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(54) **INTERNAL COMBUSTION ENGINE FOR A SNOWMOBILE**

(75) Inventors: **Mamoru Atsuumi**, Shizuoka-ken (JP); **Takashi Ashida**, Shizuoka-ken (JP)

(73) Assignee: **Yamaha Hatsudoki Kabushiki Kaisha**, Shizuoka-ken (JP)

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B62M 27/02 (2006.01)

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(58) **Field of Classification Search** 180/190, 180/191, 192, 231, 9.1, 9.23, 9.25, 9.62, 180/9.64, 186; 123/90.31
See application file for complete search history.

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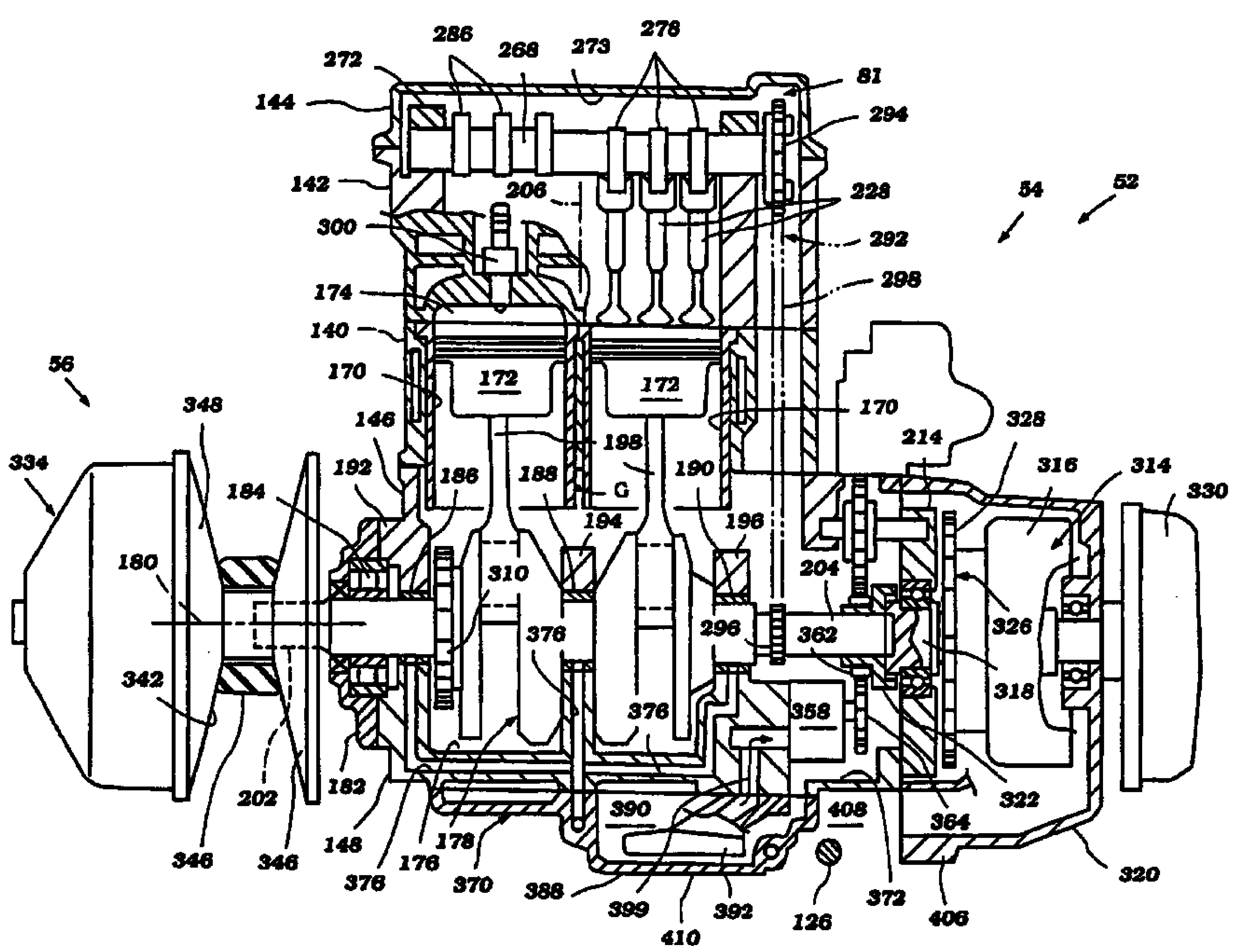
Primary Examiner—Tony Winner

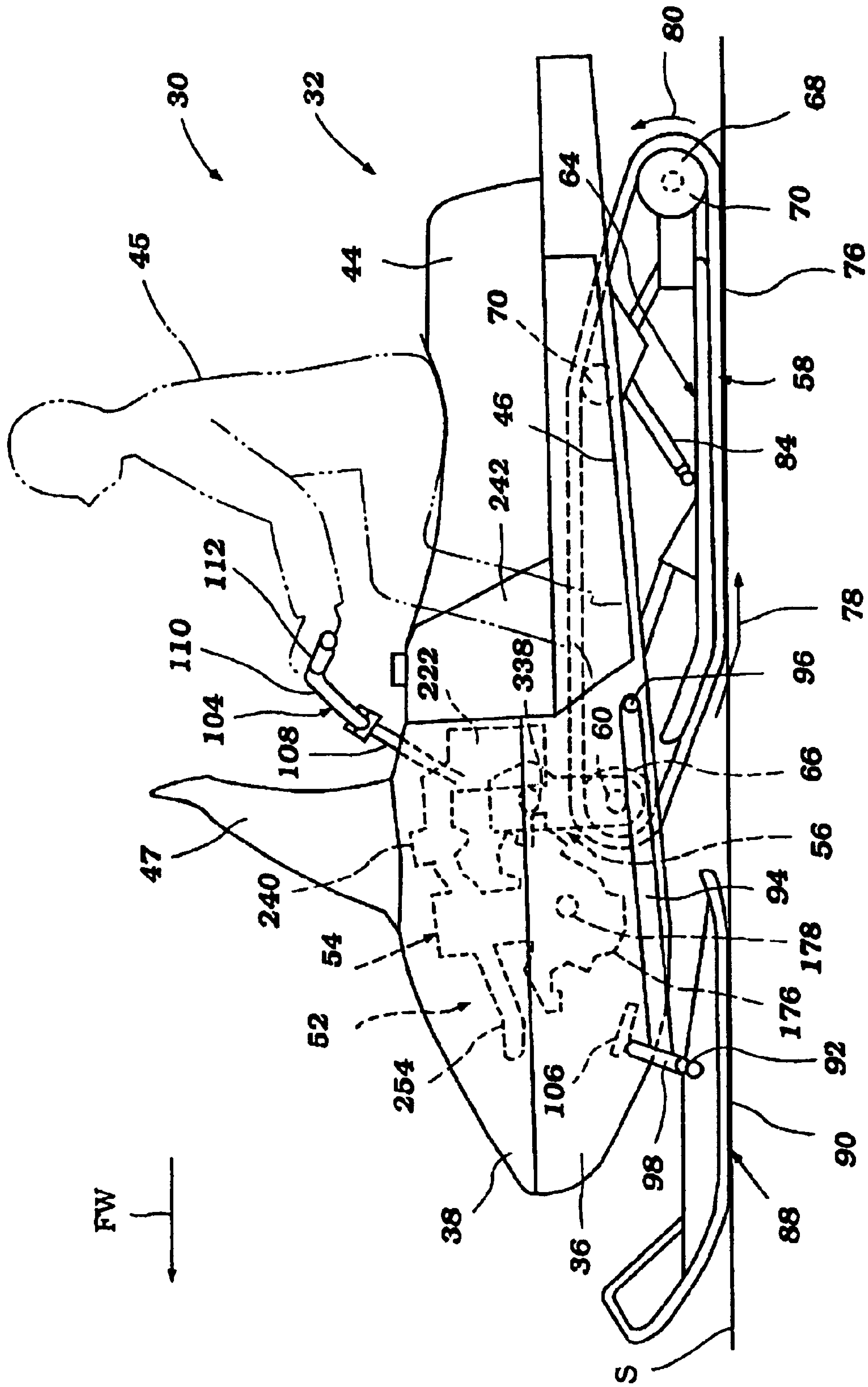
(74) *Attorney, Agent, or Firm*—Knobbe Martens Olson & Bear LLP

(57) **ABSTRACT**

A snowmobile includes an improved internal combustion engine. The engine comprises a crankcase, a crankshaft rotatably journaled within the crankcase, a cylinder block assembly extending from the crankcase, and a cylinder head assembly connected to an end of the cylinder block opposite the crankcase. A cam drive mechanism including at least one camshaft is rotatably journaled within the cylinder head assembly. A transmission is coupled to the crankshaft to transmit power from the engine to the drive assembly. The cam drive mechanism is connected to the crankshaft at a first end portion of the crankshaft. The transmission is connected to the crankshaft at a second end portion of the crankshaft opposite the first end portion.

19 Claims, 7 Drawing Sheets

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52
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98
90
FW
38
36
88
S

