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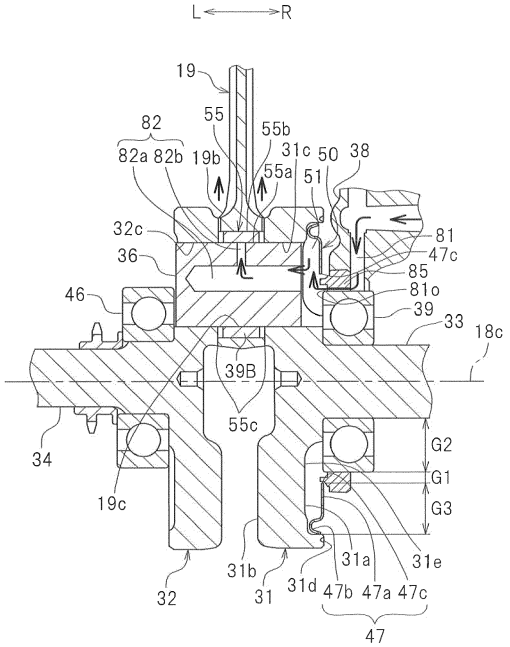
(54) STRADDLED VEHICLE

(57) A straddled vehicle is capable of supplying clean lubricant, which has been removed of foreign matter, to a transmission. A straddled vehicle includes an annular plate (47) fixed to a first side wall (31a) of a first crank web (31), with a part of the annular plate (47) being spaced apart from the first side wall (31a). The first side wall (31a) and the annular plate (47) together form a centrifugal filter (50) that is closed on the radially outer side and is open on the radially inner side. The straddled vehicle further includes a first oil path (81) configured to guide lubricant to the centrifugal filter (50), and a second oil path (82) configured to guide lubricant from the centrifugal filter (50) to a gap between a connecting rod (19) and a crankpin (36). A front end of a transmission is located rearward of a rear end of a cylinder (6). The transmission is placed rearward of the centrifugal filter (50) . A part of the transmission overlaps with the centrifugal filter (50), as the vehicle is seen from the front.

FIG.4



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Description

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The present invention relates to a straddled vehicle having an internal combustion engine.

Description of the Related Art

[0002] Straddled vehicles having an internal combustion engine placed inside a crankcase, and a V-belt continuously variable transmission placed outside the crankcase are known in the art. Also, straddled vehicles having an internal combustion engine placed inside a crankcase, and a transmission including a plurality of gears placed inside the crankcase are known in the art. With such a straddled vehicle, in which the transmission is placed inside the crankcase, foreign matter generated by abrasion of the transmission may contaminate the lubricant inside the crankcase. Therefore, such a straddled vehicle may have a larger amount of foreign matter contaminating the lubricant, as compared with a straddled vehicle in which the transmission is placed outside the crankcase.

[0003] Japanese Laid-Open Patent Publication No. 2014-70568 discloses a straddled vehicle having a first oil path provided inside a crankshaft, a second oil path provided inside the crankshaft, and a centrifugal filter attached to the crankshaft. The centrifugal filter communicates with the first oil path via a first communicating hole, and communicates with the second oil path via a second communicating hole. With this straddled vehicle, if the lubricant flowing through the first oil path is contaminated with foreign matter, the foreign matter is removed by the centrifugal filter. The lubricant, which has been removed of the foreign matter, is supplied to the second oil path.

SUMMARY OF THE INVENTION

[0004] It is an object of the present invention to provide a straddled vehicle with which it is possible to supply clean lubricant, which has been removed of foreign matter, to the transmission.

[0005] This object is achieved by a straddled vehicle as defined in the independent claim.

[0006] With the known straddled vehicle described above, the lubricant, which has been removed of the foreign matter by the centrifugal filter, flows through the second oil path inside the crankshaft and is guided to the big end of the connecting rod. The lubricant in the centrifugal filter needs to be pressurized in order for the lubricant in the centrifugal filter to flow into the second oil path inside the crankshaft against the centrifugal force. Therefore, the space inside the centrifugal filter is sealed except for the first communicating hole and the second communicating hole. The lubricant, having flowed into the second oil path inside the crankshaft, is used for lubricating sliding parts, such as the big end and the small end of the connecting rod, and for cooling the piston. The lubrication of the small end of the connecting rod and the cooling of the piston are done by the lubricant being ejected upward from between the big end of the connecting rod and the crank web.

[0007] When a crankshaft is provided with a centrifugal filter, as in the straddled vehicle described above, the filter maintainability is better than that of a vehicle provided with an oil filter. When a crankshaft is provided with a centrifugal filter, however, it is difficult to supply, to the transmission, clean lubricant, which has been removed of the foreign matter by the centrifugal filter. This is because all of the lubricant, which has been removed of the foreign matter by the centrifugal filter, flows into the second oil path to lubricate and cool the piston and the connecting rod in the cylinder, after which the lubricant free-falls to be collected in an oil pan, but the transmission is absent in the path of free fall of the lubricant. In addition, when a crankshaft is provided with a centrifugal filter, it is often the case that only a simple oil filter, such as a meshed filter, is provided along the lubricant path from the oil pan to the transmission. In such a case, foreign matter having a size larger than the mesh size is removed but relatively small foreign matter is not removed. Therefore, with the straddled vehicle described above, it is not possible to supply clean lubricant, which has been removed of finer foreign matter by the centrifugal filter, to the transmission.

