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Vehicular Forward/Reverse Switching Apparatus

Abstract

A vehicular forward/reverse switching apparatus including a first engagement tab (501) rotatably disposed on a first shaft (401). The first engagement tab (501) has, on one end thereof, a pawl portion (501a) engaged with a cutout portion (206c) disposed in a shift s drum (206). A second engagement tab (502) is rotatably disposed on a second shaft (503) and has one end engaged with the other end of the first engagement tab (501). Rotation means (505) are provided for rotating the second engagement tab (502).

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COMPLETE SPECIFICATION

FOR A STANDARD PATENT

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Invention Title:	Vehicular forward/reverse switching apparatus

The following statement is a full description of this invention, including the best method of performing it known to me/us:-

Vehicular Forward/Reverse Switching Apparatus

Field of the Invention

The present invention relates to a vehicular forward/reverse switching apparatus used for switching between a forward motion and a reverse motion of a vehicle.

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Background of the Invention

Known as an example of a vehicular forward/reverse switching apparatus is an arrangement, in which a reverse stopper shaft includes a reverse stopper arm that is engaged with a stopper shoulder portion of a reverse cam groove in a shift drum for restricting rotation of the shift drum in a reverse direction. In this vehicular forward/reverse switching apparatus, the shift drum has, on an outer periphery thereof, the reverse cam groove including the stopper shoulder portion and the reverse stopper arm is urged in such a direction as to engage a leading end thereof with an inside of the reverse cam groove. The reverse stopper arm thereby restricts rotation of the shift drum in the reverse direction, while allowing the shift drum to rotate to a gear in a forward direction (refer to, for example, Japanese Patent Laid-open No. 2001-074139).

In the arrangement disclosed in Japanese Patent Laid-open No. 2001-074139, however, if a change spindle is disposed between the shift drum and the reverse stopper shaft, the shift drum and the reverse stopper shaft are disposed away from each other. The arrangement of the reverse stopper arm included in the reverse stopper shaft makes it necessary to extend the reverse stopper arm in accordance with the distance between the shift drum and reverse stopper shaft. This results in the reverse stopper arm having a large rotational range being disposed, which can lead to a larger internal combustion engine size.

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Objects of the Invention

It is the object of the invention to overcome, or at least ameliorate, one or more of the abovementioned disadvantages of the prior art.

- 5 It is an object of the present invention, at least in its preferred form, to provide a vehicular forward/reverse switching apparatus capable of promoting reduction in size of the internal combustion engine with a simple structure even with a change spindle disposed between a shift drum and a reverse stopper shaft.

Summary of the Invention

10 Accordingly, in a first aspect, the present invention provides a forward/reverse switching apparatus for a vehicle including a transmission for performing a gearshift by rotating a shift drum through a rotation of a change spindle and an internal combustion engine, the forward/reverse switching apparatus comprising:

- 15 a first engagement tab rotatably disposed on a first shaft, the first engagement tab having, on one end thereof, a pawl portion engaged with a cutout portion disposed in the shift drum;

a second engagement tab rotatably disposed on a second shaft, the second engagement tab having one end engaged with the other end of the first engagement tab;

- 20 and

rotation means for rotating the second engagement tab.

- Accordingly, the second engagement tab is rotated by the rotation means; one end of the second engagement tab is engaged with a side of the other end of the first engagement tab
25 so as to rotate the first engagement tab; the pawl portion disposed on one end of the first engagement tab is engaged with the cutout portion in the shift drum. Rotation of the

shift drum is thereby controlled. Even with the second shaft disposed away from the shift drum, therefore, rotational ranges of the first engagement tab and the second engagement tab can be set small so that reduction in size of the internal combustion engine can be promoted.

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Preferably, the first shaft includes a change spindle and the second shaft is disposed on a side opposite to the shift drum across the change spindle. This preferred arrangement allows the first engagement tab to be disposed rotatably on the change spindle disposed between the second shaft and the shift drum. Since the foregoing eliminates the need for providing a new shaft for supporting rotatably the first engagement tab, the internal combustion engine can be built to have a simple structure.

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Brief Description of the Drawings

Preferred embodiments of the invention will be described hereinafter, by way of examples only, with reference to the accompanying drawings, in which:

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Fig. 1 is a side elevational view showing a vehicle mounted with a vehicular forward/reverse switching apparatus according to an embodiment of the present invention;

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Fig. 2 is a plan view showing the vehicle shown in Fig. 1;

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Fig. 3 is a cross-sectional view taken along a line connecting centers of a cylinder head, a cylinder block, a crankshaft, a main shaft, a countershaft, an intermediate shaft, and a differential of a power unit for illustrating the vehicular forward/reverse switching apparatus according to the embodiment of the present invention;

Fig. 4 is a cross-sectional view taken along a plane that passes an axis of each of a fork shaft, the main shaft, a reverse shaft, the countershaft, and the fork shaft of the power unit shown in Fig. 3;

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Fig. 5 is a partly cutaway side elevational view showing a left crankcase of the power unit shown in Fig. 3, as viewed from an inside;

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Fig. 6 is a partly cutaway side elevational view showing the left crankcase of the power unit shown in Fig. 3, as viewed from an outside;

Fig. 7 is a partly cutaway side elevational view showing a right crankcase of the power unit shown in Fig. 3, as viewed from the outside;

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Fig. 8 is a side elevational view for illustrating a gear change mechanism shown in Fig. 7; and

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Fig. 9 is a cross-sectional view taken along a plane that passes an axis of each of the countershaft, the fork shaft, a shift drum, a change spindle, and a reverse stopper shaft of the power unit shown in Fig. 3.

Preferred Embodiments of the Invention

Figs. 1 through 9 are views showing an embodiment of the present invention. Fig. 1 is a side elevational view showing a vehicle mounted with a vehicular forward/reverse switching apparatus according to the embodiment of the present invention. Fig. 2 is a plan view showing the vehicle shown in Fig. 1. Fig. 3 is a cross-sectional view taken

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along a line connecting centers of a cylinder head, a cylinder block, a crankshaft, a main shaft, a countershaft, an intermediate shaft, and a differential of a power unit for illustrating the vehicular forward/reverse switching apparatus according to the embodiment of the present invention. Fig. 4 is a cross-sectional view taken along a plane that passes an axis of each of a fork shaft, the main shaft, a reverse shaft, the countershaft, and the fork shaft of the power unit shown in Fig. 3. Fig. 5 is a partly cutaway side elevational view showing a left crankcase of the power unit shown in Fig. 3, as viewed from an inside. Fig. 6 is a partly cutaway side elevational view showing the left crankcase of the power unit shown in Fig. 3, as viewed from an outside. Fig. 7 is a partly cutaway side elevational view showing a right crankcase of the power unit shown in Fig. 3, as viewed from the outside. Fig. 8 is a side elevational view for illustrating a gear change mechanism shown in Fig. 7. Fig. 9 is a cross-sectional view taken along a plane that passes an axis of each of the countershaft, the fork shaft, a shift drum, a change spindle, and a reverse stopper shaft of the power unit shown in Fig. 3. In Figs. 1 and 2, expressions indicating directions, that is, "front," "rear," "right," and "left," are as viewed from a rider of the vehicle, with Fr, Rr, L, and R representing front side, rear side, left-hand side, and right-hand side, respectively.

Referring to Figs. 1 and 2, a vehicle 10 is a compact four-wheeled vehicle. The vehicle 10 includes a vehicle body (vehicle body frame) 11, right and left front wheels 12, 12, right and left rear wheels, 13, 13, and a steering mechanism 14 of a handlebar 15 type disposed at a front portion thereof. The vehicle 10 also includes a front portion seat 16 and a rear portion seat 17 disposed at a central portion of the vehicle body 11, and a power unit (a forward/reverse switching apparatus, an internal combustion engine) 1 disposed at a rear lower portion of the vehicle body 11. The vehicle 10 further includes a front cover 18, a windscreen 19, a roof 20, and a rear cover 21. The front cover 18

covers an area around a front portion of the vehicle body 11. The windscreen 19 is mounted on an upper portion of the front cover 18. The roof 20 extends continuously from an upper end of the windscreen 19 rearwardly to cover an area upward of the front portion seat 16 and the rear portion seat 17. The rear cover 21 covers a rear portion of
5 the vehicle body 11.