Figure 1

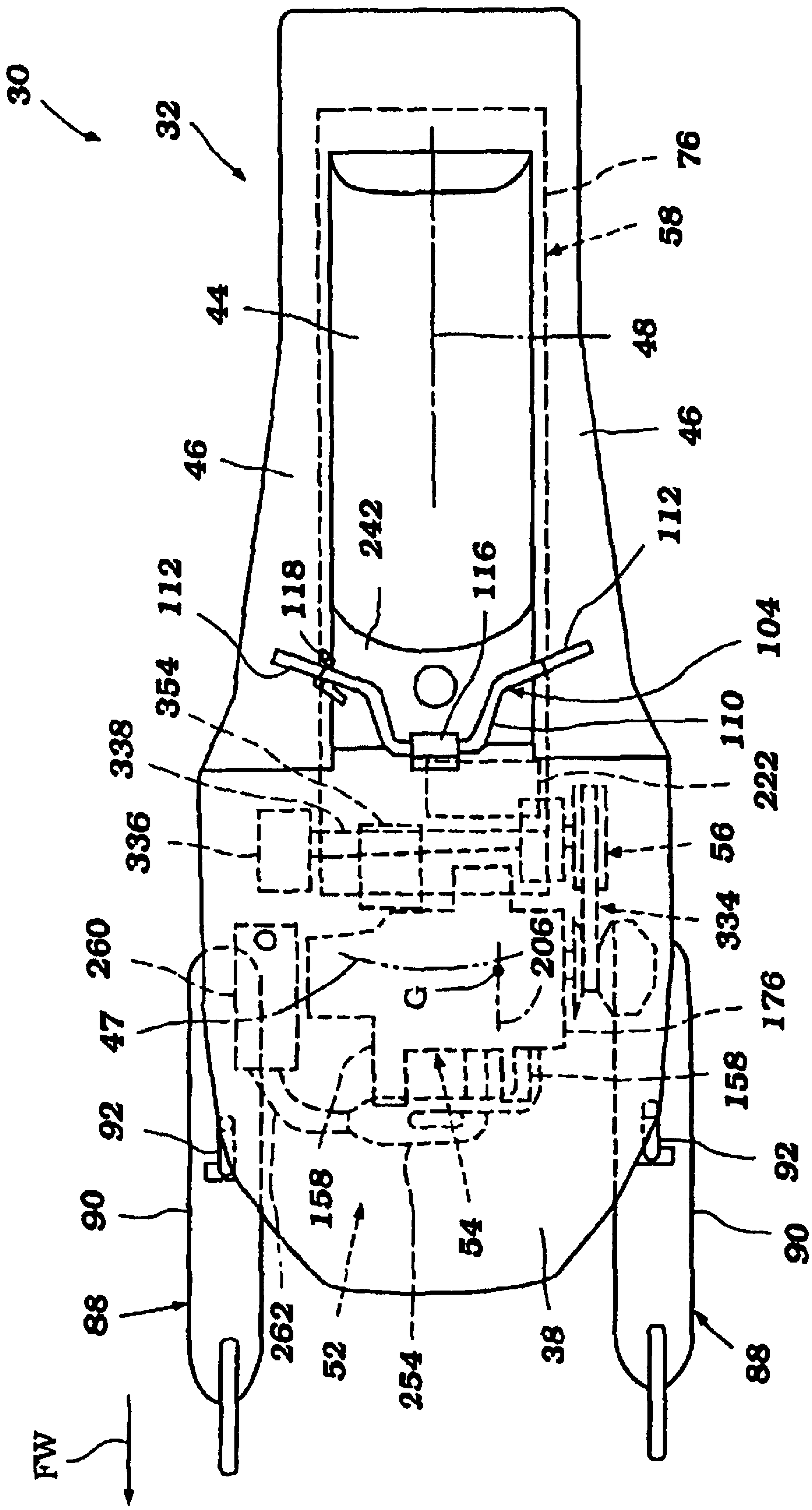
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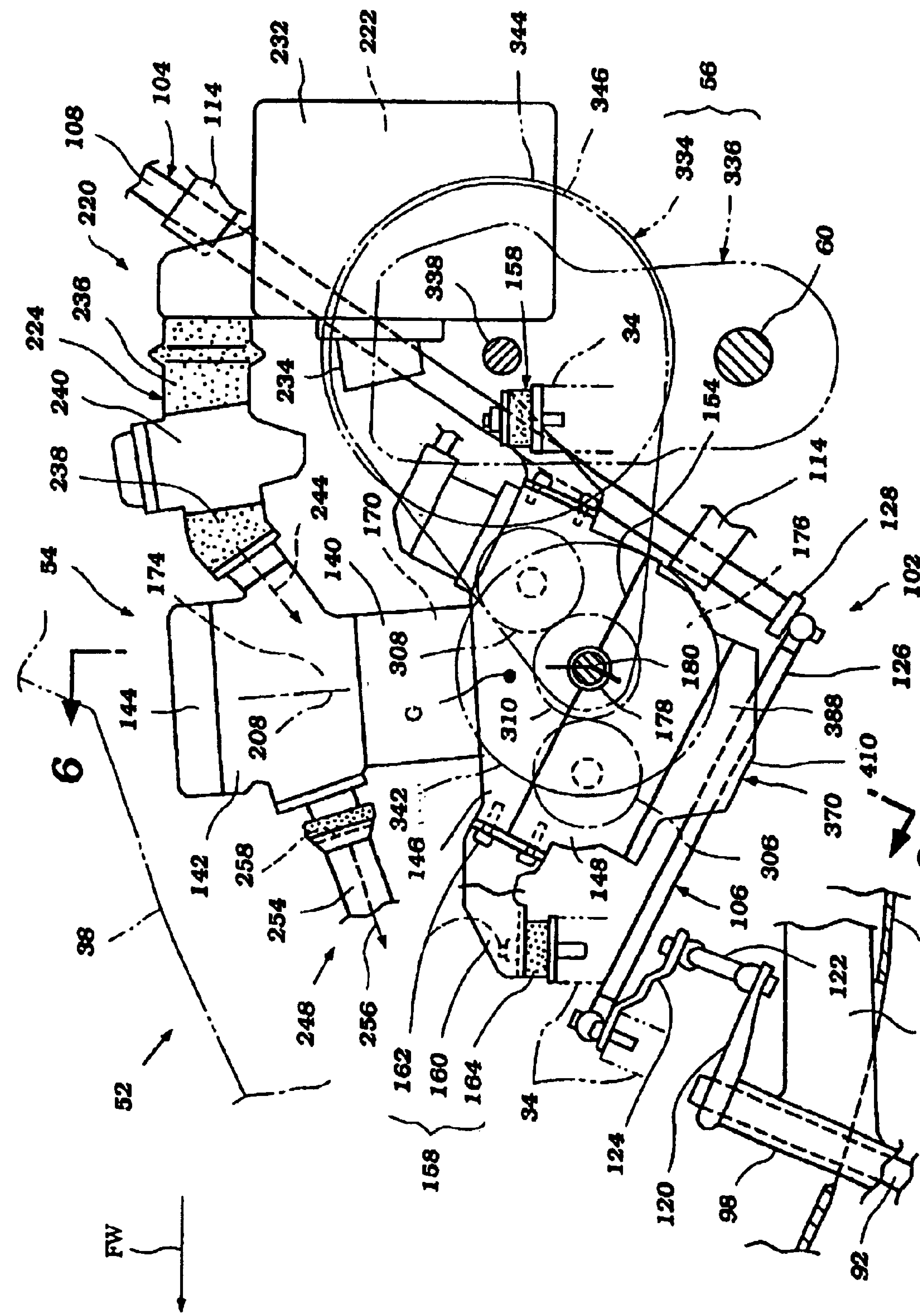
Figure 2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174
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176
102
308
180
126
6
144
G
310
178
388
208
410
142
258
342
146
148
306
370
6
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164
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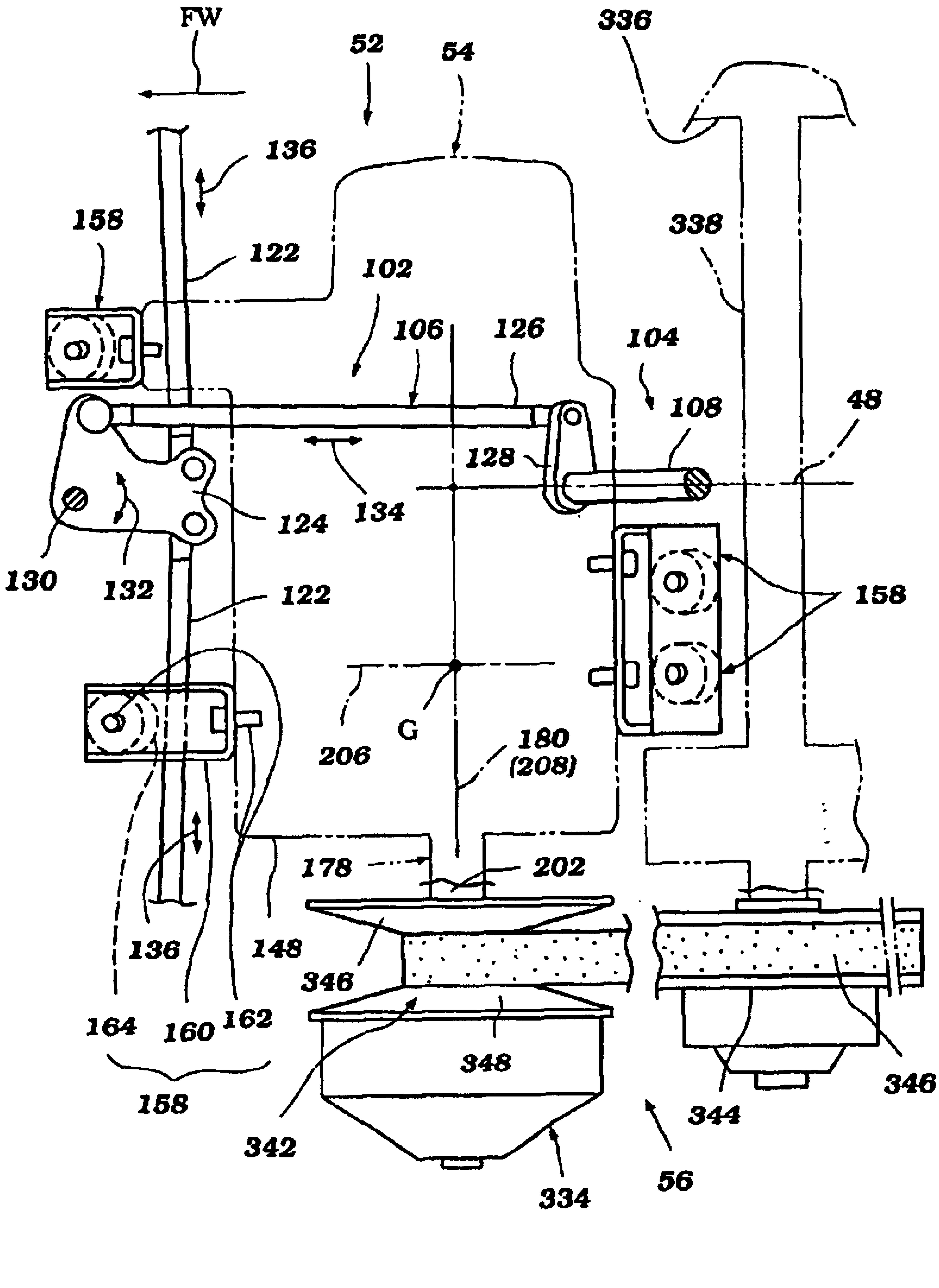
158
92
FW

Figure 3


FW
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G
180
(208)
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202
136
148
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164
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162
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346