[0008] A straddled vehicle of the present invention includes a crankcase, a cylinder, a crankshaft, a transmission, a connecting rod, a piston, a bearing, an annular plate, a first oil path, and a second oil path. The crankcase includes a wall with a hole therein. The cylinder is connected to the crankcase, at least a part of the cylinder being located above the crankcase. The crankshaft is placed inside the crankcase and includes a first crank web including a first side wall and a second side wall on an opposite side from the first side wall, a second crank web facing the second side wall of the first crank web, a crankpin connected to the first crank web and the second crank web, and a first shaft provided on the first side wall of the first crank web. The transmission is placed inside the crankcase and includes a first rotation shaft, a second rotation shaft, a plurality of first gears provided on the first rotation shaft, and a plurality of second gears provided on the second rotation shaft and meshing with the first gears. The connecting rod includes a big end and a small end, the big end including a pin hole in which the crankpin is inserted. The piston is placed inside the cylinder and connected to the small end of the connecting rod. The bearing is placed in the hole of the wall of the crankcase and configured to rotatably support the first shaft. The annular plate is fixed to the first side wall of the first crank web, a part of the annular plate being spaced apart from the first side wall. The centrifugal filter is formed by the first side wall and the annular plate, the centrifugal filter being closed on a radially outer side and

being open on a radially inner side. The first oil path communicates with the centrifugal filter and is configured to guide lubricant to the centrifugal filter. The second oil path is configured to connect between the centrifugal filter and a gap between the connecting rod and the crankpin. The second oil path includes a first channel hole formed inside the crankpin and extending in an axial direction of the crankpin, and a second channel hole formed inside the crankpin and extending in a radial direction of the crankpin, the second channel hole communicating with the first channel hole. A front end of the transmission is located rearward of a rear end of the cylinder. The transmission is placed rearward of the centrifugal filter. A part of the transmission overlaps with the centrifugal filter, as the vehicle is seen from the front.

[0009] With the straddled vehicle described above, if the lubricant having been guided from the first oil path to the centrifugal filter has been contaminated with foreign matter, the foreign matter is collected on the outer side in the radial direction of the centrifugal filter by virtue of the centrifugal force from the rotation. As a result, the foreign matter is separated from the lubricant, and clean lubricant, which has been removed of the foreign matter, is sent from the centrifugal filter to the second oil path. Clean lubricant, which has been removed of foreign matter, is supplied to the gap between the connecting rod and the crankpin. With the straddled vehicle, at least a part of the cylinder is placed upward of the crankcase, and the front end of the transmission is located rearward of the rear end of the cylinder. Therefore, lubricant free-falling from the gap between the connecting rod and the crankpin is unlikely to be supplied to the transmission. However, with the straddled vehicle, since the centrifugal filter is open on the radially inner side, not all of the lubricant, which has been removed of foreign matter by the centrifugal filter, does not flow into the second oil path. A part of the clean lubricant, which has been removed of foreign matter by the centrifugal filter, overflows the centrifugal filter to be scattered outward in the radial direction of the crankshaft by virtue of the centrifugal force. Since the transmission is placed rearward of the centrifugal filter, the lubricant that has been scattered from the centrifugal filter is supplied to the transmission. Therefore, with the straddled vehicle, clean lubricant, which has been removed of foreign matter by the centrifugal filter, can be supplied to the transmission.

[0010] According to a preferred embodiment of the present invention, the first side wall of the first crank web includes an outer edge wall located radially outward of the first shaft and a depressed wall located radially inward of the outer edge wall and depressed relative to the outer edge wall. The annular plate is spaced apart from at least a part of the depressed wall. The depressed wall and the annular plate together form the centrifugal filter.

[0011] According to the above embodiment, a desirable centrifugal filter is formed by the depressedwall and the annular plate.

[0012] According to another preferred embodiment of the present invention, the centrifugal filter includes an oil reservoir space defined by the first side wall and the annular plate.

[0013] According to the above embodiment, foreign matter is removed from lubricant by using the centrifugal force in the oil reservoir space.

[0014] According to another preferred embodiment of the present invention, the annular plate includes an inner circumferential edge spaced apart from the bearing in a radially outward direction.

[0015] According to the above embodiment, it is possible, with a simple configuration, to form a centrifugal filter that is closed on the radially outer side and is open on the radially inner side.

[0016] According to another preferred embodiment of the present invention, the first oil path is formed in the wall of the crankcase and includes an opening, at least a part of the opening being located radially inward of the inner circumferential edge of the annular plate.

[0017] According to the above embodiment, lubricant can be guided to the centrifugal filter through the opening formed in the wall of the crankcase.

[0018] According to another preferred embodiment of the present invention, an oil path in which lubricant flows is absent inside the first shaft.

[0019] According to the above embodiment, since there is no need to machine an oil path inside the first shaft, it is possible to reduce the machining cost and to decrease the radius of the first shaft.

[0020] According to another preferred embodiment of the present invention, the first oil path is formed in the first shaft and includes an opening, the opening being located radially inward of the inner circumferential edge of the annular plate and between the annular plate and the first side wall with respect to an axial direction of the crankshaft.

[0021] According to the above embodiment, lubricant can be guided to the centrifugal filter through the opening formed in the first shaft.

[0022] According to another preferred embodiment of the present invention, a gap in a radial direction between the inner circumferential edge of the annular plate and the bearing is smaller than a dimension of the bearing in the radial direction.

[0023] According to the above embodiment, a desirable centrifugal filter is obtained, whichmakes it possible to supply clean lubricant to the gap between the connecting rod and the crankpin and to the transmission.

[0024] According to another preferred embodiment of the present invention, a gap in a radial direction between the inner circumferential edge of the annular plate and the bearing is smaller than a dimension in the radial direction between the inner circumferential edge and an outer circumferential edge of the annular plate.

[0025] According to the above embodiment, a desirable centrifugal filter is obtained, whichmakes it possible to supply clean lubricant to the transmission.

[0026] According to another preferred embodiment of

the present invention, the crankcase includes another wall including an oil path and a discharge port formed therein, wherein lubricant flows in the oil path, and the discharge port is connected to the oil path and includes an opening facing the transmission. The discharge port is placed so as to be aligned with a part of the transmission with respect to an axial direction of the crankshaft.

[0027] According to the above embodiment, it is possible not only to supply lubricant that has overflowed the centrifugal filter to the transmission, but also to supply lubricant to the transmission via the discharge port. Therefore, it is possible to supply a sufficient amount of lubricant to the transmission.

Advantageous Effects Of Invention

[0028] According to the present invention, it is possible to provide a straddled vehicle that can supply clean lubricant, which has been removed of foreign matter, to the transmission.

BRIEF DESCRIPTION OF THE DRAWINGS

[0029]

FIG. **1** is a side view of a motorcycle according to one embodiment of the present invention.

FIG. **2** is a cross-sectional view of a power unit of the motorcycle.

FIG. **3** is a schematic view showing a positional relationship between main parts of the power unit.

FIG. **4** is a cross-sectional view of a centrifugal filter and other members around the centrifugal filter.

FIG. **5** shows a part of a crankshaft and a part of a transmission, as the vehicle is seen from the front.

