 controls the actuator 260 rather than reverse operation of the engine as is the case in the first configuration. In particular, in the second configuration of the snowmobile 100, the control element 150 is selectively actuated by the user to set the actuator 260 to transmit rotary motion from the countershaft 165 to the gearbox 170 via one of the forward drive gear 184 and the reverse drive gear 246.

In this embodiment, the actuator 260 is an electric actuator. In particular, the electric actuator 260 comprises a motor 264 and a linkage assembly 266 which operatively connects the motor 264 to the reverse drive gear 246 via the support collar 256. Notably, as shown in FIGS. 11 and 12, the linkage assembly 266 includes a fork 263 having connecting arms 267 which are pivotably connected to the support collar 256. The linkage assembly 266 is configured such that rotational motion of the motor 264 causes the support collar 256 to slide along the countershaft 266. More specifically, with reference to FIGS. 10 to 12 and 15, the linkage assembly 266 includes a driving lever 269 (FIGS. 10 to 12) which is connected to a driving shaft of the motor 264 such as to rotate therewith. The driving lever 269 is fastened to a generally vertically-extending linkage 271, which in turn is fastened to a generally laterally-extending linkage 273. The laterally-extending linkage 273 is fastened to a generally longitudinally-extending linkage 274 which is connected to the fork 263. The rotating motion of the driving lever 269 causes the linkages 271, 273, 274 to move such that the driving support collar 256 is moved along the countershaft 266.

It is contemplated that, in other embodiments, the actuator 260 could be a manually operated actuator, whereby the user manually operates the actuator 260 (e.g., via a handle) to selectively transmit rotary motion to the gearbox 170 via the forward drive gear 184 or the reverse drive gear 248. For instance, in such embodiments, the actuator 260 may even be incorporated by the shifter 200 whereby the shifter 200 is used to change the gear in which the gearbox 170 operates (i.e., high, low, neutral gears) as well as to selectively place the gearbox 170 in reverse operation. For example, the shifter knob 220 could have a "reverse gear position" which, when engaged, causes the transmission of rotary motion to the gearbox 170 via the reverse drive gear 248.

The actuator 260 is controlled by the user via the control element 150 to operate the gearbox 170 in either a "forward operation mode" or a "reverse operation mode". In the forward operation mode, illustrated in FIG. 14, rotary motion is transmitted from the countershaft 165 to the gearbox 170 via the forward drive gear 184 (i.e., the forward drive gear 184 is in rotational engagement with the forward driven gear 190). More particularly, when the control ele-

ment 150 is controlled by the user to engage the forward operation mode of the gearbox 170, the actuator 260 moves the reverse drive gear 246 along the countershaft 165 such that the dog teeth 252, 254 of the reverse and forward drive gears 246, 184 are engaged with one another thereby transmitting rotary motion from the reverse drive gear 246 to the forward drive gear 184 which, as it is meshed with the forward driven gear 190, drives the primary shaft 174. The manner in which motion is then transmitted to the driveshaft 175 (if the gearbox 170 is in the high or low gears) has been described above and thus will not be repeated here.

The forward operation mode is associated with a forward driving direction of the snowmobile 100 when the handlebar 126 is oriented to steer the skis 116 straight. Notably, in the forward operation mode of the gearbox 170, the driveshaft 175, when rotating (i.e., in the high gear and low gear of the gearbox 170), rotates in the same direction as the countershaft 165. Moreover, the gearbox 170 is operable in any of the high gear, the low gear and the neutral gear in the forward operation mode of the gearbox 170.

In the reverse operation mode, illustrated in FIGS. 12 and 13, rotary motion is transmitted from the countershaft 165 to the gearbox 170 via the reverse drive gear 246 (i.e., with the reverse drive gear 246 driving the reverse driven gear 248). More particularly, when the control element 150 is controlled by the user to engage the reverse operation mode of the gearbox 170, the actuator 260 moves the reverse drive gear 246 along the countershaft 165 such that the reverse drive gear 246 is aligned with and is in rotational engagement with the reverse driven gear 248 thereby transmitting rotary motion from the reverse drive gear 246 to the reverse driven gear 248. As the reverse driven gear 248 is drivingly engaged to the secondary shaft 174, it is the secondary shaft 174 that is coupled to the countershaft 165 in the reverse operation mode of the gearbox 170 rather than the primary shaft 172 (as is the case in the forward operation mode). The driving sprocket 204, which is also mounted to the secondary shaft 174, thus rotates and drives the output sprocket 208 via the flexible driving member 206. Thus, in the reverse operation mode, the selected one of the high, low and neutral gears of the gearbox 170 as set by the shifter 200 does not affect the rotational output at the driveshaft 175 since rotary motion is not transmitted from the primary shaft 172 to the secondary shaft 174.