Figure 4

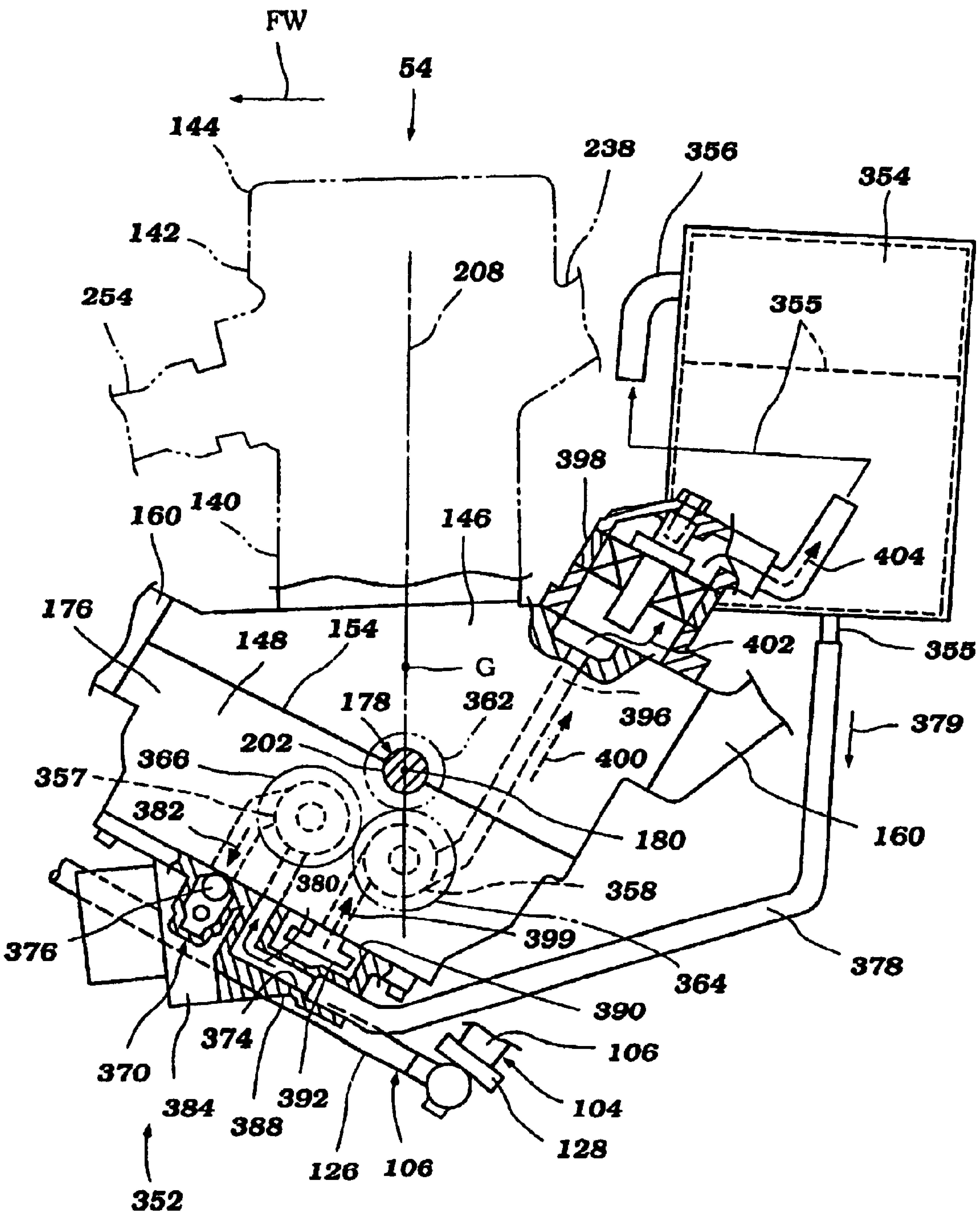
FW
54
144
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Figure 5

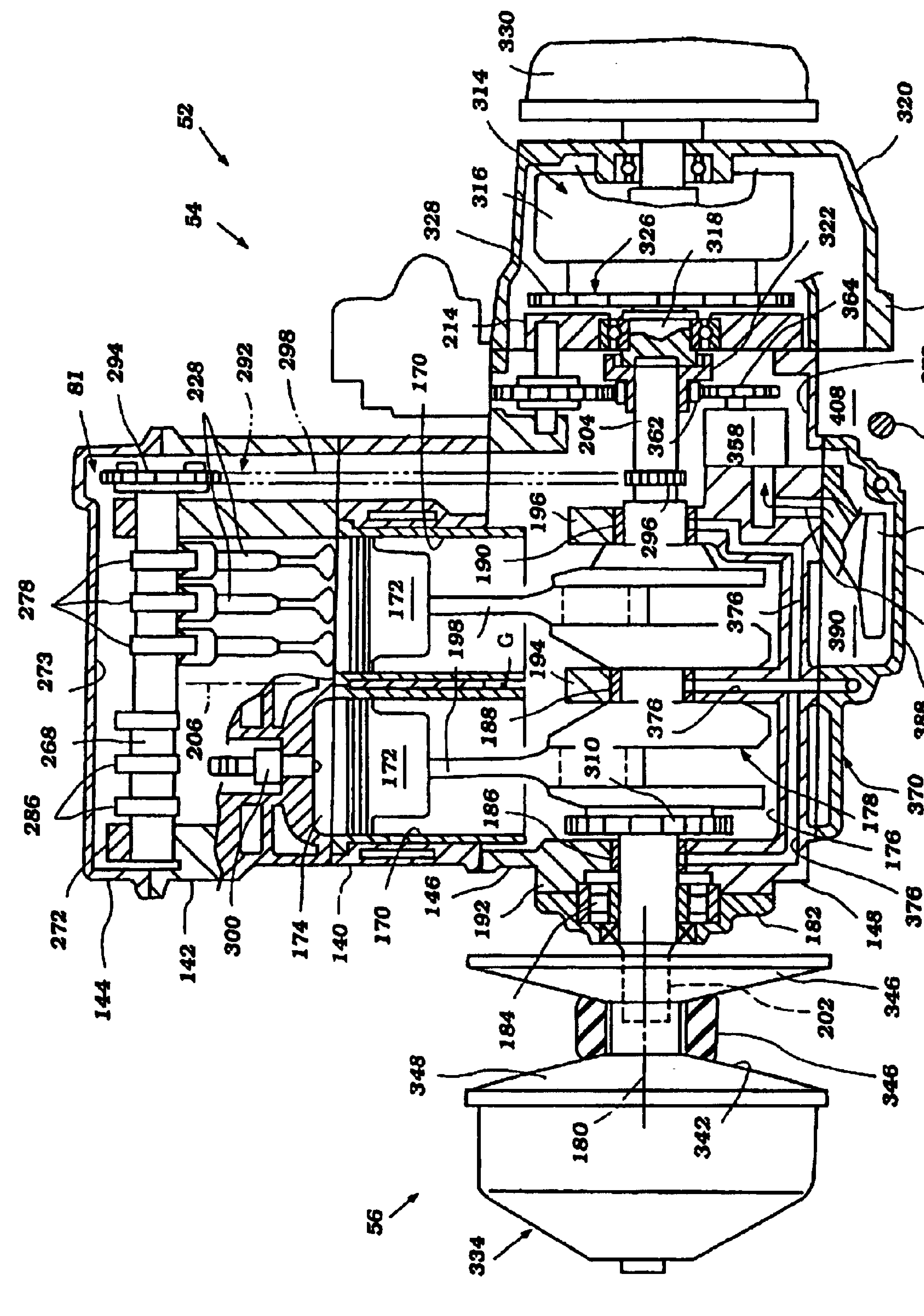
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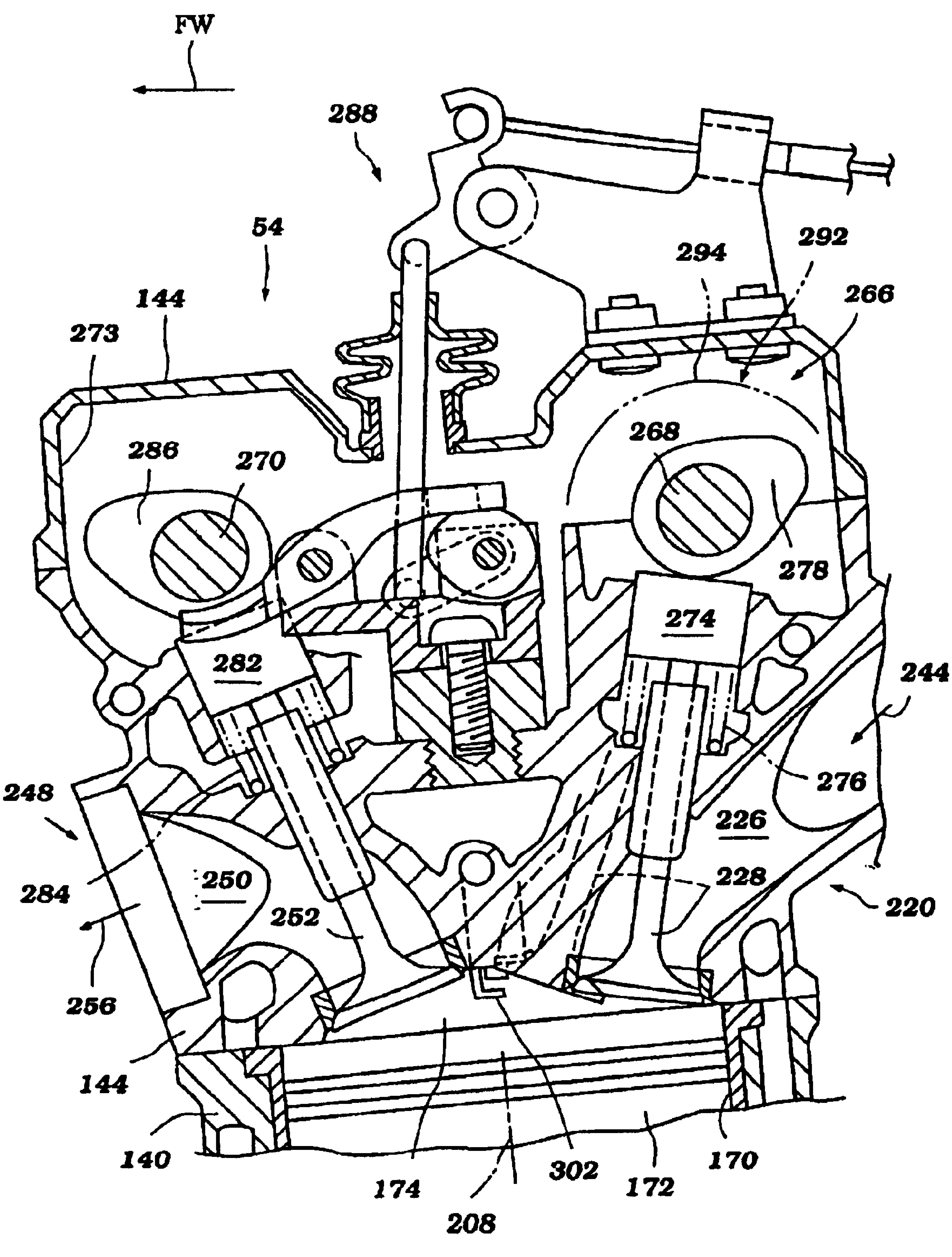
Figure 6



FW
288
54
144
273
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292
266
286
270
268
278
274
282
244
276
248
226
284
250
228
220
252
256
144
140
174
302
172
170
208

Figure 7

INTERNAL COMBUSTION ENGINE FOR A SNOWMOBILE

Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue.