FIG. **6** is a schematic view showing a configuration of an oil supply system.

FIG. **7** is a cross-sectional view showing an oil path provided in the crankcase wall and a part of the transmission.

FIG. **8** is a cross-sectional view of a power unit according to another embodiment.

FIG. **9** is a cross-sectional view of a power unit according to another embodiment.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0030] One embodiment of the present invention will now be described with reference to the drawings. As shown in FIG. **1,** a vehicle of the present embodiment is a motorcycle **1,** which is an example straddled vehicle to be straddled by a passenger. Note however that the vehicle of the present invention is not limited to the motorcycle **1,** but may be any other straddled vehicle to be straddled by a passenger, such as a three-wheeled vehicle, an all terrain vehicle (ATV) and a snowmobile.

[0031] The terms front, rear, left, right, up and down, as used in the description below, refer to these directions as seen from a passenger seated in a seat **4** while the motorcycle **1** is stationary in an upright position on a horizontal surface, unless specified otherwise. The designations F, Re, L, R, U and D, as used in the figures, refer to front, rear, left, right, up and down, respectively. The terms forward and rearward refer to these directions in the vehicle front-rear direction, unless specified otherwise. The terms upward and downward refer to these directions in the vehicle up-down direction. The terms leftward and rightward refer to these directions in the vehicle left-right direction.

[0032] As shown in FIG. **1,** the motorcycle **1** includes a vehicle body frame **2** including a head pipe **12,** a power unit **3** supported on the vehicle body frame **2,** a front wheel **20** and a rear wheel **30.** A steering shaft **13** is rotatably supported on the head pipe **12.** A handle bar **11** is fixed on an upper portion of the steering shaft **13,** and a front fork **14** is fixed on a lower portion of the steering shaft **13.** The front wheel **20** is attached to the front fork **14.** A fuel tank **10** is placed upward of the power unit **3.** The seat **4** is placed rearward of the fuel tank **10.** The power unit **3** is linked to the rear wheel **30** via a transmission member such as a chain **26** (not shown in FIG. **1;** see FIG. **2).**

[0033] Next, a configuration of the power unit **3** will be described. As shown in FIG. **2,** the power unit **3** includes an internal combustion engine **5.** The power unit **3** drives the rear wheel **30** using the power from the internal combustion engine **5.** In the present embodiment, the internal combustion engine **5** is a single-cylinder internal combustion engine including a single cylinder **6.** Note however that the internal combustion engine **5** may be a multi-cylinder internal combustion engine including a plurality of cylinders.

[0034] The power unit **3** includes a crankcase **7,** a cylinder block **8** fixed on the crankcase **7,** a cylinder head **9** fixed on the cylinder block **8,** and a cylinder head cover **15** fixed on the cylinder head **9.** The cylinder **6** is provided inside the cylinder block **8,** and a piston **16** is placed inside the cylinder **6.** Note that although the cylinder **6** is a part of the cylinder block **8,** the cylinder **6** in the present embodiment is a cylinder sleeve, which is separate from the other part of the cylinder block **8.** Note however that the present invention is not limited to this. The cylinder **6** may be integral with the other part of the cylinder block **8.** For example, the cylinder **6** may be provided by, for example, plating the wall surface of the circular hole of the cylinder block **8.** A combustion chamber **17** is defined by the piston **16,** the cylinder **6** and the cylinder head **9.** At least a part of the cylinder block **8** is placed upward of the crankcase **7** (see FIG. **3).** Therefore, at least a part of the cylinder **6** is placed upward of the crankcase **7.**

[0035] A crankshaft **18** is placed inside the crankcase **7.** The crankshaft **18** and the piston **16** are linked together by a connecting rod **19.** The piston **16** is connected to a small end **19a** of the connecting rod **19.** The crankshaft **18** is connected to a big end **19b** of the connecting rod

19. The small end **19a** is placed upward of the big end **19b.** A generator **21** is attached to the left end of the crankshaft **18.** A gear **28** is placed at the right end of the crankshaft **18.**

[0036] A main shaft **23** and a drive shaft **24** are placed inside the crankcase **7.** The main shaft **23** and the drive shaft **24** are an example of the "first rotation shaft" and an example of the "second rotation shaft", respectively. The main shaft **23** and the drive shaft **24** are placed parallel to the crankshaft **18.** A plurality of transmission gears **25A** are provided on the main shaft **23**. Transmission gears **25B,** meshing with the transmission gears **25A,** are provided on the drive shaft **24.** The transmission gears **25A** and **25B** are an example of the "first gears" and an example of the "second gears", respectively. The main shaft **23,** the transmission gears **25A,** the transmission gears **25B** and the drive shaft **24** together form a transmission **35** placed inside the crankcase **7.** The left end **24a** of the drive shaft **24** is placed outside the crankcase **7.** A sprocket **26A** is fixed at the left end **24a** of the drive shaft **24,** with the chain **26** wrapped around the sprocket **26A.**

[0037] As shown in FIG. **3,** a front end **35f** of the transmission **35** is located rearward of a rear end **6b** of the cylinder **6.** Note that the front end **35f** of the transmission **35** is the most forward part of the transmission **35** in the vehicle front-rear direction. In the present embodiment, the most forward part of the transmission gears **25A** in the vehicle front-rear direction is the front end **35f.** The rear end **6b** of the cylinder **6** is the most rearward part of the cylinder **6** in the vehicle front-rear direction. Thus, the transmission **35** is absent directly below the cylinder **6.** The transmission **35** is absent in the path in which the lubricant freefalls from the cylinder **6.**

[0038] As shown in FIG. **2,** a clutch **40** is provided at the right end of the main shaft **23.** While the clutch **40** is a wet multiple-disc clutch in the present embodiment, there is no particular limitation on the type of the clutch **40.** The clutch **40** includes a clutch housing **41** rotatably supported on the main shaft **23,** a clutch boss **42** non-rotatably supported on the main shaft **23,** a plurality of plates **27** which are supported on the clutch housing **41** and rotate together with the clutch housing **41,** a plurality of plates **29** which are supported on the clutch boss **42** and rotate together with the clutch boss **42,** a pressure plate **43** configured to press the plates **27** and the plates **29** against each other, and a spring **45** configured to urge the pressure plate **43** toward the plates **27** and the plates **29.**