The roof 20 has a support structure, in which right and left roof side pillars 22, 22 support the roof 20. The right and left roof side pillars 22, 22 are pipe roof pillars curved into an arch extending from a vehicle body front portion to a vehicle body rear portion. The
10 roof side pillars 22, 22 are a structure combining front pillars 23, 23 at the front portion and rear pillars 24, 24 at the rear portion.

The right and left front pillars 23, 23 are extended upwardly toward the rear from an upper end of the front cover 18 at the vehicle body front portion. A front portion cross
15 member 25 is then placed across upper ends of the right and left front pillars 23, 23. The windscreen 19 is disposed between the right and left front pillars 23, 23.

The right and left rear pillars 24, 24 are extended upwardly from upper ends of right and left support members 26, 26 disposed in the vehicle body rear portion and further
20 extended forwardly therefrom. Front ends of the right and left rear pillars 24, 24 are then removably bolted to rear ends of the front pillars 23, 23. A rear portion cross member 27 is then placed across upper ends of rear portions of the right and left rear pillars 24, 24. The right and left support members 26, 26 support the right and left rear pillars 24, 24 removably with bolts at upper ends thereof.

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The roof 20 having substantially a flat sheet shape is removably mounted to a frame including the right and left front pillars 23, 23, the right and left rear pillars 24, 24, and the front portion and rear portion cross members 25, 27. The roof 20 can thereby be supported.

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A rear end of the roof 20 is located rearward of the rear portion seat 17. The roof 20 has a width that is substantially equal to or slightly smaller than a vehicle width. The vehicle 10 has open sides, providing the rider and a rear portion passenger free egress/ingress.

10 As described in the foregoing, while the windscreen 19 can cover a front of the front portion seat 16, the roof 20 can cover the areas upward of the front portion seat 16 and the rear portion seat 17. Not only the rider, but also the rear portion passenger can thereby be protected from rain and the like. The arrangement is also advantageous in terms of rain and the like when luggage needs to be placed on the rear portion seat 17. Moreover,
15 because of the open sides with only the roof 20 placed overhead, egress/ingress is easy despite the presence of the roof 20.

The vehicle 10 further includes a gearshift lever 28, a parking lever 29, a headlamp 30, a turn signal light 31, a side mirror 32, front fenders 33, 33, rear fenders 34, 34, an
20 accelerator pedal (not shown), and a brake pedal (not shown).

Referring to Fig. 3, the power unit 1 is a water-cooled, four-stroke-cycle, single-cylinder internal combustion engine. As shown in Fig. 1, the power unit 1 has a crankshaft, the axis of which is orthogonal to a direction of travel of the vehicle. The power unit 1 is
25 mounted in the vehicle 10 such that a cylinder axis runs substantially horizontally along the direction of travel so that a cylinder head faces forward.

Referring again to Fig. 3, the power unit 1 includes a left crankcase 2, a right crankcase 3, a cylinder block 40, a cylinder head 50, a left crankcase cover 60, a right crankcase cover 61, and an intermediate gear accommodation chamber cover 62, all being connected
5 together to form an outer shell. A crankshaft 100, a transmission 200, and a differential 300 are disposed inside a crank chamber 4 formed by connecting the left crankcase 2 and the right crankcase 3 together. The left crankcase cover 60 is bolted to a left side surface of the left crankcase 2. The right crankcase cover 61 is bolted to a right side surface of the right crankcase 3.

10 The left crankcase 2 forms an intermediate gear accommodation chamber 5 for disposing therein a first intermediate gear 202a and a second intermediate gear 203a. The first intermediate gear 202a is secured to a countershaft 202 of the transmission 200 built in the left crankcase 2. The second intermediate gear 203a is secured to an intermediate
15 shaft 203. This is done to dispose the first intermediate gear 202a and the second intermediate gear 203a in a chamber different from the crank chamber 4. The intermediate gear accommodation chamber 5 is formed by making a peripheral wall 2c, which surrounds the first intermediate gear 202a and the second intermediate gear 203a, protrude outwardly of the left crankcase 2. An opening portion is closed by bolting the
20 intermediate gear accommodation chamber cover 62 to the left crankcase 2.

The cylinder head 50 is jointly fastened with the cylinder block 40, inserted into an upper portion opening of the left crankcase 2 and the right crankcase 3 connected together, by a stud bolt 45. A combustion chamber 51 is formed on a lower surface of the cylinder
25 head 50 and a spark plug 52 is mounted so as to face the combustion chamber 51.

A camshaft 53 of a valve train is rotatably supported in the cylinder head 50. A cam sprocket 54 is secured to an end portion of the camshaft 53. A cam chain 94 mounted around a drive sprocket 102 secured to the crankshaft 100 is mounted around the cam sprocket 54. A rotational driving force of the crankshaft 100 is thereby transmitted to the
5 camshaft 53. This drives a rocker arm 55 disposed in the cylinder head 50, thereby opening and closing an intake valve 56 (see Fig. 5) and an exhaust valve 57 (see Fig. 5) at predetermined timings in the combustion chamber 51.

A water pump 95 is disposed on the left-hand side of the cylinder head 50. A right end
10 portion of a pump shaft 96 of the water pump 95 is connected to a left end portion of the camshaft 53 of the valve train. This makes the pump shaft 96 rotate with the camshaft 53 to operate the water pump 95.

A water jacket 58 is formed adjacently upward of the combustion chamber 51 of the
15 cylinder head 50. Further, a water jacket 44 is formed in areas surrounding and near the combustion chamber 51 of the cylinder block 40. The water jacket 58 and the water jacket 44 are brought into communication with each other by connecting the cylinder head 50 to the cylinder block 40.

20 The crankshaft 100 includes left-hand and right-hand halves which are integrated together by a crankpin 101. The crankshaft 100 is rotatably supported via rolling bearings 70, 71 disposed in the left crankcase 2 and the right crankcase 3, respectively. An alternator 90 is assembled on the left-hand side in an axial direction of the crankshaft 100 and a torque converter 91 is assembled on the right-hand side in the axial direction of the crankshaft
25 100. A piston 42 is connected via a connecting rod 41 to the crankpin 101. The piston

42 makes a reciprocating motion in a cylinder axial direction in a cylinder liner 43 integrally molded with an inside of the cylinder block 40.

The alternator 90 generates a high voltage to be applied to the spark plug 52 through an
5 ignition coil (not shown), while generating a charge current for a battery (not shown).

The torque converter 91 includes a pump impeller 91a, a turbine runner 91b, a stator 91d,
and a stator fixing plate 91e. The pump impeller 91a is in splined connection with the
crankshaft 100. The turbine runner 91b is disposed opposingly to the pump impeller 91a.
10 The stator 91d is connected to the crankshaft 100 via a one-way clutch 91c. The stator
fixing plate 91e receives a reaction force applied to the stator 91d.

The torque converter 91 is packed with a torque converter oil that serves also for
lubrication of the crank chamber 4. If the turbine runner 91b does not follow the pump
15 impeller 91a as the pump impeller 91a rotates with the crankshaft 100, the stator 91d
receives a reaction force in a direction opposite to the direction of rotation of the pump
impeller 91a. The stator fixing plate 91e in turn receives the reaction force. A
rotational power drive of the turbine runner 91b is transmitted to a primary driven gear 93
of a multiple disc clutch 92 mounted on the right of a main shaft 201 via a primary drive
20 gear 103 mounted externally on the crankshaft 100.

The multiple disc clutch 92 is a wet type shift change clutch, assembled to the right of the
main shaft 201. The multiple disc clutch 92 includes an outer case 92a, in which a
plurality of clutch plates 92b and a plurality of clutch discs 92c are disposed alternately.
25 The multiple disc clutch 92 has a damper spring, a drive plate, a stop ring, a clutch spring,
a clutch weight, an outer drive gear, a center clutch, a free spring, and a set ring, all built

therein. In the multiple disc clutch 92, a clutch lifter lever 408 connected to a change spindle (a first shaft) 401 supported by the left crankcase 2 and the right crankcase 3 rotates a clutch lifter cam plate 92d assembled to the multiple disc clutch 92. This arrangement achieves the following. Specifically, during a gear change in the transmission 200, the rotational power drive of the crankshaft 100 is not transmitted to the transmission 200 so as to establish a neutral condition. At the same time that the gear change in the transmission 200 is completed, the rotational power drive of the crankshaft 100 is transmitted to the transmission 200.