RELATED APPLICATIONS

This application is related to Japanese Patent Application No. 11-184466, filed Jun. 29, 1999.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention generally relates to internal combustion engines for land vehicles and, more particularly, to internal combustion engines for powering snowmobiles.

2. Description of Related Art

Snowmobiles are popular land vehicles that are operated primarily in the winter over snowy terrain. A typical snowmobile comprises a frame assembly, a drive assembly that is coupled to the frame assembly and engages a ground surface to propel the snowmobile, an internal combustion engine supported by the frame for powering the snowmobile, and a transmission for transmitting power from the engine to the drive assembly.

In the past, two-stroke engines were typically used to power snowmobiles. More recently, however, four-cycle engines have been used, primarily for their reduced emissions. The four-stroke snowmobile engine typically comprises a crankcase assembly, a crankshaft supported for rotation within the crankcase assembly, a cylinder block assembly that extends from the crankcase, and a cylinder head assembly connected to an end of the cylinder block opposite the crankcase. A crankshaft is typically supported for rotation within the cylinder head to actuate a valve mechanism of the engine.

The crankshaft typically includes a drive sprocket located at one end of the crankshaft. The crankshaft may include a driven sprocket. The camshaft is driven from the crankshaft by a timing chain or belt that extends around the drive sprocket and the driven sprockets.

The transmission of the snowmobile is typically driven from the end of the crankshaft at which the drive sprocket is located. This end of the crankshaft typically has a relatively large diameter to transmit torque from the engine to the transmission. Because the drive sprocket is located at this same end of the crankshaft, the diameter of the drive sprocket is also typically relatively large.

For proper actuation of the valve mechanism, the driven sprockets of the camshafts generally must have a diameter that is twice the diameter of the drive sprocket. As a result, the size of the cylinder head which typically contains camshaft and driven sprockets must be relatively large. This undesirably increases the overall size of the engine.

In addition, in order to minimize engine vibrations during operation of the snowmobile, it is preferable that the center of gravity of the engine be located in the proximity of the cylinder (e.g., at the central axis of the cylinder in a single cylinder engine, or at the center of the group of cylinders in a multi-cylinder engine). However, because the large diameter end of the crankshaft extends from one side of the engine to power the transmission and the camshafts, the center of gravity of the engine typically is offset towards the end of the crankshaft.

A need therefore exists for a snowmobile having an improved four-cycle engine.

SUMMARY OF THE INVENTION

In accordance with one aspect of the present invention, a snowmobile is provided comprising a frame assembly and a drive assembly coupled to the frame assembly. The drive assembly includes a drive belt adapted to contact a ground surface to propel the snowmobile over the ground surface. An internal combustion engine is supported by the frame assembly. The engine comprises a crankcase, a crankshaft rotatably journaled within the crankcase, a cylinder block assembly extending from the crankcase, and a cylinder head assembly connected to an end of the cylinder block opposite the crankcase. A cam drive mechanism including at least one camshaft is rotatably journaled within the cylinder head assembly. A transmission is coupled to the crankshaft to transmit power from the engine to the drive assembly. The cam drive mechanism is connected to the crankshaft at a first end portion of the crankshaft. The transmission is connected to the crankshaft at a second end portion of the crankshaft opposite the first end portion.

In accordance with another aspect of the present invention, a snowmobile is provided comprising a frame assembly and a drive assembly coupled to the frame assembly. The drive assembly includes a drive belt adapted to contact a ground surface to propel the snowmobile over the ground surface. An internal combustion engine is supported by the frame assembly. The engine comprises a crankcase, a crankshaft rotatably journaled within the crankcase, and a cylinder block assembly extending from the crankcase and defining a cylinder bore. A piston is positioned for reciprocating movement in the cylinder bore. A connecting rod is coupled to the piston and the crankshaft to transmit motion therebetween. A cylinder head assembly is connected to an end of the cylinder block opposite the crankshaft, and a cam drive mechanism including at least one camshaft is rotatably journaled within the cylinder head assembly. A transmission is coupled to the crankshaft to transmit power from the engine to the drive assembly. The transmission and the cam drive mechanism are coupled to the crankshaft on opposite sides of the connecting rod.

Further aspects, features and advantages of this invention will become apparent from the detailed description of the preferred embodiment which follows.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other features, aspects and advantages of the present invention will now be described with reference to the drawings of a preferred embodiment, which is intended to illustrate and not to limit the invention. The drawings comprise seven figures.

FIG. **1** is a simplified side elevation view of a snowmobile configured and arranged in accordance with certain features, aspects and advantages of the present invention. Certain internal components have been illustrated with hidden lines.

FIG. **2** is a top plan view of the snowmobile of FIG. **1**.

FIG. **3** is an enlarged side elevation view, primarily showing an engine and a steering linkage.

FIG. **4** is an enlarged top plan view, primarily showing the engine and the steering linkage.

FIG. **5** is another enlarged side elevation view, primarily showing a lubrication system of the engine.

FIG. **6** is a cross-sectional view taken along the line **6**—**6** of FIG. **3**.

FIG. **7** is a cross-sectional view showing a combustion chamber, intake and exhaust ports, intake and exhaust valves and a valve drive mechanism of the engine.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT OF THE INVENTION

With reference initially to FIGS. **1**–**3**, a snowmobile **30** configured in accordance with certain features, aspects and advantages of the present invention is illustrated. Although the present invention will be shown and described in the context of the illustrated snowmobile **30**, some aspects and features of the present invention also can be employed with other land vehicles in manners that will become apparent.

In general, the snowmobile **30** operates over a snowfield or terrain, indicated generally with the reference letter S in FIG. **1**, which typically is covered with snow. The reference mark FW in the figures indicates a forward direction in which the snowmobile **30** generally moves. As used through this description, the terms "right" and "left" will mean at or to the respective sides in a top plan view relative to the forward direction FW.

The illustrated snowmobile **30** generally comprises a frame assembly **32**, which can include a plurality of frame members **34** (see FIG. **3**). The frame members **34** can be formed with sheet metal, metal pipes or the like and preferably are assembled in any suitable manner to have sufficient rigidity. Two side panels **36** generally cover the sides of the frame assembly **32** in the illustrated arrangement. In addition, a cowling member or hood **38** covers a forward portion of the frame assembly **32**. Preferably, the cowling member **38** is detachably coupled with the frame assembly **32** or pivotally hinged thereto at one end so as to pivot about the hinged portion. The side panels **36** and the cowling member **38** can be made of plastic or synthetic resin. A bottom plate **40** (see FIG. **3**), which can be made of sheet metal, advantageously covers a bottom portion of the frame assembly **32**. Thus, a substantially closed compartment is formed over a forward portion of the frame assembly **32** by the side panels **36**, the cowling member **38** and the bottom plate **40**.

A seat **44** can be disposed above a rear portion of the frame assembly **32**. In some arrangements, the seat **44** can be positioned such that a rider **45** can place her feet in front of the seat **44**. In the illustrated arrangement, the seat **44** is disposed such that the rider **45** straddles the seat with a foot positioned on each side of the seat **44**. Thus, in the illustrated arrangement, a pair of foot rests **46** are disposed on both sides of the seat **44**. A windshield **47** extends upwardly from the cowling member **38** to protect the rider **45** from wind and/or snow impinging upon him or her.

With reference to FIG. **2**, the frame assembly **32**, when provided with the side panels **36**, the cowling member **38**, the seat **44** and the wind shield **46**, generally is substantially symmetrically formed relative to an imaginary center plane **48** extending generally vertically and fore to aft through the frame assembly **32**. Due to the arrangement of the various body components, such as the seat **44**, the cowling **38**, and the side panels **36**, for instance, the frame assembly **32** is substantially enclosed.

The side panels **36** and the bottom plate **40** placed in front of the seat **44** together with the cowling member **38** define a generally closed cavity, as discussed above. A prime mover assembly **52** can be enclosed within the cavity. Because the cowling member **38** is detachably coupled with or pivotally hinged to the frame assembly **32**, the rider **45**, a mechanic or a repairman can access the prime mover asembly **52** for maintenance or the like. The illustrated prime mover assembly **52** generally comprises an internal combustion engine **54** and a transmission **56** which transmits power from the engine **54** to a drive assembly or unit **58** through a driveshaft **60**. In other words, the transmission converts the engine output to speed and torque. In the illustrated arrangement, the driveshaft **60** is journaled on the frame assembly **32**.

With reference again to FIG. **1**, the drive assembly **58** depends from the frame assembly **32** and is generally disposed beneath the seat **44**. The drive assembly **58**, although somewhat schematically shown in FIG. **1**, preferably includes a slide rail unit **64**, a drive sprocket **66**, a set of idle shafts **68** and a corresponding set of idle sprockets **70**. The slide rail unit **64** comprises a pair of slide rails which extend fore and aft along the center plane **48**. Preferably, the slide rails are spaced apart from one another. The respective idle shafts **68** extend generally transversely and are journaled on the illustrated slide rail unit **64**. The idle sprockets **70** preferably are suitably secured to the respective idle shafts **68**.

The slide rail unit **64** together with the drive sprocket **66** and the idle sprockets **70** support an endless drive belt **76**. More specifically, the slide rail unit **64** abuts a backside of the drive belt **76**, which is opposite the side of the drive belt **76** facing the terrain S, and the drive sprocket **66** engages with the drive belt **76** to provide rotational movement to the drive belt **76**. The respective idle sprockets **70** contact the drive belt **76** in known manners. With reference to FIG. **2**, the drive belt **76** has a relatively broad width and a longitudinal center line of the drive belt **76** is placed generally on the center plane **48**. When the drive sprocket **66** rotates, the drive belt **76** also rotates in a direction indicated by the arrows **78**, **80** in FIG. **1**. Because the drive belt **76** has a sufficient contact area with the terrain S, the drive belt **76** produces a friction or traction force and the rotation of the drive belt **76** propels the snowmobile along the terrain S.

The drive assembly **58** preferably is provided with at least one suspension unit **68**. The suspension units **84** suspend the slide rail units **64** and damp movement of the suspension unit **84** relative to the frame assembly **32**. The damping movement of the suspension units **84** properly absorbs shocks coming from rough surfaces of the terrain S and hence the rider **45** can enjoy a comfortable ride.

In the illustrated arrangement, the snowmobile **30** also includes a pair of steering skis **88**. Each ski **88** preferably comprises a ski member **90** and a knuckle pin **92**. The ski member **90** includes a contact area, which typically abuts on the terrain S during movement of the snowmobile **30**. The knuckle pin **92** is coupled with the ski member **90** at a generally top center portion of the ski member **90** and allows the ski to pivot fore and aft such that the ski member **90** can follow rough surfaces of the terrain S.