[0039] The crankshaft **18** includes a first crank web **31,** a second crank web **32,** a first shaft **33** and a second shaft **34.** The first crank web **31** and the first shaft **33** are provided as an integral part, and the second crank web **32** and the second shaft **34** are provided as an integral part. As shown in FIG. **4,** the first crank web **31** includes a first side wall **31a,** and a second side wall **31b** on the opposite side from the first side wall **31a.** The second crank web **32** is facing the second side wall **31b** of the first crank web **31.** The first shaft **33** is provided on the first side wall **31a** of the first crank web **31.** In the present embodiment, the first side wall **31a** and the second side wall **31b** are the right side wall and the left side wall, respectively, of the first crank web **31.** The first shaft **33** extends rightward from the first side wall **31a.** The second shaft **34** extends leftward from the second crank web **32.**

[0040] The first crank web **31** includes a pin hole **31c,** and the second crank web **32** includes a pin hole **32c.** A pin hole **19c** is provided in the big end **19b** of the connecting rod **19.** A crankpin **36** is inserted through these pin holes **31c, 32c** and **19c.** The crankpin **36** is connected to the first crank web **31,** the big end **19b** of the connecting rod **19** and the second crank web **32.** The first crank web **31,** the big end **19b** of the connecting rod **19** and the second crank web **32** are linked together by the crankpin **36.**

[0041] As shown in FIG. **2,** the crankcase **7** includes a wall **38** with a hole **37** therein, and a wall **44** with a hole **66** therein. A bearing **39** rotatably supporting the first shaft **33** and a metal sleeve **85** are placed in the hole **37.** Note that the sleeve **85** is not always needed, and it may be omitted. A bearing **46** rotatably supporting the second shaft **34** is placed in the hole **66.** The bearings **39** and **46** are ball bearings in the present embodiment. Note however that the bearings **39** and **46** are not limited to ball bearings.

[0042] As shown in FIG. **4,** an annular plate **47** is fixed to the first side wall **31a** of the first crank web **31.** The first side wall **31a** includes an outer edge wall **31d** located radially outward of the first shaft **33,** and a depressed wall **31e** located radially inward of the outer edge wall **31d** and depressed relative to the outer edge wall **31d.** Note that the terms radially inward and radially outward refer to a direction toward an axis **18c** of the crankshaft **18** and a direction away from the axis **18c,** respectively. The annular plate **47** includes a flat portion **47a** perpendicular to the direction of the axis **18c** of the crankshaft ***18** (hereinafter referred to as the axis direction), and a depressed portion **47b** located radially outward of the flat portion **47a** and depressed toward the first side wall **31a** relative to the flat portion **47a.** In the present embodiment, the depressed portion **47b** of the annular plate **47** is in contact with the first side wall **31a.** The flat portion **47a** of the annular plate **47** is spaced apart from at least a part of the depressed wall **31e.** The flat portion **47a** of the annular plate **47** is spaced apart in the axis direction from the part of the depressed wall **31e.** Herein, the flat portion **47a** of the annular plate **47** is spaced apart rightward from the part of the depressed wall **31e.** The most radially inward portion of the flat portion **47a** is an inner circumferential edge **47c** of the annular plate **47.** The inner circumferential edge **47c** is spaced apart from the bearing **39** in the radially outward direction. There is a gap between the inner circumferential edge **47c** and the bearing **39.**

[0043] The first side wall **31a** and the annular plate **47** together form a centrifugal filter **50** that is closed on the

radially outer side and is open on the radially inner side. Note that in the present embodiment, the gap between the inner circumferential edge **47c** of the annular plate **47** and the bearing **39** is the opening of the centrifugal filter **50.** As described above, the annular plate **47** is in contact with the depressed wall **31e** of the first side wall **31a** in the present embodiment. Therefore, the centrifugal filter **50** is formed by the depressed wall **31e** and the annular plate **47.** The centrifugal filter **50** includes an oil reservoir space **51** defined by the first side wall **31a** and the annular plate **47.** While there is no particular limitation on the gap **G1** in the radial direction between the inner circumferential edge **47c** of the annular plate **47** and the bearing **39,** the gap **G1** is herein smaller than the width **G2** of the bearing **39** in the radial direction. The gap **G1** is smaller than the distance **G3** in the radial direction between the inner circumferential edge **47c** and the outer circumferential edge of the annular plate **47.**

[0044] As shown in FIG. **3,** the transmission **35** is placed rearward of the centrifugal filter **50.** The front end **35f** of the transmission **35** is placed rearward of a rear end **50b** of the centrifugal filter **50.** As shown in FIG. **5,** a part of the transmission **35** overlaps the centrifugal filter **50.** Note that hatching representing the cross section of the crankshaft **18** and the connecting rod **19** is omitted in FIG. **5** for a better view of the transmission **35** located rearward of the crankshaft **18** and the connecting rod **19.**

[0045] The power unit **3** includes a number of sliding parts. Therefore, the power unit **3** includes an oil supply system **70** configured to supply lubricant to the sliding parts. FIG. **6** is a schematic view showing a configuration of the oil supply system **70.** Arrows in FIG. **6** each represent a lubricant flow.

[0046] The oil supply system **70** includes an oil pan **61,** a meshed oil filter **61A,** an oil pump **62** and the centrifugal filter **50** described above. The oil pan **61** is provided at the bottom of the crankcase **7.** Lubricant, having lubricated sliding parts of the power unit **3,** is collected in the oil pan **61.** The oil pan **61** and an inlet **62i** of the oil pump **62** are connected to each other by an oil path **71.** The oil filter **61A** is provided in the oil path **71** and is configured to filter oil which is sucked into the oil pump **62** from the oil pan **61.** Oil having been cleaned through the oil filter **61A** is supplied to the oil pump **62.** An oil path **72** is connected to an outlet **62o** of the oil pump **62.** The oil path **72** diverges into an oil path **73** and an oil path **76.**

[0047] The oil path **73** further diverges into an oil path **74** and an oil path **75.** The oil path **74** extends to the cylinder head cover **15** via the crankcase **7,** the cylinder block **8** and the cylinder head **9.** Oil supply ports **74a** and **74b** provided along the oil path **74** are configured to supply lubricant from above to an intake valve **67,** an intake cam **67a** (see FIG. **2**), an exhaust valve **48** and an exhaust cam **48a** (see FIG. **2**).