Referring to Figs. 3 through 5, the transmission 200 includes the main shaft 201, the countershaft 202, the intermediate shaft 203, a reverse shaft 204, a fork shaft 205, and a shift drum 206. Each of these shafts is disposed in parallel with the crankshaft 100. It should be noted that Fig. 4 is a cross-sectional view taken along a line connecting the fork shaft 205, the main shaft 201, the reverse shaft 204, the countershaft 202, and the fork shaft 205, and accordingly, Fig. 4 shows two fork shafts 205. In reality, however, there is only one fork shaft 205.

The main shaft 201 is rotatably supported via rolling bearings 72, 73 disposed in the left crankcase 2 and the right crankcase 3, respectively. The main shaft 201 includes gears 201a, 201b, 201c, and 201d. The gears 201a and 201b are relatively rotatably passed over the main shaft 201. The gear 201c is rotationally locked, while axially slidably along the main shaft 201 between the gears 201a and 201b. The gear 201c can be engaged with the gear 201a or the gear 201b by the movement of a first shift fork 207. The gear 201d is integrally formed with the main shaft 201.

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The countershaft 202 is rotatably supported via rolling bearings 74, 75 disposed in the left crankcase 2 and the right crankcase 3, respectively. The countershaft 202 includes gears 202b, 202c, 202d, and 202e. The gear 202b is fixed in place. The gears 202c and 202d are relatively rotatably passed over the countershaft 202. The gear 202e is rotationally
5 locked, while axially slidably along the countershaft 202 between the gears 202c and 202d. The gear 202e can be engaged with the gear 202c or the gear 202d by the movement of a second shift fork 208. In addition, the first intermediate gear 202a (see Fig. 3) is secured to a left end portion of the countershaft 202. The first intermediate gear 202a is disposed inside the intermediate gear accommodation chamber 5.

10

The intermediate shaft 203 is rotatably supported via bearings 76, 77 disposed in the left crankcase 2 and the right crankcase 3, respectively. The intermediate shaft 203 includes the second intermediate gear 203a and a gear 203b. The second intermediate gear 203a is secured to the left end portion. The gear 203b is rotationally locked by being urged to
15 the left by a spring mechanism 209. The second intermediate gear 203a is disposed in the intermediate gear accommodation chamber 5. The gear 203b is disposed in a differential chamber 301. It is to be noted herein that the differential chamber 301 is formed, in the crank chamber 4 rearward of the transmission 200, independently of the crank chamber 4 and the intermediate gear accommodation chamber 5 by bulkheads 6, 7
20 formed in the left crankcase 2 and the right crankcase 3, respectively. The first intermediate gear 202a and the second intermediate gear 203a are in constant mesh with each other.

The reverse shaft 204 is supported by a fitting portion formed in each of the left crankcase
25 2 and the right crankcase 3. The reverse shaft 204 rotatably journals gears 204a, 204b formed integrally with each other.

The fork shaft 205 is supported by a fitting portion formed in each of the left crankcase 2 and the right crankcase 3. The fork shaft 205 journals the first shift fork 207 and the second shift fork 208 axially slidably. The first shift fork 207 and the second shift fork
5 208 slide along an axis of the fork shaft 205 through a stepwise rotation of the shift drum 206.

The shift drum 206 includes spiral cam grooves 206a, 206b formed on an outer periphery thereof. As the shift drum 206 rotates, the first and the second shift forks 207, 208
10 engaged with the cam grooves 206a, 206b, respectively, axially slide to effect a gearshift operation. In addition, the shift drum 206 is coaxially connected to a star-shaped cam plate 405 of a gear change mechanism 400 and rotated as the star-shaped cam plate 405 is rotated in a stepwise fashion.

15 The shift drum 206 further includes a reverse cam groove (a cutout portion) 206c formed on the outer periphery thereof on the side of the star-shaped cam plate 405. A pawl portion 501a formed on a stopper plate (a first engagement tab) 501 is engaged with the reverse cam groove 206c. The reverse cam groove 206c includes a stopper shoulder portion 206d that is formed therein and against which the pawl portion 501a abuts.

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The differential 300 is disposed inside the differential chamber 301. A ring gear 302 is engaged with the gear 203b of the intermediate shaft 203. Accordingly, a rotational power drive of the intermediate shaft 203 is transmitted to the ring gear 302 via the gear 203b and a differential gear mechanism 303 rotates left and right drive shafts 304, 305.

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Referring to Fig. 5, the cylinder head 50 includes an intake port 50a and an exhaust port 50b formed therein. The intake valve 56 is disposed in the intake port 50a. The exhaust valve 57 is disposed in the exhaust port 50b. An injector 59 is assembled into the intake port 50a. The injector 59 is electrically connected to an engine control unit not shown. By a current applied by this engine control unit, the injector 59 injects fuel under high fuel pressure into the intake port 50a according to an engine speed.

A parting surface of each of the left crankcase 2 and the right crankcase 3 includes an oil feed path 2a for feeding lubricating oil. The oil feed path 2a is formed symmetrically. The oil feed path 2a is hermetically sealed when the two crankcases 2, 3 are connected together. A front end portion of the oil feed path 2a is connected in fluid communication with a delivery port of an oil pump 80 (see Fig. 7) via an oil feed path 3a (see Fig. 7) and a distribution port 3b (see Fig. 7). A rear end portion of the oil feed path 2a is connected in fluid communication with an oil feed path (see Fig. 6) 5a included in the intermediate gear accommodation chamber 5. The oil pump 80 is operated as the crankshaft 100 rotates through a pump gear 81 and a gear 104 keyed to the crankshaft 100, delivering the lubricating oil to the distribution port 3b.

Referring to Fig. 6, the intermediate gear accommodation chamber 5 is formed by making the peripheral wall 2c, which surrounds the first intermediate gear 202a and the second intermediate gear 203a, protrude outwardly of the left crankcase 2, as described earlier. The peripheral wall 2c includes the oil feed path 5a having substantially an inverted L shape in side view formed in an end face thereof. The oil feed path 5a includes a center hole 5b, a main shaft hole 5c, a reverse shaft hole 5d, and connection grooves 5e, 5e. The center hole 5b communicates with the oil feed paths 2a, 3a. The main shaft hole 5c is disposed downward of the center hole 5b. The reverse shaft hole 5d is disposed

rearward of the center hole 5b. The connection grooves 5e, 5e connect the main shaft hole 5c, the center hole 5b, and the reverse shaft hole 5d in the end face of the peripheral wall 2c. Further, the main shaft hole 5c and the reverse shaft hole 5d penetrate into the crank chamber 4 from the end face of the peripheral wall 2c.

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The left crankcase 2 further includes an orifice hole 2d that penetrates therethrough. The orifice hole 2d is disposed adjacent to the main shaft hole 5c in the intermediate gear accommodation chamber 5. As shown also in Fig. 3, the orifice hole 2d communicates with the oil feed path 5a via the main shaft hole 5c and communicates with a lubricating oil path 201e (see Fig. 3) formed in the main shaft 201. In addition, a lubricating oil return hole 2e is open at a position on a backside of the first intermediate gear 202a in the intermediate gear accommodation chamber 5. The lubricating oil return hole 2e penetrates into the crank chamber 4.

10

Assembling the intermediate gear accommodation chamber cover 62 to the intermediate gear accommodation chamber 5 closes up the openings therein and hermetically seals the oil feed path 5a. While lubricating the first intermediate gear 202a and the second intermediate gear 203a through a bathtub system, the lubricating oil delivered through the orifice hole 2d drains to a bottom portion of the peripheral wall 2c. The lubricating oil accumulated in the bottom portion of the peripheral wall 2c is thereafter returned to the crank chamber 4 through the lubricating oil return hole 2e.