With reference to FIG. **1**, a pair of support members **94** supports the respective steering skis **88** at both sides of the frame assembly **32**. Each support member **94** preferably has one end **96** secured to the frame assembly **32**. A sleeve **98** is formed at the other end of the support member **94**. The sleeve **98** extends generally vertically and inclines slightly rearwardly. Preferably, the sleeve **98** is welded at a mid portion thereof to the support member **94**. The sleeve **98** pivotally supports the rod member **94** about a steering axis that extends generally vertically. Through this mounting arrangement, the ski members **90** can be steered, i.e., their forward portions are selectively directed in the right or left direction.

In order to steer the skis **88**, the snowmobile **30** includes a steering linkage **102** that is arranged and configured in accordance with certain features, aspects and advantages of the present invention. With reference now to FIGS. 2–5, the steering linkage **102** comprises a steering handle assembly **104** and a linkage assembly **106**.

The illustrated steering handle assembly **104** comprises a handle post **108**, a handle bar **110** and a pair of grips **112**. The handle post **108** extends generally vertically but its top portion inclines slightly rearward. The frame assembly **32** supports the handle post **108** with support members **114** (see FIG. **3**) in a manner that provides for pivotal movement of the handle post **108** about a steering axis. The handle bar **110** is positioned atop the handle post **108** and is coupled thereto by a coupling member **116** or in any other suitable manner. The grips **112** can be secured to both ends of the handle bar **110**. Preferably, a throttle lever **118** is provided on the right hand side of the handle bar **110**. In the illustrated arrangement, the handle post **108** defines a first linkage member in the linkage assembly **106**.

The linkage assembly **106** couples the steering handle assembly **104** with the steering skis **88** such that the pivotal movement of the steering handle assembly **102** about the steering axis moves the steering skis **88** in the right or left direction. The linkage assembly **106** in the illustrated arrangement includes two knuckle arms **120** (see FIG. **3**), two tie rods **122** (see FIG. **4**), a center arm **124**, a relay rod **126** and a pitman arm **128**. Of course, other components also can be incorporated and some components can be integrated into a single component.

In the illustrated arrangement, the knuckle arms **120** are mounted to the respective knuckle pins **92**. The tie rods **122** then couple the knuckle arms **120** with the center arm **124** which can pivot about a pivot axis **130** extending generally vertically as indicated by the arrows **132** of FIG. **4**. Of course, as shown in FIG. **3**, generally vertically should be construed to encompass a slight incline to accommodate the angles formed by the rotation axes running through the various components.

The forward end of the relay rod **126** in the illustrated arrangement is pivotally connected to a portion of the center arm **124**. The connection between the relay rod **126** and the center arm **124** preferably is offset from the pivot axis **130** so that the center arm **124** pivots about the pivot axis **130** when the relay rod **126** is pushed or pulled. The other end, i.e., the rear end, of the relay rod **126** is pivotally connected to one end of the pitman arm **128**. The pitman arm **128** preferably is affixed to a lower portion of the handle post **106**. In the illustrated arrangement, the relay rod **126** inclines such that the forward end of the relay rod **126** is positioned higher than the rear end. Such a configuration advantageously increases the area for the forward linkage to be positioned for operation by increasing the ground clearance at that location. In other words, the simpler connection is mounted lower than the more complicated connection (i.e., that having more moving components). In the illustrated arrangement, the relay rod **126** defines a second linkage member.

Because of this arrangement, when the rider **45** turns the handle post **108** with the handle bar **110**, the pitman arm **128** pivots about an axis of the handle post **108**. With this movement of the pitman arm **128**, the relay rod **126** is pushed or pulled in an axial direction as indicated by the arrows **134** of FIG. **4**. The center arm **124** thus pivots about the pivot axis **130** and moves the respective tie rods **122** right or left as indicated by the arrows **136**. Both of the tie rods **122** then move in the corresponding right or left direction. For example, if the tie rod **122** on the right hand moves in the right direction, the other tie rod **122** moves also in the right direction, and vice versa. The knuckle arms **120** then pivot the respective knuckle pins **92**. Accordingly, the respective steering skis **88** pivot in the right direction or left direction in compliance with the pivotal direction of the center arm **124**.

With reference now to FIGS. **3**–**7**, the prime mover assembly **52** is disposed within the substantially closed protective cavity defined by the side panels **36**, the bottom plate **40** and the cowling member **38**. The engine **54** is placed generally forward of the transmission **56** within this cavity.

In the illustrated arrangement, the engine **54** operates on a four-cycle principle and includes a cylinder block **140**, a cylinder head member **142**, a cylinder head cover member **144**, an upper crankcase member **146** and a lower crankcase member **148**. It is anticipated that some features, aspects and advantages of the present could be used with a two-stroke or rotary engine; however, the configuration of a four cycle engine particularly benefits from most features, aspects and advantages of the present invention.

In the illustrated arrangement, the upper crankcase member **146** is placed under the cylinder block **140** and the lower crankcase member **148** is placed under the upper crankcase member **146**. Both the crankcase members **146**, **148** are joined together at a coupling line **154** which is generally defined by a lower surface of the upper crankcase member **146** and an upper surface of the lower crankcase member **148**. In the illustrated arrangement, the coupling line **154** is inclined downwardly and rearwardly. In addition, the coupling line generally extends through at least a portion of the crankshaft **178** and, more preferably, is aligned with a rotational axis of the crankshaft.

With reference now to FIGS. **3** and **4**, the upper crankcase member **146** is mounted to the frame members **34** alone or in combination with the lower crankcase member **148** by a plurality of mount assemblies **158**. The illustrated mounting arrangement allows the engine **54** to be securely mounted to the frame assembly **32**. Each mount assembly **158** preferably includes a bracket or stay **160**, bolts **162** and an elastic member **164**. The brackets **160** can be attached to the crankcase members **146**, **148** directly by the bolts **162** and can be affixed to the frame assembly **32** indirectly via the elastic members **164** by the bolts **162**. The elastic members **164** preferably are made of a rubber material to isolate vibration energy from the frame. Advantageously, because the engine **54** is mounted on the frame assembly **32** in this manner, most of the low grade vibration produced by the engine **54** are not transferred to the frame assembly **32**. Although not shown, the transmission **56** preferably is coupled with the engine **54** and also can be mounted to the frame assembly **32** directly or indirectly via the engine **54**. IN other words, in some arrangements, the transmission **56** and the engine **54** are mounted to the frame assembly **32** as a single unit.

With reference now to FIG. **6**, the illustrated cylinder block **140** defines two cylinder boxes **170**. The cylinder bores **170** extend generally vertically and are horizontally spaced from each other so as to stand side by side. This type of engine, however, is only exemplary. Engines having other numbers of cylinder bores, having other cylinder arrangements, and/or operating on other combustion principles (e.g., two-stroke crankcase combustion or rotary) all can be used with certain features, aspects and advantages of the present invention.

A piston **172** can reciprocate in each cylinder bore **170**. The cylinder head member **142** is affixed to the top end of the cylinder block **140** and, together with the pistons **172** and the cylinder bores **170**, defines two combustion chambers **174**.

The upper and lower crankcase members **146**, **148** preferably close the lower end of the cylinder block **140**. The crankcase members **146**, **148** together define a crankcase chamber **176**. A crankcase **178** extends generally horizontally within the crankcase chamber **176** so that an axis **180** of the crankshaft **178** extends generally normal to the center plane **48**. In other words, the engine preferably is transversely mounted. The coupling line **154** crosses the axis **180** (see FIG. **5**). A crankcase cover member **182** preferably covers a left end of the coupled upper and lower crankcase members **146**, **148** and substantially encases a set of bearings **184** and a seat.

The crankcase **178** is journaled by the crankcase members **146**, **148** and the cover member **182**. In the illustrated arrangement, a plurality of bearings **184**, **186**, **188**, **190**, which are positioned at the cover member **182** and a left side portion **192**, a middle portion **194** and a right side portion **196** of the crankcase members **146**, **148**, respectively, support the crankcase **178**. The crankshaft **178** is connected to the pistons **172** by connecting rods **198** and is rotated by the reciprocating movement of the piston **172**. In the illustrated arrangement, the crankshaft **178** is configured so that the pistons **172** move 360 degrees out of phase relative to one another. That is, for example, when one of the pistons **172** is in the power stroke, the other piston **172** is in the intake stroke.

A left side end **202** of the crankshaft **178** extends beyond the cover member **182**, while the right side end **204** of the crankshaft **178** extends beyond the right portion **196**. In the illustrated embodiment, an imaginary vertical plane **206** extends through a center of the middle portion **194** generally parallel to the center plane **48**. Another imaginary vertical plane **208** which includes the crankshaft axis **180** crosses the vertical plane **206**. The center of gravity G of the engine **54** preferably exists generally in the line where both the vertical planes **206**, **208** cross each other and in generally a top area of the crankcase chamber **176**, as shown in FIGS. **3**–**6**.

With reference to FIG. **6**, in the illustrated arrangement, although the left side portion **192** actually defines an end wall of the crankcase chamber **176**, the right side portion **196** does not define the outer wall end of the crankcase chamber **176** and the chamber **176** expands further beyond the right side portion **196**. A bearing member **214**, which will be described shortly, substantially defines the right side end wall of the crankcase chamber **176**. A portion of the crankshaft **178** between the middle portion **194** and the right side portion **196** is positioned almost at the center of the crankcase chamber **176** along the crankshaft axis **180**.

With reference again to FIG. **3**, the engine **54** includes an air induction system **220** through which air is introduced into the combustion chambers **174**. The induction system **220** preferably includes a plenum chamber **222**, two air intake passages **224** and six intake ports **226** (FIG. **7**). As will be recognized, the number of intake passages and ports can vary.

The intake ports **226** are defined by the cylinder head member **142**. In the illustrated arrangement, three of the intake ports **226** are assembled with a single intake passage **224** and these intake ports **226** open into a single combustion chamber **174**. The intake ports **226** are repeatedly opened and closed by intake valves **228**. When the intake ports **226** are opened, the respective intake passages **224** communicate with the associated combustion chambers **174**.

The plenum chamber **222** generally functions as an intake silencer and/or a coordinator of air charges. The plenum chamber **222** preferably also functions as an air cleaner and contains a cleaner element that removes foreign substances (i.e., dirt and dust) from the air. In the illustrated arrangement, a plenum chamber member **232** defines the plenum chamber **222** and is mounted to the frame assembly **32** in a conventional manner. The plenum chamber member **232** preferably has an air inlet opening **234** that opens forwardly in the closed cavity. The illustrated intake passages **224** extend forwardly from the plenum chamber member **232**. Each intake passage **224** is defined by an upstream intake duct **236**, a downstream intake duct **238** and a carburetor **240** interposed between both the intake ducts **236**, **238**. The respective ducts **236**, **238** preferably are made of elastic material such as rubber.