The reverse operation mode is associated with a rearward driving direction of the snowmobile 100 when the handlebar 126 is oriented to steer the skis 116 straight. Notably, in the reverse operation mode of the gearbox 170, the driveshaft 175, when rotating (which is at all times during the reverse operation mode), rotates in a reverse direction opposite to a direction of rotation of the countershaft 165.

As will be understood, the snowmobile 100 can be provided in the first configuration or the second configuration with relative ease as most of the components are similar in both configurations. This may thus provide a drivetrain platform for a snowmobile that can accommodate an engine having an electronic reverse function (i.e., a two-stroke engine) as well as an engine which is not operable in reverse (e.g., a two-stroke or four-stroke engine) while using many of the same components. In turn, this may facilitate manufacturing of snowmobiles of both configurations as fewer parts are needed to produce different models of the snowmobile 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 gearbox for a vehicle, comprising:
 - a housing;
 - a first shaft rotatably supported by the housing;
 - a second shaft rotatably supported by the housing and extending parallel to the first shaft;
 - a plurality of first transmission gears mounted to the first shaft;
 - a plurality of second transmission gears mounted to the second shaft, the first and second transmission gears being helical gears,
 - each of the first transmission gears being in constant mesh with a corresponding one of the second transmission gears to form a plurality of gear pairings engageable to operate the gearbox in different gears;
 - a drive gear configured to be mounted to an input shaft extending into the housing, the input shaft being operatively connected to an engine of the vehicle, the drive gear being a spur gear;
 - a driven gear mounted to the second shaft and configured to engage the drive gear, the driven gear being a spur gear; and
 - a flexible driving member configured to drivingly connect one of the first shaft and the second shaft to an output shaft.
2. The gearbox of claim 1, wherein:
 - the drive gear is a reverse drive gear;
 - the driven gear is a reverse driven gear;
 - the gearbox further comprises:
 - a forward drive gear configured to be mounted to the input shaft; and
 - a forward driven gear mounted to the first shaft, the forward driven gear engaging the forward drive gear;
 - the gearbox is operable to selectively operate in a forward operation mode and a reverse operation mode;
 - when the gearbox operates in the forward operation mode, rotary motion is transferred from the input shaft to the first shaft via rotational engagement of the forward drive gear with the forward driven gear; and
 - when the gearbox operates in the reverse operation mode, rotary motion is transferred from the input shaft to the second shaft via rotational engagement of the reverse drive gear with the reverse driven gear.
3. The gearbox of claim 2, wherein:
 - the vehicle is a snowmobile comprising:
 - a frame;
 - at least one ski connected to the frame;
 - a rear suspension assembly connected to the frame;
 - a drive track disposed around the rear suspension assembly;
 - an internal combustion engine supported by the frame, the engine comprising a crankshaft;
 - a continuously variable transmission (CVT) operatively connected to the crankshaft, comprising:
 - a drive pulley operatively connected to the crankshaft;
 - a driven pulley; and
 - a transmission belt interconnecting the drive pulley and the driven pulley;
 - the input shaft is a countershaft of the snowmobile connected to the driven pulley of the CVT; and
 - the output shaft is a driveshaft of the snowmobile operatively connected to the drive track to propel the snowmobile.

4. The gearbox of claim 3, wherein:
 - the plurality of gear pairings includes a high gear pairing and a low gear pairing;
 - for each of the high and low gear pairings:
 - a given one of the first and second transmission gears is in selective free-spin engagement with a corresponding one of the first shaft and the second shaft to which the given one of the first and second transmission gears is mounted; and
 - an other one of the first and second transmission gears is in fixed engagement with a corresponding one of the first shaft and the second shaft to which the other one of the first and second transmission gears is mounted;
 - the snowmobile further comprises a shifter operable by a user for selectively operating the gearbox in one of a high gear, a low gear and a neutral gear;
 - when the gearbox operates in the high gear, the given one of the first and second transmission gears corresponding to the high gear pairing is engaged by the shifter to cause driving engagement of the given one of the first and second transmission gears corresponding to the high gear pairing with the corresponding one of the first shaft and the second shaft;
 - when the gearbox operates in the low gear, the given one of the first and second transmission gears corresponding to the low gear pairing is engaged by the shifter to cause driving engagement of the given one of the first and second transmission gears corresponding to the low gear pairing with the corresponding one of the first shaft and the second shaft; and
 - when the gearbox operates in the neutral gear, the first and second transmission gears are disengaged from the shifter so that the given one of the first and second transmission gears of each of the high and low gear pairings remains in free-spin engagement with the corresponding one of the first shaft and the second shaft.
5. The gearbox of claim 4, wherein:
 - the snowmobile further comprises an actuator for selectively transmitting rotary motion from the countershaft to the gearbox via a selected one of the forward drive gear and the reverse drive gear,
 - when the selected one of the forward drive gear and the reverse drive gear is the forward drive gear:
 - when rotating, the driveshaft rotates in the same direction as the countershaft; and
 - the gearbox is operable in one of the high gear, the low gear and the neutral gear;
 - and
 - when the selected one of the forward drive gear and the reverse drive gear is the reverse drive gear:
 - when rotating, the driveshaft rotates in a reverse direction opposite to a direction of rotation of the countershaft.
6. The gearbox of claim 4, wherein:
 - the given one of the first and second transmission gears of each of the high and low gear pairings in selective free-spin engagement with the corresponding one of the first shaft and the second shaft is the first transmission gears such that:
 - the first transmission gears are in selective free-spin engagement with the first shaft; and
 - the second transmission gears are in fixed engagement with the second shaft.