20

Accordingly, the lubricating oil delivered from the oil pump 80 is fed to the distribution port 3b (see Fig. 7). Part of the lubricating oil is then fed to a lubricating hole 105 of the crankshaft 100 through an oil feed path (not shown) formed in the right crankcase cover 61. The rest of the lubricating oil is fed to the oil feed path 3a formed in the right

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crankcase 3. The lubricating oil fed to the lubricating hole 105 flows through the torque converter 91 before being fed into the crankpin 101.

5 The lubricating oil fed to the oil feed path 3a in the right crankcase 3 is fed from the front end portion to the rear end portion of the oil feed path 2a formed in the left and right crankcases 2, 3 connected in fluid communication with the oil feed path 3a. The lubricating oil is then branched, in the oil feed path 5a of the intermediate gear accommodation chamber 5, from the center hole 5b to the main shaft hole 5c and to the reverse shaft hole 5d. The lubricating oil fed to the main shaft hole 5c is fed to the
10 rolling bearing 72 on the left of the main shaft 201 from the main shaft hole 5c. The lubricating oil is temporarily drawn into the lubricating oil path 201e (see Fig. 3) formed in the main shaft 201 before being fed to the orifice hole 2d, from which the oil is delivered into the intermediate gear accommodation chamber 5.

15 The lubricating oil fed from the center hole 5b to the reverse shaft hole 5d is, on the other hand, sent to a left-hand side portion of the reverse shaft 204 from the reverse shaft hole 5d. The lubricating oil is then fed into a lubricating oil path 204c (see Fig. 4) formed in the reverse shaft 204. It is to be noted herein that the lubricating oil accumulated in an oil pocket 3c formed in the right crankcase 3 is supplied to a lubricating hole 202f (see
20 Fig. 4) formed in the countershaft 202.

Referring to Figs. 4 and 7, the gear change mechanism 400 is mounted on the outer side surface of the right crankcase 3. The gear change mechanism 400 includes the change spindle 401, a change arm 402 including a shift plate 403, a sub-arm 404, the star-shaped
25 cam plate 405, a change arm return spring 406, a stopper roller 407, and the clutch lifter lever 408 (see Fig. 3).

The change spindle 401 is passed through a spindle pipe 401a (see Fig. 9) supported by the left and right crankcases 2, 3 and rotatably supported by a radial needle bearing 401b (see Fig. 9) disposed in the left crankcase 2. A sealing member 401c (see Fig. 9) is
5 disposed to the left of the radial needle bearing 401b.

Referring to Fig. 8, the change arm 402 includes a first arm portion 411 and a second arm portion 412, each extending from a center of a tubular support portion 410 journaled on the change spindle 401 in two directions with an included angle of substantially 60
10 degrees therebetween. A pair of guide pins 413, 414 is secured to the first arm portion 411 along a centerline thereof. The shift plate 403 is disposed on the side of the right crankcase 3.

The shift plate 403 has a head portion that is substantially shaped like an umbrella. The
15 shift plate 403 is held by the guide pins 413, 414 on the change arm 402 with a centerline thereof aligned with a centerline of the first arm portion 411. The shift plate 403 includes feed protrusions 415, 416 on edges of both ends. Slots 417, 418 are externally inserted over the guide pins 413, 414. Both ends of a shift plate urge spring 419 assembled to the guide pin 413 are locked to the feed protrusions 415, 416. Accordingly,
20 the shift plate 403 is supported slidably according to a length of the slots 417, 418 relative to the first arm portion 411. The shift plate 403 is thereby urged so as to overlap the first arm portion 411.

The second arm portion 412 includes an opening portion 420 at a central portion thereof.
25 The second arm portion 412 also includes a protrusion 421 in the opening portion 420 on

the side of the tubular support portion 410. The protrusion 421 is engaged with the change arm return spring 406.

5 The sub-arm 404 is disposed on a centerline of the second arm portion 412 in the change arm 402. The sub-arm 404 is welded to the change spindle 401 passed through the tubular support portion 410 of the change arm 402. The sub-arm 404 includes a protrusion 422 inserted in the opening portion 420 in the change arm 402 and engaged with the change arm return spring 406. The sub-arm 404 is rotated integrally with the change spindle 401 with the clutch lifter lever 408.

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Further, the change arm 402 and the sub-arm 404 are urged in a central direction of a restricting shaft member 429 protruding from the right crankcase 3 by two leading end portions 427, 428 of the change arm return spring 406 assembled onto an outer periphery of the tubular support portion 410 of the change arm 402 and the restricting shaft member 15 429 projected from the right crankcase 3. As a result, regardless of in which direction the change arm 402 and the sub-arm 404 rotate, an urge force acts such that the protrusion 422 of the sub-arm 404, the restricting shaft member 429, and the protrusion 421 of the second arm portion 412 are aligned coaxially when a rotational force of the change arm 402 and the sub-arm 404 is gone.

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The star-shaped cam plate 405 is a sheet member having substantially a star shape with six peaks. The star-shaped cam plate 405 is secured to a right end portion of the shift drum 206 using a bolt 423 (see Fig. 4). The star-shaped cam plate 405 includes six peaks 424 and six troughs 425 formed continuously on an outer periphery thereof. 25 Further, six feed pins 426 are press-fitted in place in the star-shaped cam plate 405 at positions corresponding to a central position of each of the six peaks 424. These feed

pins 426 are equally-spaced in a circumferential direction of the star-shaped cam plate 405.

The stopper roller 407 is rotatably bolted to an outer side surface of the right crankcase 3.

5 The stopper roller 407 rotatably journals a pressure roller 430 at a leading end portion thereof. The stopper roller 407 has a stopper roller return spring 431 hooked thereto for urging to press the pressure roller 430 toward the star-shaped cam plate 405 at all times.

In this gear change mechanism 400, the change spindle 401 is rotated by operation of the
10 gearshift lever 28 (see Fig. 1). In accordance with either a forward or a backward rotation of the change spindle 401, the sub-arm 404 and the clutch lifter lever 408 rotate forward or backward. With the rotation of the clutch lifter lever 408, the clutch lifter cam plate 92d is rotated to place the multiple disc clutch 92 in a neutral condition. As the sub-arm 404 rotates, on the other hand, the change arm 402 is rotated. Then, either
15 one of the feed protrusions 415, 416 on the edges of both ends of the shift plate 403 contacts one of the feed pins 426 of the star-shaped cam plate 405, causing the star-shaped cam plate 405 to be rotated. This results in the shift drum 206, in which the star-shaped cam plate 405 is mounted, being rotated. When the change spindle 401 loses its rotational force and the change arm 402 is returned to its reference position by a snapping
20 force of the change arm return spring 406, an outer edge portion of either one of the feed protrusions 415, 416 of the shift plate 403 abuts against one of the feed pins 426 of the star-shaped cam plate 405. The shift plate 403 then overcomes the urge force of the shift plate urge spring 419 to slide away from the change spindle 401. This causes either one of the feed protrusions 415, 416 to ride over one of the feed pins 426. The star-shaped
25 cam plate 405 is thereby rotated through one step of 60 degrees. The star-shaped cam plate 405 is stably held in positions before and after the rotation as follows. Specifically,

the pressure roller 430 of the stopper roller 407 fits into one of the troughs 425 of the star-shaped cam plate 405 by the urge force of the stopper roller return spring 431. It is to be noted herein that the star-shaped cam plate 405 (shift drum 206) is rotated in a clockwise direction (see Fig. 5) to make a downshift and in a counterclockwise direction to make an
5 upshift.

When an attempt is made with the gear change mechanism 400 to rotate the shift drum 206 from the neutral condition in a reverse direction, a shift drum control mechanism 500 for restricting or releasing rotation of the shift drum 206 restricts the rotation of the shift
10 drum 206 in the clockwise direction (see Fig. 5). It should be noted that rotation of the shift drum 206 through the neutral – 1st speed – 2nd speed – 3rd speed is not restricted both in upshift and downshift.

Referring to Figs. 5 and 9, the shift drum control mechanism 500, disposed inside the
15 right crankcase 3, includes the stopper plate 501, a reverse stopper arm (a second engagement tab) 502, a reverse stopper shaft (a second shaft) 503, a stopper plate return spring 504, and a reverse release arm (rotation means) 505. The reverse stopper shaft 503 supports the reverse stopper arm 502. The stopper plate return spring 504 urges the stopper plate 501. Reference numeral 503a in Fig. 9 represents a sealing member fitted
20 between the reverse stopper shaft 503 and the left crankcase 2.