The carburetor **240** includes a throttle valve and a fuel measurement mechanism that measures an amount of fuel supplied to the associated combustion chamber **174** in proportion to an amount of air measured by the throttle valve. The throttle valve is coupled with the throttle lever **118** on the handle bar **110** by an appropriate control cable so that the rider **45** can operate it. The fuel is introduced into the carburetor **240** from a fuel supply tank **242** (FIG. **1**), which preferably is disposed between the cowling member **38** and the seat **44**, through a proper fuel supply conduit.

The air in the cavity is introduced into the plenum chamber **222** through the air inlet opening **234** and then is introduced into the combustion chambers **174** through the respective intake passages **224** and the intake ports **226**, as indicated by the arrow **244** of FIGS. **3** and **7**. On the way to the combustion chambers **174**, the fuel is mixed with the air in the carburetors **240** to form air/fuel charges that can be burned in the combustion chambers **174**. The engine **30**, of course, can include a fuel injection system (either direct or indirect) instead of, or in addition to, the carburetors **240**, which are shown as one type of charge formers that can be employed.

The engine **54** also includes an exhaust system **248** that discharges burnt air/fuel charges or exhaust gases from the combustion chambers **174**. Two exhaust ports **250** are defined in the illustrated cylinder head member **144** for each combustion chamber **174** and are repeatedly opened and closed by a corresponding set of exhaust valves **252**. When the exhaust ports **250** are opened, the combustion chambers **174** communicate with an exhaust manifolds **254** (FIGS. **2** and **3**) which collects the exhaust gases and directs them away from the combustion chambers **174**, as indicated by the arrow **256** of FIGS. **3** and **7**. Preferably, the exhaust manifold **254** is connected to the exhaust ports **250** by intermediate tubular members **258** made of an elastic material, such as rubber. The exhaust manifold **254** is coupled with an exhaust silencer **260** through an exhaust conduit **262**. The exhaust gases move to the silencer **260** from the exhaust manifold **254**. The silencer **260** reduces exhaust noise to a predetermined level and then discharges the exhaust gases to the atmosphere, i.e., out of the cavity, through an appropriate exhaust pipe. The exhaust system can be tuned in any suitable manner.

The engine **54** preferably has a valve drive mechanism **266** that comprises an intake camshaft **268** and an exhaust camshaft **270**. The camshafts **268**, **270** extend generally parallel to one another and are journaled within the cylinder head member **142**, which has an appropriate bearing construction. Camshaft caps **272** (see FIG. **6**), which also have a suitable bearing construction, fix the camshafts **268**, **270** onto the cylinder head member **142**. The cylinder head cover member **144** defines a camshaft chamber **273** together with the cylinder head member **142**.

Each illustrated intake valve **228** comprises an intake valve tappet **274**. A bias spring **276** preferably urges each tappet **274** in a direction that closes the valve **228**. The intake camshaft **268** that has cam lobes **278** that can push the respective intake valve tappets **274** downwardly with the rotation of the intake camshaft **268** against the urging force of the bias springs **276**. The intake camshaft **268** thus actuates the intake valves **228** with the cam lobes **278** that push the tappets **274**. Accordingly, the associated intake ports **226** are opened and closed repeatedly by rotation of the camshaft **268**.

Like the intake valve **228**, each illustrated exhaust valve **252** comprises an exhaust valve tappet **282**. A bias spring **284** urges each tappet **282** such that the valve **252** is closed. The exhaust camshaft **270** also has cam lobes **268** that can push the respective exhaust valve tappets **282** downwardly against the urging force of the bias springs **284** with the rotation of the exhaust camshaft **270**. The exhaust camshaft **270** thus actuates the exhaust valves **252** with the rotation of the camshaft **270**. Accordingly, the associated exhaust ports **250** are opened and closed repeatedly by rotation of the camshaft **270**.

In the illustrated arrangement, the valve drive mechanism **266** further includes a decompression mechanism **288**. This mechanism **288** advantageously assists manual starting of the engine **54** (i.e., use of a recoil starter) by holding the exhaust valves **252** in the open position before the engine **54** starts. By holding the exhaust valves in an open position, the compression within the cylinder can be greatly reduced during the compression stroke of this piston. After the engine **54** starts, the mechanism **288** immediately releases the valves **252** for normal operation.

With reference again to FIG. **6**, the crankshaft **178** drives the camshaft **268**, **270** through a suitable cam drive mechanism **292**. The crankshaft **178** includes a drive sprocket **296** which, in the illustrated arrangement, is located at the right side end **204** of the crankshaft **178** to the right side of the connecting rods **198**. The driven sprockets **294** have a diameter that is twice as great as a diameter of the drive sprocket **296**. A flexible transmitter **298**, such as a timing chain or belt, is wound around the respective sprockets **294**, **296**. The crankshaft **178** therefore drives the respective camshafts **268**, **270**. A rotational speed of the camshafts **268**, **270** is half of the rotational speed of the crankshaft **178** because of the difference in the diameter of the respective sprockets **294**, **296**. That is, the engine **54** completes one cycle comprising the intake stroke, compression stroke, power stroke and exhaust stroke during two rotations of the crankshaft **178** and, thus, the valves are opened and closed once during the two cycles of the piston.

In the illustrated arrangement, the crankshaft **178** has a diameter at the right side end **204** thereof that is less than a diameter at the left side end **202**. The diameter of the left side end **202** of the crankshaft **178** must be relatively large in order to transfer power from the engine **54** to the transmission **56**. The diameter of the right side end **204** of the crankshaft **178**, however, need not be as large. Because the cam drive mechanism **292** is connected to the right side end **204** of the crankshaft **178** in the illustrated arrangement, the diameter of the drive sprocket **296** can be reduced. Consequently, the diameter of the driven sprockets **294**, which must be twice the diameter of the drive sprocket **296**, is reduced. The cylinder head member **142** and the cylinder head cover member **144** which house the driven sprockets **294** can therefore be reduced in size, thereby reducing the overall size of the engine **54**.

As indicated above, it is preferable that the center of gravity G of the engine **54** be located generally in the vertical plane **206** extending between the cylinders **170** in order to reduce engine vibrations during operation of the snowmobile **30**. Because, in the illustrated arrangement, the cam drive mechanism **292** is connected to the right side of end **204** of the crankshaft **178** instead of the left side end **202**, a length of the left side end **202** of the crankshaft **178** is reduced. Because the left side end **202** of the crankshaft **178** has a larger diameter than the right side end **204**, and thus has a greater mass per unit length, reducing the length of the left side end **202** serves to shift the center of gravity G of the engine **54** towards the vertical plane **206**. The location of the cam drive mechanism **292** at the right side end **204** of the crankshaft **178** further serves to balance the engine **54**.

The engine **54** further includes an ignition of fringe system that ignites the air/fuel charges in the combustion chambers **174** during every power stroke. Each combustion chamber **174** is provided with a spark plug **300** (see FIG. **6**) which has an electrode **302** (see FIG. **7**) exposed into the associated combustion chamber **174**. The ignition system makes a spark at each electrode **302** at an appropriate ignition timing under control of an ignited control device so that the air/fuel charge is properly ignited. The air/fuel charge burns and abruptly expands in a manner that pushes the piston **172** downward. The movement of the pistons **172** rotates the crankshaft **178**. The burnt charge or exhaust gases are then discharged through the exhaust system **248**, which has been described above.

With reference again to FIG. **3**, the engine **54** preferably includes balancers **306**, **308** disposed within the crankcase chamber **176** to balance the synchronous movement of the piston and to provide smooth rotation of the crankshaft **178**. The balancer **306** is journaled by the lower crankcase member **148** and is placed forwardly of the crankcase **178**, while the balancer **308** is journaled by the upper crankcase member **146** and is placed rearwardly of the crankcase **178**. The respective balancers **306**, **308** are driven through gear configurations. In the illustrated arrangement, the crankshaft **178** has a gear **310** next to the left side wall **192** of the crankcase members **146**, **148**. The balancers **306**, **308** mesh with the gear **310** so that the crankshaft **178** rotates both the balancers **306**, **308**. Preferably, the gear ratio is one-to-one to provide synchronous movement of the balancers and the crankshaft.

With reference again to FIG. **6**, the engine **54** further comprises a flywheel magneto assembly **314** positioned at a location beyond the bearing member **214**. The flywheel magneto assembly **314** preferably is housed in its own chamber and includes a rotor **316** and has a shaft **138** journaled for rotation by the bearing member **214**. A housing member **320** is affixed to the crankcase members **146**, **148** so as to enclose the flywheel magneto assembly **314** therein. A joint **322** couples the shaft **318** with the right side end **204** of the crankshaft **178** adjacent to the bearing member **214**. The crankshaft **178** thus rotates the shaft **218** of the rotor **316** through the joint **322**. The rotor **316** is configured in a generally cup-shape and a plurality of permanent magnets is affixed to an inner surface that defines the cup-shape. The flywheel magneto assembly **314** also includes a plurality of stator coils preferably affixed to a support member extending from an inner surface of the housing member **320** toward the rotor **316**. The arrangement allows the magnets to intermittently pass the coils. The flywheel magneto assembly **314** thus generates AC power when the magnets in the rotor **316** rotate relative to the stator coils. Preferably, a rectifier-regulator circuit converts the AC power to DC power and a battery accumulates the DC power for usage of electrical devices of the snowmobile **30**.

The rotor **316** preferably is made of metal and has sufficient weight to act as a flywheel. Because the rotor shaft **318** is separately formed from the crankshaft **178** and is coupled with the crankshaft **178** by the joint **332**, the crankshaft **178** length is advantageously shortened. This is advantageous because production of the crankshaft becomes easier.

The engine **54** also has a starter mechanism **326** that can start the engine **54**. The starter mechanism **326** preferably includes a starter gear **328** formed around the rotor shaft **318** and a starter motor which has a motor gear that meshes with the starter gear **328**. A main switch activates the starter motor. When the rider **45** turns on the main switch before the engine **54** has started, the starter motor rotates and the rotor shaft **318** is driven by the starter motor through the combination of the motor gear and the starter gear **328**. The rotor shaft **318** then rotates the crankshaft **178** through the joint **322** and the engine **54** thus is started.

In the illustrated embodiment, the starter mechanism **326** also includes a manual starter assembly **330** disposed outside of the housing **320** and at the outer end of the rotor shaft **318**. The manual starter assembly **330** preferably is a recoil starter and includes a coiled rope with a handle affixed to an outer end of the rope. By pulling the rope with the handle, the crankshaft **178** is rotated and the engine **54** can be started. The foregoing decompression mechanism **288** can assists this manual start. The rider **45** therefore can selectively use the electrical starter assembly, which comprises the starter gear **328** and the starter motor, or the manual starter assembly **330** for starting the engine **54**.

As described above, the snowmobile **30** is provided with the transmission **56**, which defines the other section of the prime mover assembly **52**, to transmit the output of the engine **54** to the drive assembly **58**. With reference to FIG. **3**, the transmission **56** includes an automatic transmission mechanism **334**, a reduction gear combination mechanism **336** and a transmission shaft **338**.