[0048] A discharge port **75a** provided along the oil path **75** is configured to supply lubricant to the transmission **35.** As shown in FIG. **7,** the discharge port **75a** is provided in a wall **49** of the crankcase **7,** and has an opening facing toward the transmission **35.** The oil path **75** includes an oil path **75b** formed inside the wall **49.** The oil path **75b** is connected to the discharge port **75a.** The discharge port **75a** is placed so as to be aligned with a part of the transmission **35** with respect to the axial direction of the crankshaft **18** (the left-right direction of FIG. **7**). The discharge port **75a** is configured to inject lubricant toward the transmission **35.** In the present embodiment, the discharge port **75a** has an opening facing toward transmission gear **25A** that is the first gear. Note however that the opening of the discharge port **75a** may be facing toward a transmission gear **25A** that is other than the first gear. The opening of the discharge port **75a** may be facing the main shaft **23,** the drive shaft **24** and/or the transmission gears **25B.** There is no particular limitation on the number of the discharge ports **75a.**

[0049] As shown in FIG. **6,** the oil path **76** is connected to a first oil path **81** configured to guide oil to the centrifugal filter **50.** As shown in FIG. **4,** the first oil path **81** is formed inside the wall **38** of the crankcase **7.** The first oil path **81** includes an opening **81o** for discharging oil. The opening **81o** is formed in the wall **38.** In the present embodiment, the opening **81o** is defined by the gap, in the hole **37** of the wall **38,** between the bearing **39** and the sleeve **85.** Note however that the position and the configuration of the opening **81o** are not limited to those of the present embodiment. At least a part of the opening **81o** is located radially inward of the inner circumferential edge **47c** of the annular plate **47.** The opening **81o** is facing toward the first side wall **31a** of the first crank web **31.**

[0050] A gap **55** is formed between the big end **19b** of the connecting rod **19** and the crankpin **36.** The gap **55** includes a gap **55a** between the crankpin **36** and a needle bearing **39B,** a gap **55b** between the needle bearing **39B** and the big end **19b,** and a gap **55c** between the big end **19b** and the crank webs **31** and **32.** The centrifugal filter **50** and the gap **55** communicate with each other via a second oil path **82.** The second oil path **82** includes a first channel hole **82a** formed inside the crankpin **36** and extending in the axial direction of the crankpin **36,** and a second channel hole **82b** formed inside the crankpin **36** and extending in the radial direction of the crankpin **36.** The first channel hole **82a** and the second channel hole **82b** communicate with each other. Note that as used herein, "extending in the axial direction of the crankpin **36"** may refer not only to extending in the axis direction of the crankpin **36,** but also to extending in a direction inclined from the axis direction. As used herein, "extending in the radial direction of the crankpin **36"** may refer not only to extending in a direction perpendicular to the axis direction of the crankpin **36,** but also to extending in a direction inclined from the direction perpendicular to the axis direction.

[0051] As shown in FIG. **2,** an oil path in which lubricant flows is absent inside the first shaft **33** of the crankshaft **18.** An oil path in which lubricant flows is also absent inside the second shaft **34.** Note however that it is pos-

sible to form an oil path inside the first shaft **33,** in addition to the first oil path **81.**

[0052] The power unit **3** is configured as described above. Next, oil circulation in the power unit **3** will be described.

[0053] Lubricant is stored in the oil pan **61.** Note however that the lubricant stored in the oil pan **61** is lubricant having lubricated sliding parts (e.g. , the intake cam **67a,** the exhaust cam **48a,** the transmission **35,** etc.). For example, the lubricant stored in the oil pan 61 may include foreign matter from lubricated parts like the intake cam. Therefore, foreign matter may be contained in the lubricant stored in the oil pan **61.** The lubricant stored in the oil pan **61** is guided to the oil path **72** by the oil pump **62.** The lubricant in the oil path **72** diverges into the oil path **73** and the oil path **76,** and the lubricant in the oil path **73** diverges into the oil path **74** and the oil path **75.**

[0054] The lubricant in the oil path **74** is supplied to the intake cam **67a** and the intake valve **67** via the oil supply port **74a,** and to the exhaust cam **48a** and the exhaust valve **48** via the oil supply port **74b.** These streams of lubricant fall down by virtue of gravity to lubricate the intake cam **67a,** the intake valve **67,** the exhaust cam **48a** and the exhaust valve **48,** and are supplied further to a cam chain **54,** etc., to be collected in the oil pan **61.**

[0055] The lubricant in the oil path **75** is supplied to the transmission **35** via the discharge port **75a.** The lubricant injected from the discharge port **75a** is supplied to the transmission **35** in the form of mist. Thus, the transmission **35** is lubricated and cooled. Oil supplied to the transmission **35** falls down under the influence of gravity to be collected in the oil pan **61.**

[0056] The lubricant in the oil path **76** flows through the first oil path **81,** and is guided to the centrifugal filter **50** via the opening **81o.** When the lubricant having been guided to the centrifugal filter **50** contains foreign matter therein, the foreign matter, which has a greater specific gravity, is collected on the outer side in the radial direction. Therefore, in the centrifugal filter **50,** foreign matter is separated from lubricant. The centrifugal filter **50** is closed on the radially outer side. Therefore, foreign matter is caught in a radially outward area of the centrifugal filter **50.** A part of clean lubricant, which has been removed of foreign matter, flows through the second oil path **82** to be supplied to the gap **55** between the connecting rod **19** and the crankpin **36.** This lubricant lubricates the connecting rod **19** and the crankpin **36.** A part of the lubricant having flown through the gap **55** is scattered toward the piston **16.** The lubricant having been scattered toward the piston **16** lubricates the piston **16** and the cylinder **6** and cools the piston **16.** The lubricant falls down under the influence of gravity to be collected in the oil pan **61.**