The stopper plate 501 is rotatably supported by the spindle pipe 401a of the change spindle 401. The stopper plate 501 is disposed so as to make a sliding contact with an inner surface of the right crankcase 3. The stopper plate 501 includes the pawl portion
25 501a formed on one end thereof and a protruding tab 501b formed on the other end thereof. The pawl portion 501a is engaged with the reverse cam groove 206c of the shift

drum 206. The protruding tab 501b is engaged with the reverse stopper arm 502. One end portion of the stopper plate return spring 504, which is assembled to the spindle pipe 401a and the other end of which is locked onto an engagement portion 3d of the right crankcase 3, is locked onto an upper end portion of the pawl portion 501a of the stopper plate 501. This arrangement causes the stopper plate 501 to be urged in the direction of the shift drum 206 and the pawl portion 501a to be engaged with the reverse cam groove 206c in the shift drum 206.

The reverse stopper arm 502 is welded to a right end portion of the reverse stopper shaft 503 that is rotatably supported by a fitting portion formed in each of the left crankcase 2 and the right crankcase 3. The reverse stopper arm 502 is disposed so as to make a sliding contact with the inner surface of the right crankcase 3. The reverse stopper arm 502 is a sheet member having substantially an L shape. The reverse stopper arm 502 includes an engagement tab 502a formed on one end thereof, the engagement tab 502a being engaged with the protruding tab 501b of the stopper plate 501. The reverse stopper arm 502 also includes a stroke restriction tab 502b formed on the other end thereof, the stroke restriction tab 502b restricting rotation of the reverse stopper arm 502. These arrangements allow the reverse stopper arm 502 to be rotated until the stroke restriction tab 502b contacts an arm stopper 3e of the right crankcase 3. Accordingly, there is no chance that engagement of the protruding tab 501b with the engagement tab 502a will be disengaged.

The reverse stopper shaft 503 has a left end portion protruded to a side surface of the left crankcase 2. The reverse release arm 505 is bolted to this protruded left end portion. A reverse release lever (not shown) included in the vehicle 10 is connected to the reverse release arm 505 via a cable or the like. When the gearshift lever 28 (see Fig. 1) is placed

in reverse, the reverse release arm 505 is rotated in the clockwise direction (see Fig. 6) through operation of the reverse release lever not shown. This rotates the reverse stopper arm 502 in the counterclockwise direction (see Fig. 5), which in turn rotates the stopper plate 501 in the clockwise direction (see Fig. 5).

5

As the stopper plate 501 is rotated in the clockwise direction (see Fig. 5) through the rotation of the reverse release arm 505, the engagement between the pawl portion 501a of the stopper plate 501 and the reverse cam groove 206c in the shift drum 206 is disengaged. This allows the shift drum 206 to be rotated in the reverse direction (in the clockwise
10 direction in Fig. 5). The gear change mechanism 400 is now able to rotate the shift drum 206 in the reverse direction through the operation of the gearshift lever 28. The transmission 200 can now be shifted into reverse.

As a modified example of this embodiment of the present invention, the stopper plate
15 return spring 504 may be installed in the reverse stopper shaft 503, instead of the spindle pipe 401a of the change spindle 401. In this modified arrangement, the stopper plate return spring 504 is disposed such that the reverse stopper arm 502 is urged in the clockwise direction (see Fig. 5).

20 The vehicular forward/reverse switching apparatus 1 as described in the foregoing includes: the stopper plate 501 rotatably disposed on the change spindle 401, the stopper plate 501 having, on one end thereof, the pawl portion 501a engaged with the reverse cam groove 206c disposed in the shift drum 206; the reverse stopper arm 502 rotatably disposed on the reverse stopper shaft 503, the reverse stopper arm 502 having the
25 engagement tab 502a one end thereof engaged with the other end of the protruding tab 501b on the side of the other end of the stopper plate 501; and the reverse release arm 505

for rotating the reverse stopper arm 502. Accordingly, the reverse stopper arm 502 is rotated by the reverse release arm 505; the engagement tab 502a of the reverse stopper arm 502 is engaged with the protruding tab 501b of the stopper plate 501 so as to rotate the stopper plate 501; the pawl portion 501a of the stopper plate 501 is engaged with the
5 reverse cam groove 206c in the shift drum 206. Rotation of the shift drum 206 is thereby controlled. Even with the reverse stopper shaft 503 disposed away from the shift drum 206, therefore, rotational ranges of the stopper plate 501 and the reverse stopper arm 502 can be set small so that reduction in size of the internal combustion engine can be promoted.

10

The vehicular forward/reverse switching apparatus 1 as described in the foregoing has the arrangement, in which the stopper plate 501 is disposed rotatably on the change spindle 401 disposed between the reverse stopper shaft 503 and the shift drum 206. This eliminates the need for providing a new shaft for supporting rotatably the stopper plate
15 501, which allows the internal combustion engine to be built to have a simple structure.

While the invention has been described with reference to specific embodiments, it will be appreciated that it may also be embodied in many other forms.

The claims defining the invention are as follows:

1. A forward/reverse switching apparatus for a vehicle including a transmission for performing a gearshift by rotating a shift drum through a rotation of a change spindle and an internal combustion engine, the forward/reverse switching apparatus comprising:

5 a first engagement tab rotatably disposed on a first shaft, the first engagement tab having, on one end thereof, a pawl portion engaged with a cutout portion disposed in the shift drum;

a second engagement tab rotatably disposed on a second shaft, the second engagement tab having one end engaged with the other end of the first engagement tab;

10 and

rotation means for rotating the second engagement tab.

2. The forward/reverse switching apparatus according to claim 1, wherein the first shaft includes a change spindle and the second shaft is disposed on a side opposite to the shift drum across the change spindle.

3. A forward/reverse switching apparatus for a vehicle including a transmission for performing a gearshift by rotating a shift drum through a rotation of a change spindle and an internal combustion engine, the forward/reverse switching apparatus substantially as hereinbefore described with reference to any one of the embodiments, as that embodiment is shown in the accompanying drawings.

Dated 3 March, 2006

Honda Motor Co., Ltd.