With reference to FIGS. **4** and **6**, the automatic transmission mechanism **334** preferably is generally disposed along the left side of the snowmobile **30**. The automatic transmission mechanism **334** includes a drive pulley **342** which, in the illustrated arrangement, is affixed to the left side end **202** of the crankshaft **178**. A driven pulley **344** is affixed to the left side end of the transmission shaft **338** and a transmission belt **346** is wound around both the pulleys **342**, **344**. The transmission belt **346** conveys the output power of the engine **54** to the transmission shaft **338**.

The drive pulley **342** includes a fixed member **347** and a moveable member **348**, which have conical shape. The moveable member **348** can move along the axis **180** of the crankshaft **178** and the separation between the fixed member **347** and the moveable member **348** can vary by centrifugal force. The belt **346** thus is positioned in a valley formed between the respective members **347**, **348**, which have conical shapes. When the engine speed increases, the effective diameter of the drive pulley **342** of the belt **346** increases because the moveable member **348** moves to the right. Of course, the driven pulley size also can be varied.

As seen in FIGS. **2** and **4**, the reduction gear combination mechanism **336** is generally disposed on the right hand side of the snowmobile **30**. This mechanism **336** includes a gear train that has at least a relatively small diameter gear affixed to the transmission shaft **338** and a relatively large diameter gear affixed to the driveshaft **60**. The gears mesh either directly or via other one or more other gears. The driveshaft **60** therefore rotates in a fixed reduced speed relative to the rotation of the transmission shaft **338**.

When the engine **54** operates under normal running condition, the output of the engine **54** is transmitted to the transmission shaft **338** from the crankshaft **178** through the automatic transmission mechanism **334**. The transmission shaft **338** rotates at a speed that is defined with the variable reduction ratio relative to the crankshaft **178** by the automatic transmission mechanism **354**. The transmission shaft **338** then rotates the driveshaft **60** in a speed that is defined with the fixed reduction ratio relative to the transmission shaft **338** by the reduction gear combination mechanism **336**. The driveshaft **60**, in turn, drives the endless drive belt **76** through the drive sprocket **66**. Accordingly, the drive belt **76** rotates and the snowmobile **30** can move.

With reference to FIGS. **3**–**6**, a lubrication system **352** is provided within the engine **54**. The lubrication system **352** is provided for lubricating engine portions such as bearings **186**, **188**, **190** and piston **172** that require lubrication to avoid seizure. In the illustrated arrangement, the lubrication system **352** employs a dry-sump configuration. This type of lubrication system **352** primarily includes a lubricant oil reservoir **354**, a delivery oil pump **357** and, in some arrangements, an oil return pump **358**.

With reference to FIGS. **2** and **5**, the oil reservoir **354** can be disposed generally behind the engine **54** and can be mounted on the frame assembly **32**. More specifically, in the illustrated arrangement, the oil reservoir **354** is positioned behind the cylinder block **140** and higher than the flywheel magneto assembly **314**. The location of the oil reservoir **354** is generally opposite to the drive pulley **342** of the automatic transmission mechanism **334** relative to the vertical plane **206**. The illustrated oil reservoir **354** has a supply outlet port **355** at a bottom portion thereof and a return inlet port **356** at a side portion thereof. The oil reservoir **354** preferably contains a preset level of lubricant oil. This level is generally kept substantially constant by oil that returns to the reservoir **354** after lubricating the engine portions. The oil is returned through an oil circulation mechanism that works with the delivery and return pumps **357**, **358** in the illustrated arrangement. Of course, the oil can be returned under the forces of gravity in some arrangements.

The delivery pump **357** and the return pump **358** in the illustrated arrangement are generally disposed in a space defined between the right side portion **196** of the crankcase members **146**, **148** an the bearing member **214**. That is, the pumps **357**, **358** are positioned lower than the oil reservoir **354**. Any type of pumps, for example, a trotted-type and a displacement-type, can be applied as the oil pumps **357**, **358**.

With reference to FIG. **5**, in the illustrated arrangement, the crankshaft **178**, the return pump **358** and the delivery pump **357** have gears **362**, **364**, **366**, respectively. The gear **362** of the crankshaft **178** meshes with the gear **364** of the return pump **358** and this gear **364** meshes with the gear **366** of the delivery pump **357**. Such a gear train or gear combination is only exemplary and can be of course changeable to any suitable arrangements. In addition, the pumps can be electrically driven, drive by chain or belt or any other suitable drive mechanism.

Preferably, an oil pan **370** depends from the lower crankshaft chamber **148** so that the oil that has lubricated the engine portions temporally accumulation therein. The oil pan **370** communicates with the crankcase chamber **176** through a plurality of oil return passageways 372 (see FIG. **6**). The oil pan **370** also comprises an inner oil supply passage **374** (see FIG. **5**) and an oil delivery passage **376**, at least in part. Both of the passages **374**, **376** communicate with the oil delivery pump **357**. An external oil supply conduit **378** couples the oil supply outlet port **355** with the inner oil supply passage **374**. The oil delivery pump **357** takes the oil in through the oil supply passages **378**, **374** and moves the oil through the oil delivery passage **376** as indicated with the arrows **379**, **380**, **382** of FIG. **5**. The pressurized oil is delivered to, for example, the bearings **186**, **188**, **190** and further to other engine portions. An oil filter assembly **384** (see FIG. **5**) preferably is provided for removing alien substances in the oil.

As noted above, the oil that has lubricated the engine portions return to the oil pan **370** through the oil return passageways **372**. The illustrated oil pan **370** preferably has a bulge portion **388** that defines a temporary oil chamber **390** wherein the returned oil temporarily accumulates. With reference to FIG. **6**, the bulge portion **388** advantageously is formed at the bottom area of the lower crankcase member **148** so as to be positioned generally at the center thereof along the axis **180** of the crankshaft **178**. In other words, the bulge portion **388** is positioned adjacent to the vertical plane **206** along the crankshaft axis **180**. An oil strainer **392** depends from the bottom surface of the lower crankcase member **148** into the temporary oil chamber **390** and a portion of the oil passes through the oil strainer **392**. The oil strainer **392** removed foreign substances from the returned oil to reduce the amount of foreign particulate matter that passes along the circulation system beyond the strainer **392**. It should be noted that the bulge portion **388** preferably is closely sized and configured to accommodate the strainer **392** such that the protrusion of the bulge portion **388** into the clearance area below the engine can be reduced.

The oil pump **388** is positioned along the oil return passage **396** which connects the temporary oil chamber **390** with the oil reservoir **354**. More specifically, the oil return passage **396** preferably is defined between an inlet opening or suction port of the strainer **392** and the return inlet port **356** of the oil reservoir **354**. In the illustrated arrangement, an oil cooler **398** is interposed between the oil return pump **358** and the oil reservoir **354** in the oil return passage **396**. The oil cooler **398** cools the oil before returning to the oil reservoir **354** because the oil that has lubricated the engine portions accumulates much heat and its viscosity therefore is lowered. The oil cooler **398** restores at least a portion of the lost viscosity and somewhat reconditions the oil. The oil return pump **358** collects the oil in the oil chamber **390** through the oil strainer **392** as indicated by the arrow **399** of FIGS. **5** and **6** and moves it through the oil return passage **396** up to the oil reservoir **354** as indicated by the arrows **400**, **402**, **404** of FIG. **5**. On the way to the reservoir **354**, the oil cooler **398** removes the heat accumulated in the oil.

When the engine **54** operates, the crankshaft **178** drives the oil delivery pump **357** and the oil return pump **358** through the gear train. The oil in the oil reservoir **354** pulled into the delivery pump **357** through the external oil supply passage **378** and the inner oil supply passage **374**. The oil then is pressurized by the delivery pump **357** and is delivered to the engine portions including the bearings **186**, **188**, **190** through the oil delivery passages **376**. After lubricating the engine portions, the oil drops down to the crankcase chamber **176** and gathers in the oil chamber **390** through the return passageways **372**. Then the oil is pumped up by the oil return pump **358** through the oil strainer **392** and returns to the oil reservoir **354** through the oil cooler **398** due to pressurized by the return pump **358**.

Preferably, the return pump **358** has a size larger than the delivery pump **357**. This is advantageous because the oil in the oil chamber **390** can be more quickly returned to the oil reservoir **354** and the oil does not overflow the chamber **390**. The size of the oil pan **370** therefore can be reduced.

With reference to FIG. **6**, in the illustrated arrangement the foreign housing member **320** has a lower portion or second bulge portion **406** projecting downward and its bottom surface is positioned slightly higher than the bottom surface of the bulge portion **388**. A space **408** is defined between the lower portion of the housing member **320** and the bulge portion **388** of the oil pan **370**.

As noted above, the bulge portion **388** is formed at the bottom area of the lower crankcase member **148** so as to be positioned generally at the center thereof along the axis **180** of the crankshaft **178**. This construction is advantageous because all of the oil, which drops downward under gravity, can travel to the oil chamber **176** over generally equal distances from all locations within the crankcase. Accordingly, oil is less likely to pool or stand and most all of the oil returns to the oil chamber **176** over time.

It is anticipated that the lubrication system **352** can employ a wet-sump method instead of the dry-sump method. In this method, the engine **54** needs no oil reservoir but requires an oil pan that is relatively larger because the oil for circulation is stored in the oil pan. Whether the lubrication system **352** employs the dry-sump method or the wet-sump method, a relatively voluminous pan generally is formed under the crankcase chamber **176**. As described above, the snowmobile **30** has a linkage assembly **106** that includes the relay rod **126** coupling the combination of the handle post **108** and the pitman arm **128** located to the rear of the engine **54** with the combination of the tie rods **122** and the center arm **124** located forward of the engine **54**. The relay rod **126** thus must pass through the engine area and can result in the oil pan **370** being improperly formed.

In the illustrated arrangement, the relay rod **126** and the oil pan **370** are generally horizontally juxtaposed with each other. In other words, the relay rod **126** extends through a region that includes the oil pan **370** at approximately the same vertical height as a portion of the oil pan **370** without extending through the oil pan **370**. With reference to FIG. **6**, the relay rod **126** preferably is positioned next to the bulge portion **388** which projects downward from the oil pan **370**. That is, the relay rod **126** extends in the space **408** that is defined between the lower portion of the housing member **320** and the bulge portion **388** of the oil pan **370**. Preferably, a mid portion of the relay rod **126** is generally positioned higher than a bottom surface **410** of the bulge portion **388** and is positioned generally at the same height as the bottom of the housing member **320**. A higher position of the relay rod **126** than the housing member **320** is of course possible. In addition, positioning the relay rod below a portion of the housing member **320** but at least level with (or higher than) the lowest portion of the engine, which may or not be the bottom surface **410** of the bulge portion **388** of the oil pan **370**.