21

7. The gearbox of claim 6, wherein:
the shifter of the snowmobile comprises:
a shifter knob movable between a high gear position, a
low gear position and a neutral gear position corresponding
to the high gear, the low gear and the neutral gear of the
gearbox respectively;
a dog mounted on the first shaft and slidable along an
axis of the first shaft, the dog comprising dog teeth;
and
a plurality of links interconnecting the dog to the shifter
knob;
each of the first transmission gears has dog teeth configured
to match the dog teeth of the dog;
when the shifter knob is moved to the high gear position,
the dog teeth of the first transmission gear corresponding
to the high gear pairing engage the dog;
when the shifter knob is moved to the low gear position,
the dog teeth of the first transmission gear corresponding
to the low gear pairing engage the dog; and
when the shifter knob is moved to the neutral gear
position, the first transmission gears are disengaged
from the dog.

8. The gearbox of claim 4, wherein the low gear pairing
is configured to be disposed laterally between the high gear
pairing and the CVT.

9. The gearbox of claim 3, wherein:
the plurality of gear pairings includes a high gear pairing
and a low gear pairing;
the gearbox further comprises:
a driving sprocket mounted to the second shaft; and
an output sprocket configured to be mounted to the
output shaft,
the flexible driving member drivingly connecting the
driving sprocket to the output sprocket;
and
the driving sprocket is configured to be disposed laterally
between the low gear pairing and the CVT.

10. The gearbox of claim 3, wherein:
the plurality of gear pairings includes a high gear pairing
and a low gear pairing;
the gearbox further comprises:
a driving sprocket mounted to the second shaft; and
an output sprocket configured to be mounted to the
output shaft,
the flexible driving member drivingly connecting the
driving sprocket to the output sprocket;
and
the low gear pairing is disposed laterally between the high
gear pairing and the driving sprocket.

11. The gearbox of claim 2, wherein:
the plurality of gear pairings includes a high gear pairing
and a low gear pairing; and

22

the low gear pairing is disposed laterally between the
forward drive gear and the high gear pairing.

12. The gearbox of claim 11, wherein the low gear pairing
is disposed laterally between the high gear pairing and the
driven gear.

13. The gearbox of claim 12, wherein the driven gear is
disposed leftwardly of the low gear pairing.

14. The gearbox of claim 2, wherein:
the plurality of gear pairings includes a high gear pairing
and a low gear pairing;
the gearbox further comprises:
a driving sprocket mounted to the second shaft; and
an output sprocket configured to be mounted to the
output shaft,
the flexible driving member drivingly connecting the
driving sprocket to the output sprocket;
and
the driving sprocket is disposed laterally between the
forward drive gear and the low gear pairing.

15. The gearbox of claim 1, wherein the plurality of gear
pairings includes a high gear pairing and a low gear pairing.

16. The gearbox of claim 1, further comprising:
a driving sprocket mounted to the second shaft; and
an output sprocket configured to be mounted to the output
shaft,
the flexible driving member drivingly connecting the
driving sprocket to the output sprocket.

17. The gearbox of claim 16, wherein:
the first shaft defines a first shaft axis about which the first
shaft is rotatable;
the second shaft defines a second shaft axis about which
the second shaft is rotatable;
the first shaft axis is vertically higher than the second shaft
axis; and
the output sprocket is rotatable about an output sprocket
axis, the second shaft axis being vertically higher than
the output sprocket axis.

18. The gearbox of claim 1, wherein the flexible driving
member is a chain.

19. The gearbox of claim 1, wherein the housing of the
gearbox comprises a left housing portion and a right housing
portion, the left and right housing portions being affixed to
one another.

20. The gearbox of claim 1, wherein:
the first shaft defines a first shaft axis about which the first
shaft is rotatable;
the second shaft defines a second shaft axis about which
the second shaft is rotatable; and
the first shaft axis is vertically higher than the second shaft
axis.

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