Patent Attorneys for the Applicant/Nominated Person

SPRUSON & FERGUSON

FIG. 1

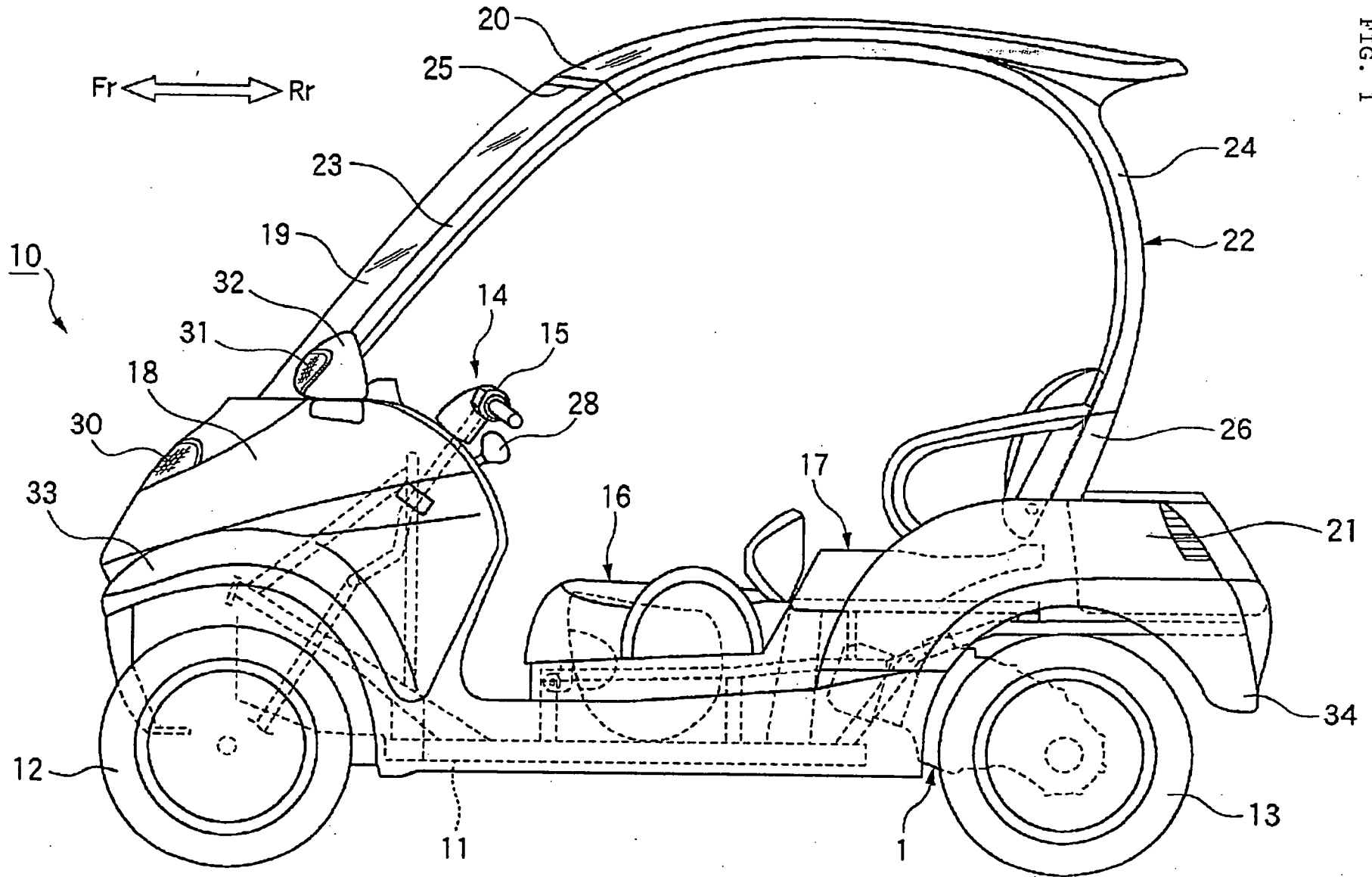


FIG. 3

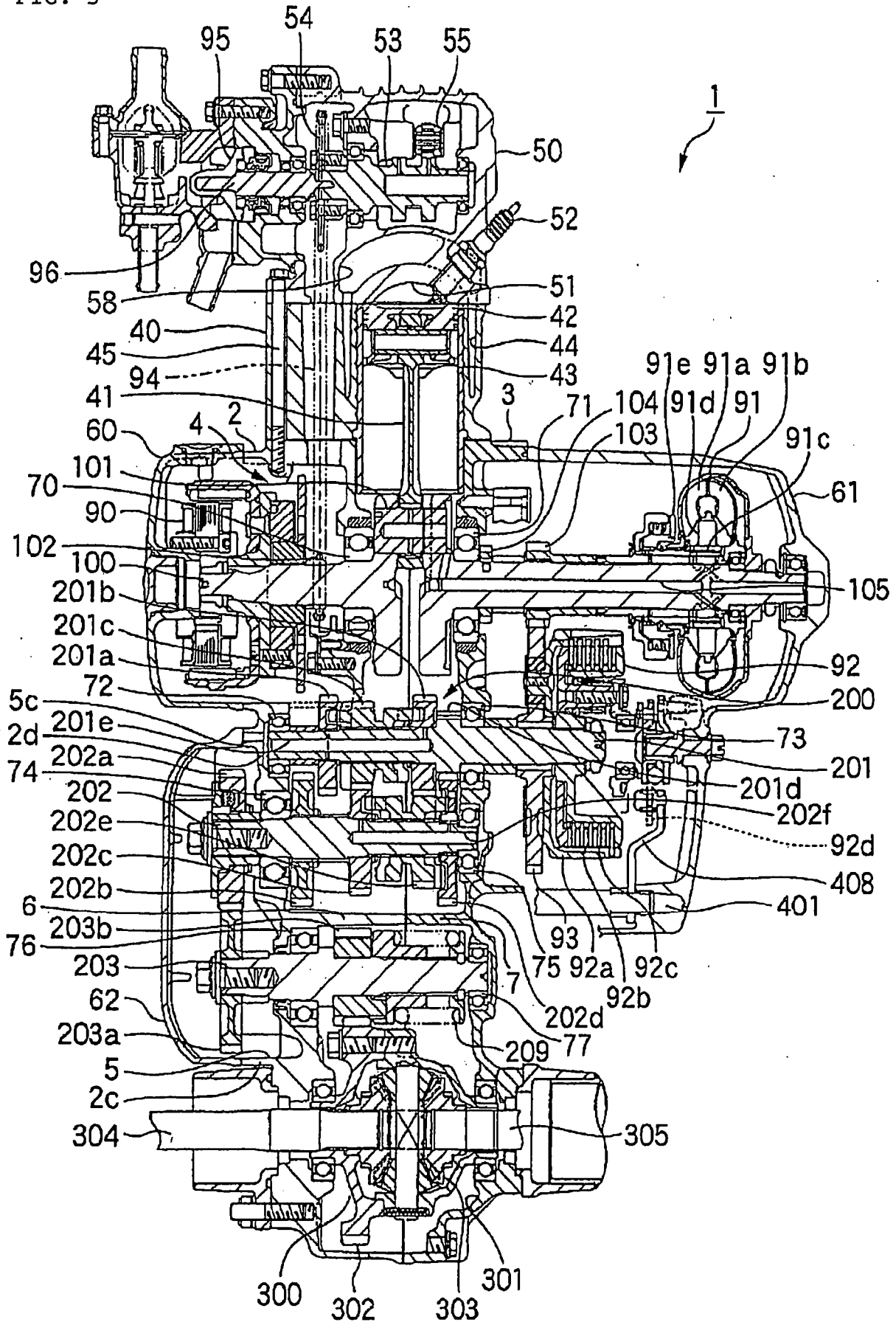
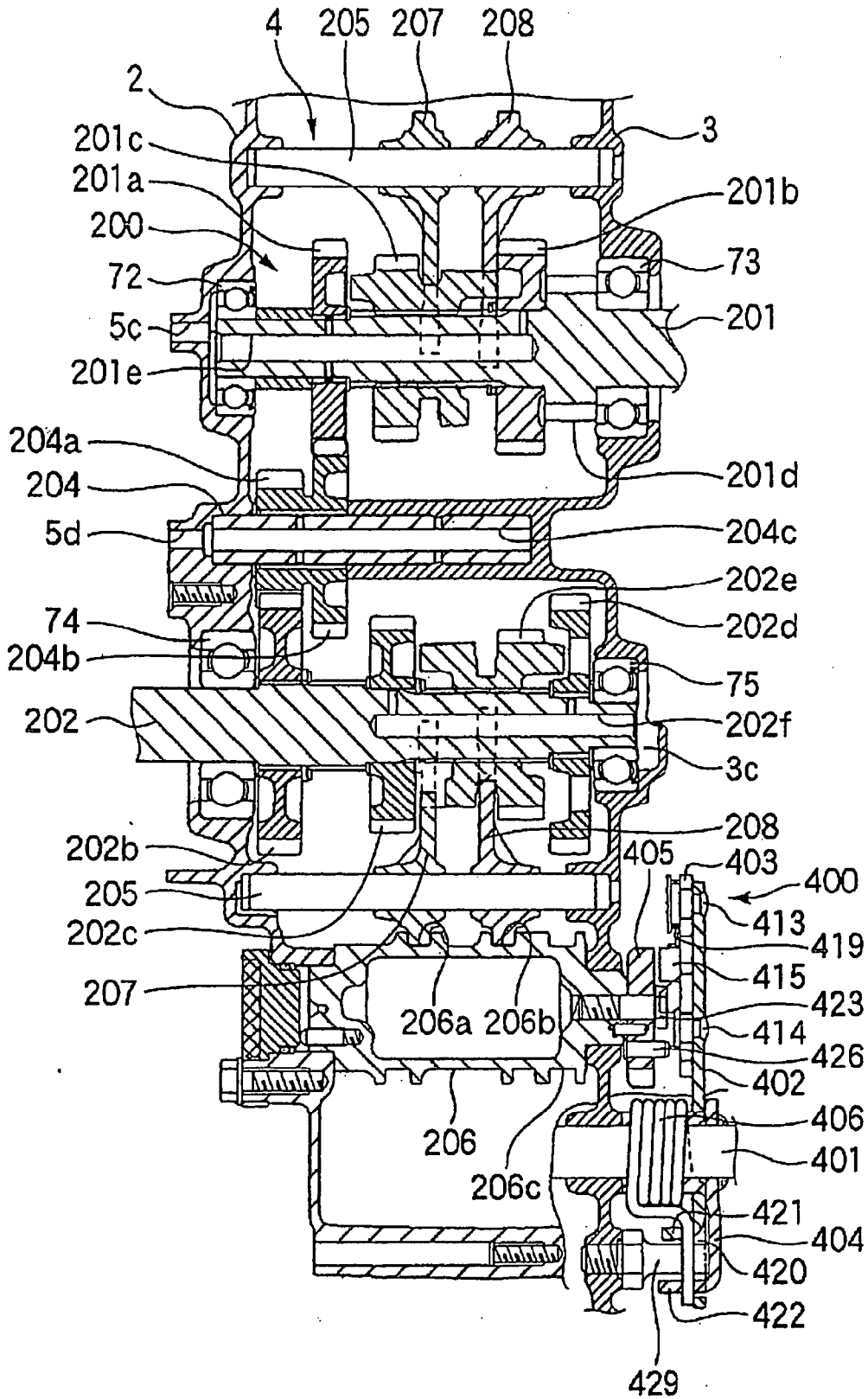