[0057] Since the centrifugal filter **50** is open on the radially inner side, lubricant, which has overflowed the oil reservoir space **51,** is scattered around the first crank web **31.** Since the first crankweb **31** is rotating, oil to be scattered is scattered radially outward. Oil is scattered also from the gap **55c** between the big end **19b** of the connecting rod **19** and the crank webs **31** and **32.** As shown in FIG. **3,** the transmission **35** is placed rearward of the centrifugal filter **50.** As shown in FIG. **5,** the centrifugal filter **50** overlaps the transmission **35,** as the vehicle is seen from the front. Therefore, a part of clean lubricant, which has overflowed the radially inner side of the centrifugal filter **50,** is supplied to the transmission **35.** The lubricant is supplied directly to the transmission **35.** Thus, lubricant is supplied to the transmission **35** via the discharge port **75a** of the oil path **75,** and clean lubricant is supplied thereto from the centrifugal filter **50.**

[0058] As described above, with the motorcycle 1 of the present embodiment, if the lubricant having been guided from the first oil path **81** to the centrifugal filter **50** has been contaminated with foreign matter, the foreign matter is collected on the outer side in the radial direction of the centrifugal filter **50** by virtue of the centrifugal force from the rotation of the crankshaft **18.** As a result, the foreign matter is separated from the lubricant, and clean oil, which has been removed of the foreign matter, is sent from the centrifugal filter **50** to the second oil path **82.** Clean lubricant, which has been removed of foreignmatter, is supplied to the gap **55** between the connecting rod **19** and the crankpin **36.** With the motorcycle **1,** at least a part of the cylinder **6** is placed upward of the crankcase **7,** and the front end **35f** of the transmission **35** is located rearward of the rear end **6b** of the cylinder **6.** Therefore, oil freefalling from the gap **55** between the connecting rod **19** and the crankpin **36** is unlikely to be supplied to the transmission **35.** However, since the centrifugal filter **50** is open on the radially inner side, a part of the clean lubricant, which has been removed of foreign matter by the centrifugal filter **50,** overflows the centrifugal filter **50** to be scattered outward in the radial direction of the crankshaft **18** by virtue of the centrifugal force. Since the transmission **35** is placed rearward of the centrifugal filter **50,** the lubricant that has been scattered from the centrifugal filter **50** is supplied to the transmission **35.** Therefore, with the motorcycle **1** of the present embodiment, clean lubricant, which has been removed of foreign matter by the centrifugal filter **50,** can be supplied to the transmission **35.**

[0059] According to the present embodiment, the centrifugal filter **50** is formed by the depressed wall **31e** of the first side wall **31a** of the first crank web **31** and the annular plate **47.** The centrifugal filter **50** can be provided by such a simple configuration.

[0060] According to the present embodiment, the opening **81o** of the first oil path **81** is formed in the wall **38** of the crankcase **7.** Oil can be guided from the first oil path **81** to the centrifugal filter **50** through the opening **81o** formed in the wall **38** of the crankcase **7.** According to the present embodiment, an oil path in which lubricant flows is not needed inside the first shaft **33** of the crankshaft **18.** According to the present embodiment, since there is no need to machine an oil path inside the first shaft **33,** it is possible to reduce the machining cost and

to decrease the radius of the first shaft **33.**

[0061] According to the present embodiment, the gap **G1** in the radial direction between the inner circumferential edge **47c** of the annular plate **47** and the bearing **39** is smaller than the dimension **G2** of the bearing **39** in the radial direction. The gap **G1** is smaller than the dimension **G3** in the radial direction between the inner circumferential edge **47c** and the outer circumferential edge of the annular plate **47.** With the gap **G1** being relatively small, clean lubricant can be desirably supplied both to the gap **55** between the connecting rod **19** and the crankpin **36** and to the transmission **35.**

[0062] In the present embodiment, the discharge port **75a** and the oil path **75b** are formed in the wall **49** of the crankcase **7,** and the discharge port **75a** is placed so as to be aligned with a part of the transmission **35** with respect to the axial direction of the crankshaft **18.** Therefore, oil can be supplied to the transmission **35** not only from the centrifugal filter **50** but also from the discharge port **75a.** Thus, it is possible to supply a sufficient amount of oil to the transmission **35.**

[0063] While one embodiment of the present invention has been described above, it is understood that the present invention is not limited to the embodiment described above. Next, some alternative embodiments will be described.

[0064] While the motorcycle **1** of the embodiment described above includes the first oil path **81** formed in the wall **38** of the crankcase **7,** there is no particular limitation on the member in which the first oil path **81** is formed. For example, the first oil path **81** may be formed in the first shaft **33** of the crankshaft **18** as shown in FIG. **8,** instead of the first oil path **81** formed in the wall **38** of the crankcase **7.** In the following description, like elements to those of the embodiment described above will be denoted by like reference numerals and will not be further discussed below.

[0065] In the motorcycle **1** according to an alternative embodiment shown in FIG. **8,** the first oil path **81** includes an oil path **81a** extending in the axial direction of the first shaft **33,** and an oil path **81b** connected to the oil path **81a** and extending in the radial direction of the first shaft **33.** Note that "extending in the axial direction of the first shaft **33"** may refer both to extending in the axial direction of the first shaft **33,** and to extending in a direction inclined from the axial direction. As used herein, "extending in the radial direction of the first shaft **33"** may refer both to extending in a direction perpendicular to the axial direction of the first shaft **33,** and to extending in a direction inclined from the direction perpendicular to the axial direction. The first oil path **81** includes the opening **81o** through which lubricant is discharged. The opening **81o** is provided at the downstream end of the oil path **81b.** The opening **81o** is formed in the outer circumferential surface of the first shaft **33.** The opening **81o** is located radially inward of the inner circumferential edge **47c** of the annular plate **47** and between the annular plate **47** and the first side wall **31a** with respect to the axial direction of the crankshaft **18.** Lubricant is supplied to the centrifugal filter **50** via the opening **81o** of the first oil path **81.**

[0066] In the present embodiment, the inner circumferential edge **47c** of the annular plate **47** is located radially inward of the radially outer end of the bearing **39.** Also in the present embodiment, the centrifugal filter **50** is formed by the first side wall **31a** of the first crank web **31** and the annular plate **47.** The centrifugal filter **50** is closed on the radially outer side and is open on the radially inner side.

[0067] Also in the present embodiment, lubricant, which has been scattered from the centrifugal filter **50,** is supplied to the transmission **35.** Therefore, cleanlubricant,which hasbeen removed of foreign matter by the centrifugal filter **50,** can be supplied to the transmission **35.** It is possible, with a simple configuration, to form the centrifugal filter **50** that is closed on the radially outer side and is open on the radially inner side.