Because of this arrangement, the relay rod **126** and the oil pan **370** can coexist without interfering with each other. In other words, the relay rod **126** can be spaced apart from the terrain S sufficiently and the engine **54** can be provided with the oil pan **370** that has a sufficient capacity.

The arrangement also has additional advantages. One of these additional advantages is that the bulge portion **388** can offer some degree of protection for the recessed relay rod **126**. For instance, in the event that the bottom plate **40** of the snowmobile **30** is deformed toward the relay rod **126** due to a collision with an obstruction in the terrain S, the deformed bottom plate **40** could ultimately contact and harm the rod **126**. In general, a rod member can be most easily damaged at is mid portion when external force is exerted thereon. Because the bottom surface **410** of the bulge portion **370** is generally positioned lower than the mid portion of the relay rod **126** in the illustrated arrangement, a deformed plate **40** would not likely contact the mid portion of the rod **126**. Thus, even if the plate were bent or otherwise distorted, the relay rod **126** would be substantially shielded from harm.

Moreover, in the illustrated arrangement, as described above, the location of the oil reservoir **354** is generally opposite to the driven pulley **342** of the automatic transmission mechanism **334** relative to the vertical plane **206**. This arrangement is useful for substantially equal allotment of the component weight to both sides of the snowmobile **30**.

Although the present invention has been described in terms of a certain preferred embodiment, other embodiments apparent to those of ordinary skill in the art also are within the scope of this invention. Thus, various changes and modifications may be made without departing from the spirit and scope of the invention. For instance, various components may be repositioned as desired. Moreover, not all of the features, aspects and advantages are necessarily required to practice the present invention. Accordingly, the scope of the present invention is intended to be defined only by the claims that follow.

What is claimed is:

[1. A snowmobile comprising a frame assembly, a drive assembly coupled to the frame assembly and including a drive belt adapted to contact a ground surface to propel the snowmobile over the ground surface, an internal combustion engine supported by the frame assembly, the engine comprising a crankcase, a crankshaft rotatably journaled within the crankcase, a cylinder block assembly extending from the crankcase, a cylinder head assembly connected to an end of the cylinder block opposite the crankcase, and a cam drive mechanism including at lest one camshaft rotatably journaled within the cylinder head assembly, and a transmission coupled to the crankshaft to transmit power from the engine to the drive assembly, wherein the cam drive mechanism is connected to the crankshaft, at a first end portion of the crankshaft, and the transmission is connected to the crankshaft at a second end portion of the crankshaft opposite the first end portion.**]**

2. The snowmobile of claim **[1]** *4*, wherein the crankshaft includes a drive sprocket at the second end portion thereof, the camshaft includes a driven sprocket, and a flexible transmitter extends around the drive sprocket and the driven sprocket to drive the camshaft from the crankshaft.

3. The snowmobile of claim **2**, wherein a diameter of the driven sprocket is twice a diameter of the drive sprocket.

4. **[**The snowmobile of claim **1**,**]** *A snowmobile comprising a frame assembly, a drive assembly coupled to the frame assembly and including a drive belt adapted to contact a ground surface to propel the snowmobile over the ground surface, an internal combustion engine supported by the frame assembly, the engine comprising a crankcase, a crankshaft rotatably journaled within the crankcase, a cylinder block assembly extending from the crankcase, a cylinder head assembly connected to an end of the cylinder block opposite the crankcase, and a cam drive mechanism including at least one camshaft rotatably journaled within the cylinder head assembly, and a transmission coupled to the crankshaft to transmit power from the engine to the drive assembly, wherein the transmission is connected to the crankshaft at a first end portion of the crankshaft, and the cam drive mechanism is connected to the crankshaft at a second end portion of the crankshaft opposite the first end portion,* wherein a diameter of the crankshaft at the second end portion is less than a diameter of the crankshaft at the first end portion.

5. **[**The snowmobile of claim **1**,**]** *A snowmobile comprising a frame assembly, a drive assembly coupled to the frame assembly and including a drive belt adapted to contact a ground surface to propel the snowmobile over the ground surface, an internal combustion engine supported by the frame assembly, the engine comprising a crankcase, a crankshaft rotatably journaled within the crankcase, a cylinder block assembly extending from the crankcase, a cylinder head assembly connected to an end of the cylinder block opposite the crankcase, and a cam drive mechanism including at least one camshaft rotatably journaled within the cylinder head assembly, and a transmission coupled to the crankshaft to transmit power from the engine to the drive assembly, wherein the transmission is connected to the crankshaft at a first end portion of the crankshaft, and the cam drive mechanism is connected to the crankshaft at a second end portion of the crankshaft opposite the first end portion,* further comprising a flywheel magneto assembly coupled to the crankshaft at the second end portion thereof.

6. The snowmobile of claim **5**, wherein the flywheel magneto assembly comprises a rotor having a shaft, and an end of the shaft is coupled to the crankshaft at the second end portion thereof.

[7. The snowmobile comprising a frame assembly, a drive assembly coupled to the frame assembly and including a drive belt adapted to contact a ground surface to propel the snowmobile over the ground surface, an internal combustion engine supported by the frame assembly, the engine comprising a crankcase, a crankshaft rotatably journaled within the crankcase, a cylinder block assembly extending from the crankcase and defining at least one cylinder bore, a piston positioned for reciprocating movement in the cylinder bore, a connecting rod coupled to the piston and to the crankshaft to transmit motion therebetween, a cylinder head assembly connected to an end of the cylinder block opposite the crankcase, and a cam drive mechanism including at least one camshaft rotatably journaled within the cylinder head assembly, and a transmission coupled to the crankshaft to transmit power form the engine to the drive assembly, wherein the transmission and the cam drive mechanism are coupled to the crankshaft on opposite sides of the connecting rod.**]**

8. The snowmobile of claim **[7]** *10*, wherein the crankshaft includes a drive sprocket at an end portion thereof, the camshaft includes a driven sprocket, and a flexible transmitter extends around the drive sprocket and the driven sprocket to drive the camshaft from the crankshaft.

9. The snowmobile of claim **8**, wherein a diameter of the driven sprocket is twice a diameter of the drive sprocket.

10. **[**The snowmobile of claim **7]** *A snowmobile comprising a frame assembly, a drive assembly coupled to the frame assembly and including a drive belt adapted to contact a ground surface to propel the snowmobile over the ground surface, an internal combustion engine supported by the frame assembly, the engine comprising a crankcase, a crankshaft rotatably journaled within the crankcase, a cylinder block assembly extending from the crankcase and* *defining at least one cylinder bore, a piston positioned for reciprocating movement in the cylinder bore, a connecting rod coupled to the piston and to the crankshaft to transmit motion therebetween, a cylinder head assembly connected to an end of the cylinder block opposite the crankcase, and a cam drive mechanism including at least one camshaft rotatably journaled within the cylinder head assembly, and a transmission coupled to the crankshaft to transmit power from the engine to the drive assembly, wherein the transmission and the cam drive mechanism are coupled to the crankshaft on opposite sides of the connecting rod,* wherein a diameter of the crankshaft at the drive sprocket is less than a diameter of crankshaft at the transmission.

11. **[**The snowmobile of claim **7]** *A snowmobile comprising a frame assembly, a drive assembly coupled to the frame assembly and including a drive belt adapted to contact a ground surface to propel the snowmobile over the ground surface, an internal combustion engine supported by the frame assembly, the engine comprising a crankcase, a crankshaft rotatably journaled within the crankcase, a cylinder block assembly extending from the crankcase and defining at least one cylinder bore, a piston positioned for reciprocating movement in the cylinder bore, a connecting rod coupled to the piston and to the crankshaft to transmit motion therebetween, a cylinder head assembly connected to an end of the cylinder block opposite the crankcase, and a cam drive mechanism including at least one camshaft rotatably journaled within the cylinder head assembly, and a transmission coupled to the crankshaft to transmit power from the engine to the drive assembly, wherein the transmission and the cam drive mechanism are coupled to the crankshaft on opposite sides of the connecting rod*, further comprising a flywheel magneto assembly coupled to the end portion of the crankshaft **[**the**]** adjacent the drive sprocket.

12. The snowmobile of claim 11, wherein the crankshaft includes a drive sprocket at an end portion thereof, the camshaft includes a driven sprocket, and a flexible transmitter extends around the drive sprocket and the driven sprocket to drive the camshaft from the crankshaft.

13. The snowmobile of claim 12, wherein a diameter of the drive sprocket is twice a diameter of the drive sprocket.

14. The snowmobile of claim 5, wherein the crankshaft includes a drive sprocket at the second end portion thereof, the camshaft includes a driven sprocket, and a flexible transmitter extends around the drive sprocket and the driven sprocket to drive the camshaft from the crankshaft.

15. The snowmobile of claim 14, wherein a diameter of the driven sprocket is twice a diameter of the drive sprocket.

16. A snowmobile comprising an engine driving a drive assembly, the drive assembly mounted to a frame assembly, the drive assembly including a drive belt adapted to contact a ground surface to propel the snowmobile over the ground surface, an internal combustion engine supported by the frame assembly, the engine comprising a center of gravity, a crankcase, a crankshaft rotatably journaled within the crankcase, a cylinder block assembly extending from the crankcase and defining at least one cylinder bore, a first valve regulating communication between a combustion gas passage and a cylinder bore and a second valve regulating communication between a combustion gas passage and a cylinder bore, a piston positioned for reciprocating movement in the cylinder bore, a connecting rod coupled to the piston and to the crankshaft to transmit motion therebetween, and a cam drive mechanism including a first cam lobe for actuating said first valve, a second cam lobe for actuating said second valve, at least one camshaft rotatably journaled within the engine and configured to actuate at least one of said first and second cam lobes, and a transmission coupled to the crankshaft to transmit power from the engine to the drive assembly, the transmission and the cam drive mechanism being coupled to the crankshaft on opposite sides of the connecting rod and arranged such that the center of gravity is located on the plane located between said first cam lobe and second cam lobe.

17. The snowmobile of claim 16, wherein the crankshaft includes a drive sprocket at an end portion thereof, the camshaft includes a driven sprocket, and a flexible transmitter extends around the drive sprocket and the driven sprocket to drive the camshaft from the crankshaft.

18. The snowmobile of claim 17, wherein a diameter of the driven sprocket is twice a diameter of the drive sprocket.

19. The snowmobile of claim 16, wherein a diameter of the crankshaft at the drive sprocket is less than a diameter of crankshaft at the transmission.

20. The snowmobile of claim 16, further comprising a flywheel magneto assembly coupled to the end portion of the crankshaft the adjacent the drive sprocket.

21. The snowmobile of claim 16, wherein the piston comprises a first piston and the connecting rod comprises a first connecting rod and further comprising a second piston and a second connecting rod, the second connecting rod coupled with the second piston and with the crankshaft to transmit motion therebetween, whereby the center of gravity of the engine is located between the first cylinder bore and the second cylinder bore.

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