FIG. 4



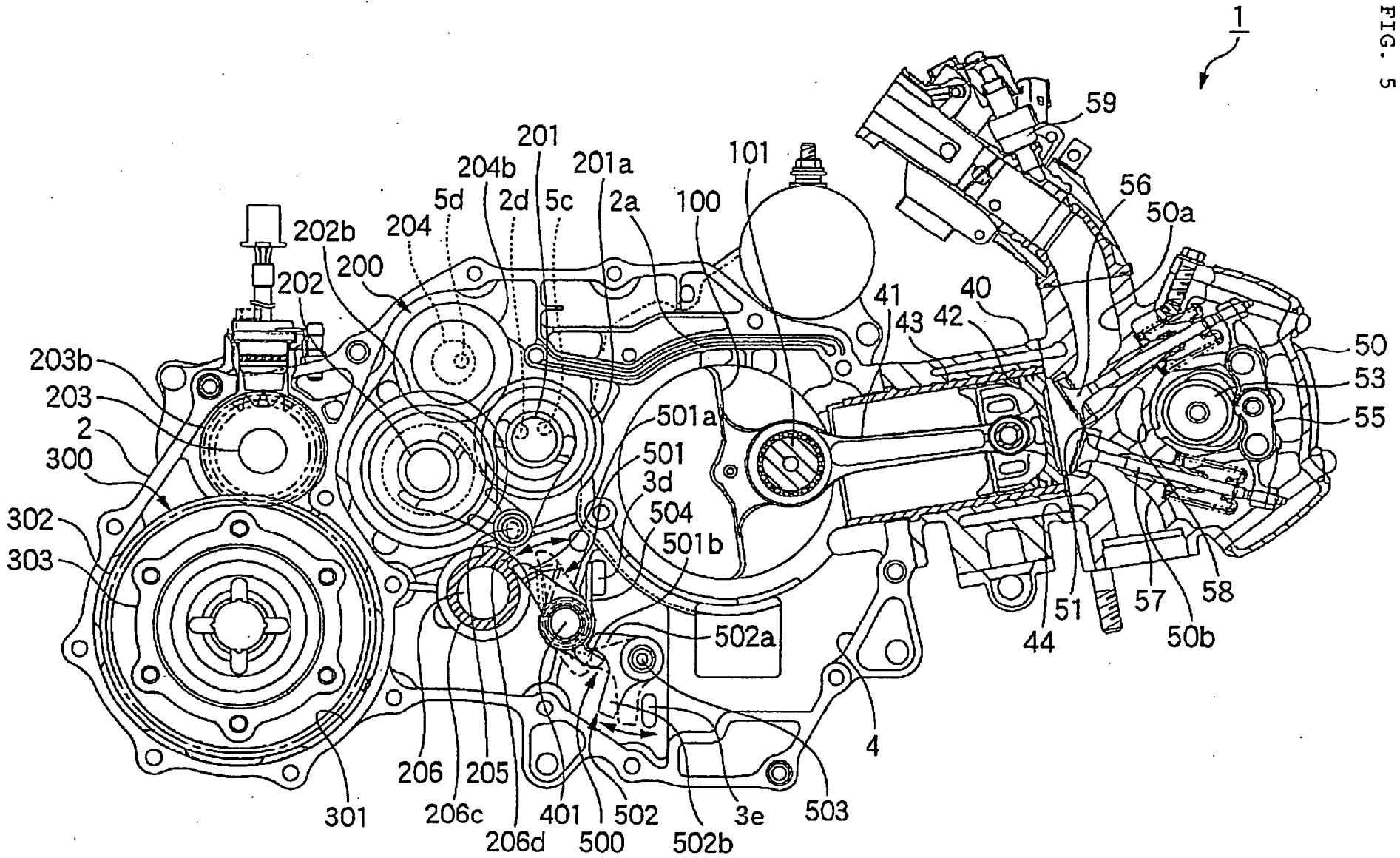


FIG. 5

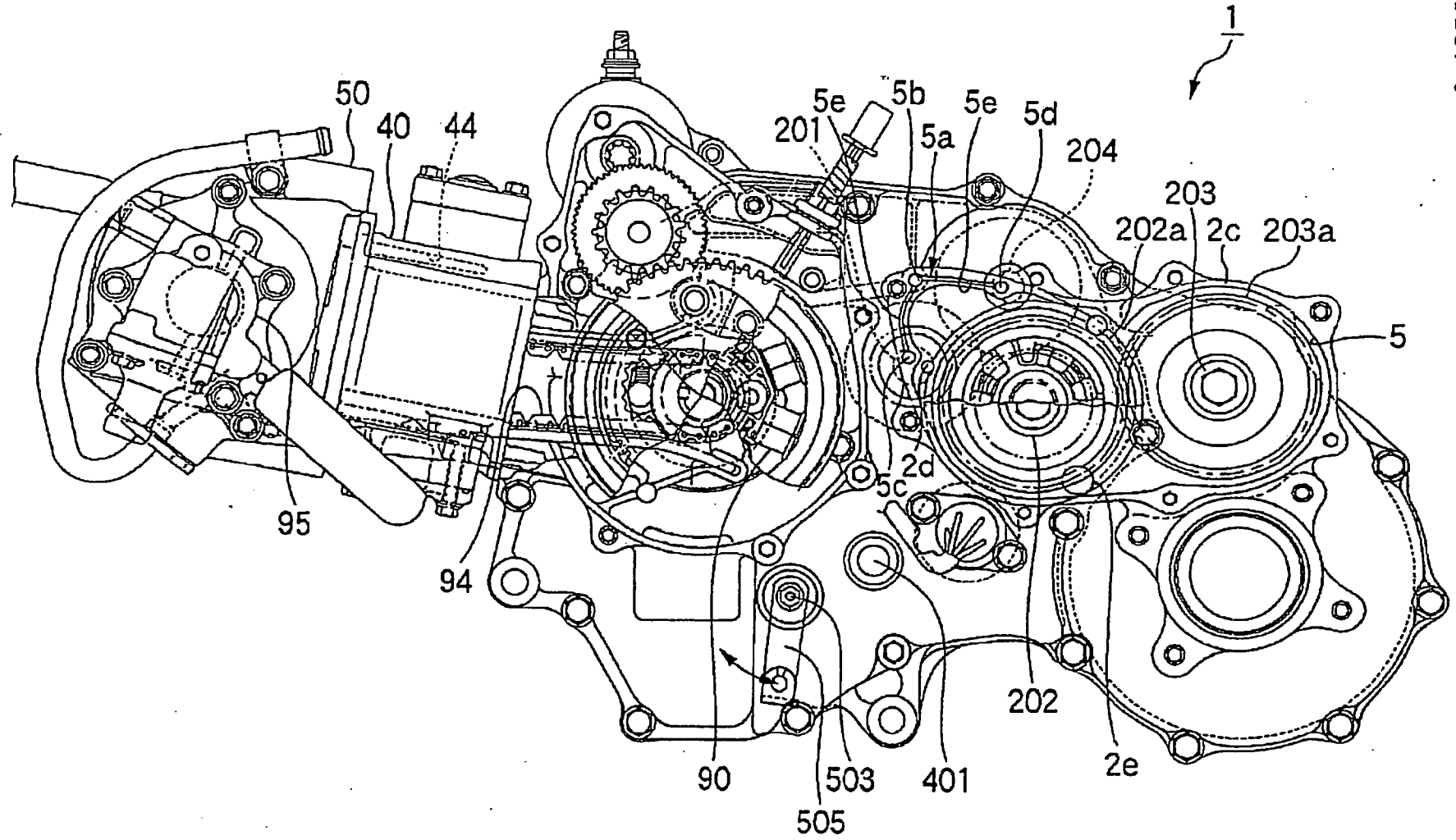


FIG. 6