[0068] In the embodiment described above, a ball bearing is used as the bearing **39,** which is placed in the hole **37** of the wall **38** of the crankcase **7** and is configured to rotatably support the first shaft **33.** However, the type of the bearing **39** is not limited to a ball bearing. For example, the bearing **39** may be a cylindrical roller bearing, as shown in FIG. **9.**

[0069] In the embodiment described above, the depressed wall **31e** is formed in the first side wall **31a** of the first crank web **31.** However, the depressed wall **31e** may not be needed as long as the centrifugal filter **50** is formed by the first side wall **31a** and the annular plate **47.**

[0070] As shown in FIG. **2,** the centrifugal filter **50** is placed rightward of the cylinder axis **CA** in the embodiment described above. However, the configuration of the embodiment described above may be placed in left-right symmetry with respect to a plane that includes the cylinder axis **CA** therein and is perpendicular to the crankshaft **18.** The annular plate **47** may be attached to the side wall, on which the second shaft **34** of the second crank web **32** is provided, and the centrifugal filter **50** may be formed by this side wall and the annular plate **47.** In such a case, the first oil path **81** may be formed in the wall **44** of the crankcase **7** or the second shaft **34.**

[0071] The positional relationships, etc., between different parts of the power unit **3** have been described above based on directions as seen from a passenger seated in the seat **4** while the motorcycle **1** is stationary in an upright position on a horizontal surface. In other words, the positional relationships, etc., between different parts of the power unit **3** have been described based on a state (i.e., a mounted state) in which the power unit **3** is supported on the vehicle body frame **2.** However, the mounted state of the power unit **3** is not limited to that of the embodiment described above. For example, the power unit **3** may be supported on the vehicle body frame **2** in an orientation that is inclined with respect to a horizontal plane from the embodiment described above. Even when the mounted state of the power unit **3** is different from that of the embodiment described above, it

is possible to uniquely specify the positional relationships between different parts of the power unit by itself, irrespective of the mounted state, by re-defining the terms forward, rearward, leftward, rightward, upward and downward to mean forward, rearward, leftward, rightward, upward and downward when the bottom of the crankcase **7** of the power unit **3** is placed on a horizontal plane in such an orientation that the crankshaft **18** extends in the left-right direction and the transmission **35** is located rearward of the crankshaft **18.**

[0072] The terms and expressions used herein are used for explanation purposes and should not be construed as being restrictive. It should be appreciated that the terms and expressions used herein do not eliminate any equivalents of features illustrated and mentioned herein, but include various modifications falling within the claimed scope of the present invention. The present invention may be embodied in many different forms. The present disclosure is to be considered as providing examples of the principles of the invention. These examples are described herein with the understanding that such examples are not intended to limit the present invention to preferred embodiments described herein and/or illustrated herein. Hence, the present invention is not limited to the preferred embodiments described herein. The present invention includes any and all preferred embodiments including equivalent elements, modifications, omissions, combinations, adaptations and/or alterations as would be appreciated by those skilled in the art on the basis of the present disclosure. The limitations in the claims are to be interpreted broadly based on the language included in the claims and not limited to examples described in the present specification or during the prosecution of the application.

Reference Signs List

1	Motorcycle (straddled vehicle)
6	Cylinder
7	Crankcase
16	Piston
18	Crankshaft
19	Connecting rod
23	Main shaft (first rotation shaft)
24	Drive shaft (second rotation shaft)
25A	Transmission gear (first gear)
25B	Transmission gear (second gear)
31	First crank web
31a	First side wall
31b	Second side wall
32	Second crank web
33	First shaft
35	Transmission
36	Crankpin
37	Hole
38	Wall
39	Bearing
47	Annular plate
50	Centrifugal filter
81	First oil path
82	Second oil path
82a	First channel hole
82b	Second channel hole

Claims

1. A straddled vehicle comprising:

a crankcase (7) including a wall (38) with a hole (37) therein;
a cylinder (6) connected to the crankcase (7), at least a part of the cylinder (6) being located above the crankcase (7) ;
a crankshaft (18) placed inside the crankcase (7) and including a first crank web (31) including a first side wall (31a) and a second side wall (31b) on an opposite side from the first side wall (31a), a second crank web (32) facing the second side wall (31b) of the first crank web (31), a crankpin (36) connected to the first crank web (31) and the second crank web (32), and a first shaft (33) provided on the first side wall (31a) of the first crank web (31);
a transmission (35) placed inside the crankcase (7) and including a first rotation shaft (23), a second rotation shaft (24), a plurality of first gears (25A) provided on the first rotation shaft (23), and a plurality of second gears (25B) provided on the second rotation shaft (24) and meshing with the first gears (25A);
a connecting rod (19) including a big end (19b) and a small end (19a), the big end (19b) including a pin hole (19c) in which the crankpin (36) is inserted;
a piston (16) placed inside the cylinder (6) and connected to the small end (19a) of the connecting rod (19);
a bearing (39) placed in the hole (37) of the wall (38) of the crankcase (7) and configured to rotatably support the first shaft (33);
an annular plate (47) fixed to the first side wall (31a) of the first crank web (31), a part of the annular plate (47) being spaced apart from the first side wall (31a),
a centrifugal filter (50) formed by the first side wall (31a) and the annular plate (47), the centrifugal filter (50) being closed on a radially outer side and being open on a radially inner side;
a first oil path (81) communicating with the centrifugal filter (50) and configured to guide lubri-

cant to the centrifugal filter (50); and
a second oil path (82) configured to connect between the centrifugal filter (50) and a gap (55) between the connecting rod (19) and the crankpin (36), wherein:

the second oil path (82) includes a first channel hole (82a) formed inside the crankpin (36) and extending in an axial direction of the crankpin (36), and a second channel hole (82b) formed inside the crankpin (36) and extending in a radial direction of the crankpin (36), the second channel hole (82b) communicating with the first channel hole (82a);
a front end of the transmission (35) is located rearward of a rear end of the cylinder (6);
the transmission (35) is placed rearward of the centrifugal filter (50); and
a part of the transmission (35) overlaps with the centrifugal filter (50), as the vehicle is seen from the front.