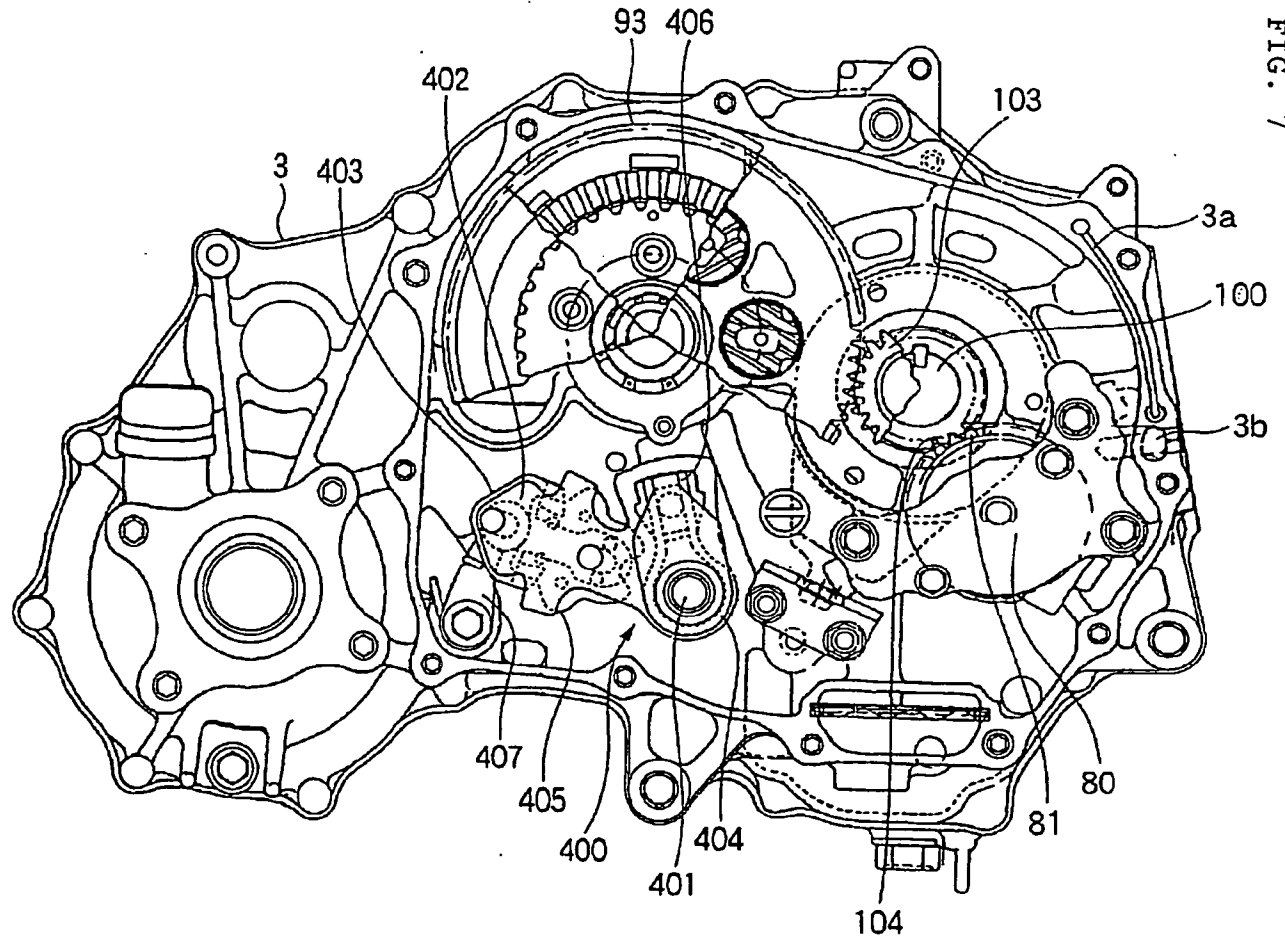


FIG. 7

FIG. 8

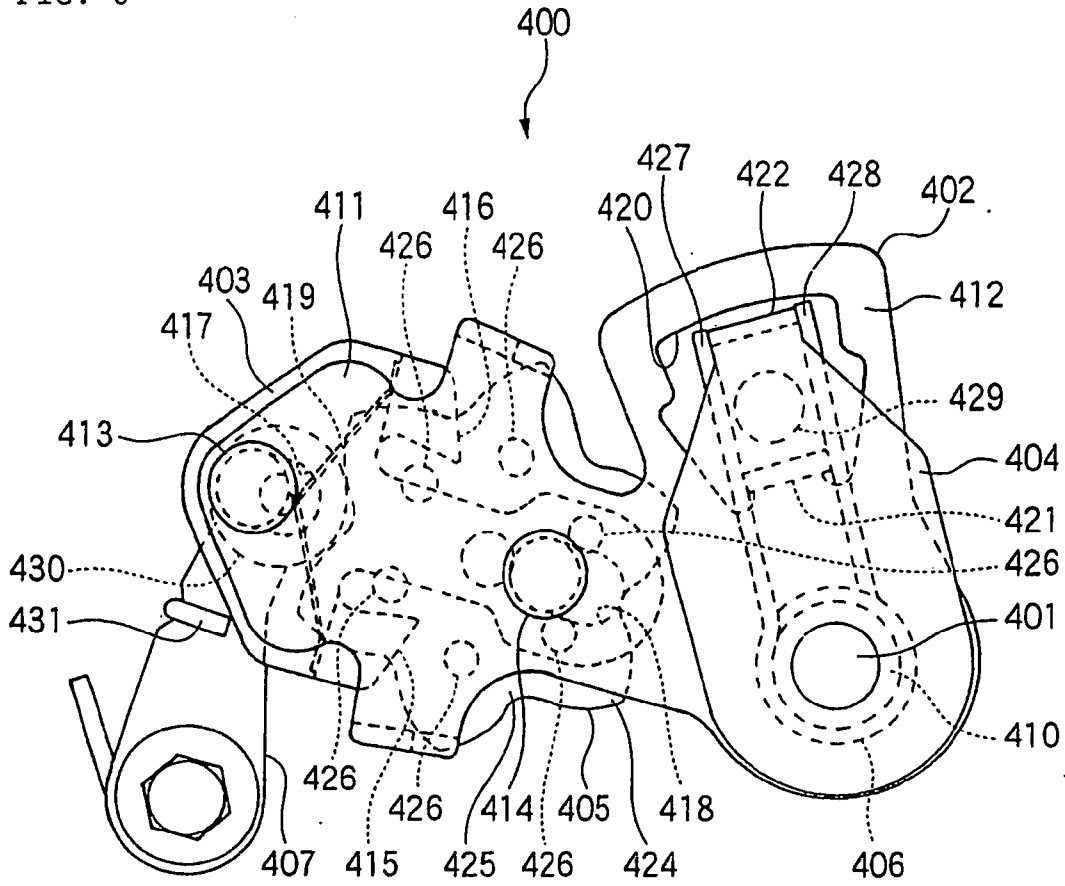


FIG. 9