2. The straddled vehicle according to claim 1, wherein:

the first side wall (31a) of the first crank web (31) includes an outer edge wall (31d) located radially outward of the first shaft (33) and a depressed wall (31e) located radially inward of the outer edge wall (31d) and depressed relative to the outer edge wall (31d);
the annular plate (47) is spaced apart from at least a part of the depressed wall (31e); and
the depressed wall (31e) and the annular plate (47) together form the centrifugal filter (50).

3. The straddled vehicle according to claim 1 or 2, wherein the centrifugal filter (50) includes an oil reservoir space (51) defined by the first side wall (31a) and the annular plate (47).

4. The straddled vehicle according to any one of claims 1 to 3, wherein the annular plate (47) includes an inner circumferential edge (47c) spaced apart from the bearing (39) in a radially outward direction.

5. The straddled vehicle according to claim 4, wherein the first oil path (81) is formed in the wall (38) of the crankcase (7) and includes an opening (81o), at least a part of the opening (81o) being located radially inward of the inner circumferential edge (47c) of the annular plate (47).

6. The straddled vehicle according to claim 4, wherein the first oil path (81) is formed in the first shaft (33) and includes an opening (81o), the opening (81o) being located radially inward of the inner circumferential edge (47c) of the annular plate (47) and between the annular plate (47) and the first side wall (31a) with respect to an axial direction of the crankshaft (18).

7. The straddled vehicle according to any one of claims 4 to 6, wherein a gap (G1) in a radial direction between the inner circumferential edge (47c) of the annular plate (47) and the bearing (39) is smaller than a dimension (G2) of the bearing (39) in the radial direction.

8. The straddled vehicle according to any one of claims 4 to 7, wherein a gap (G1) in a radial direction between the inner circumferential edge (47c) of the annular plate (47) and the bearing (39) is smaller than a dimension (G3) in the radial direction between the inner circumferential edge (47c) and an outer circumferential edge of the annular plate (47).

9. The straddled vehicle according to any one of claims 1 to 5, wherein an oil path in which lubricant flows is absent inside the first shaft (33).

10. The straddled vehicle according to any one of claims 1 to 9, wherein:

the crankcase (7) includes another wall including an oil path (75) and a discharge port (75a) formed therein, wherein lubricant flows in the oil path (75), and the discharge port (75a) is connected to the oil path (75) and includes an opening facing the transmission(35); and
the discharge port (75a) is placed so as to be aligned with a part of the transmission (35) with respect to an axial direction of the crankshaft (18).

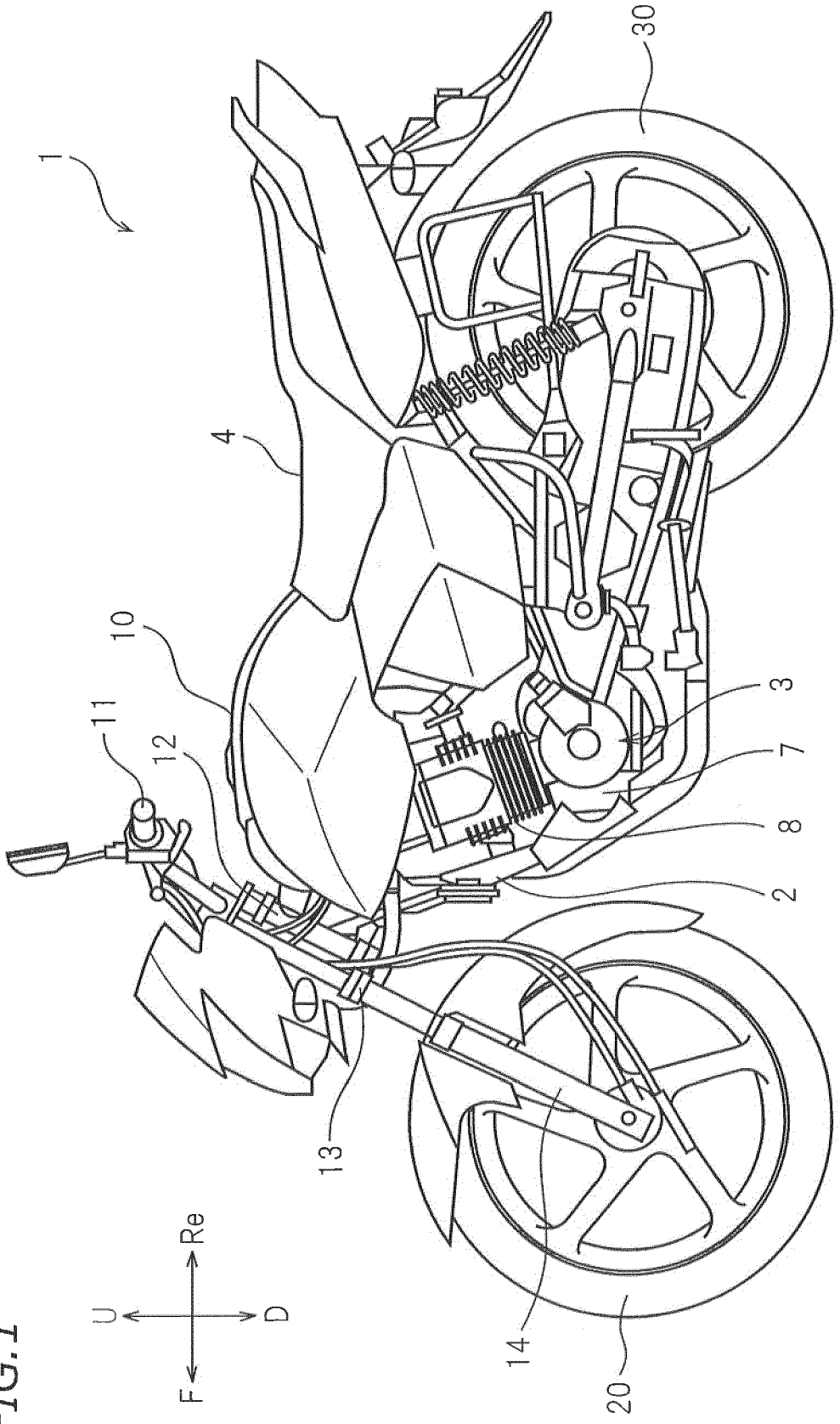
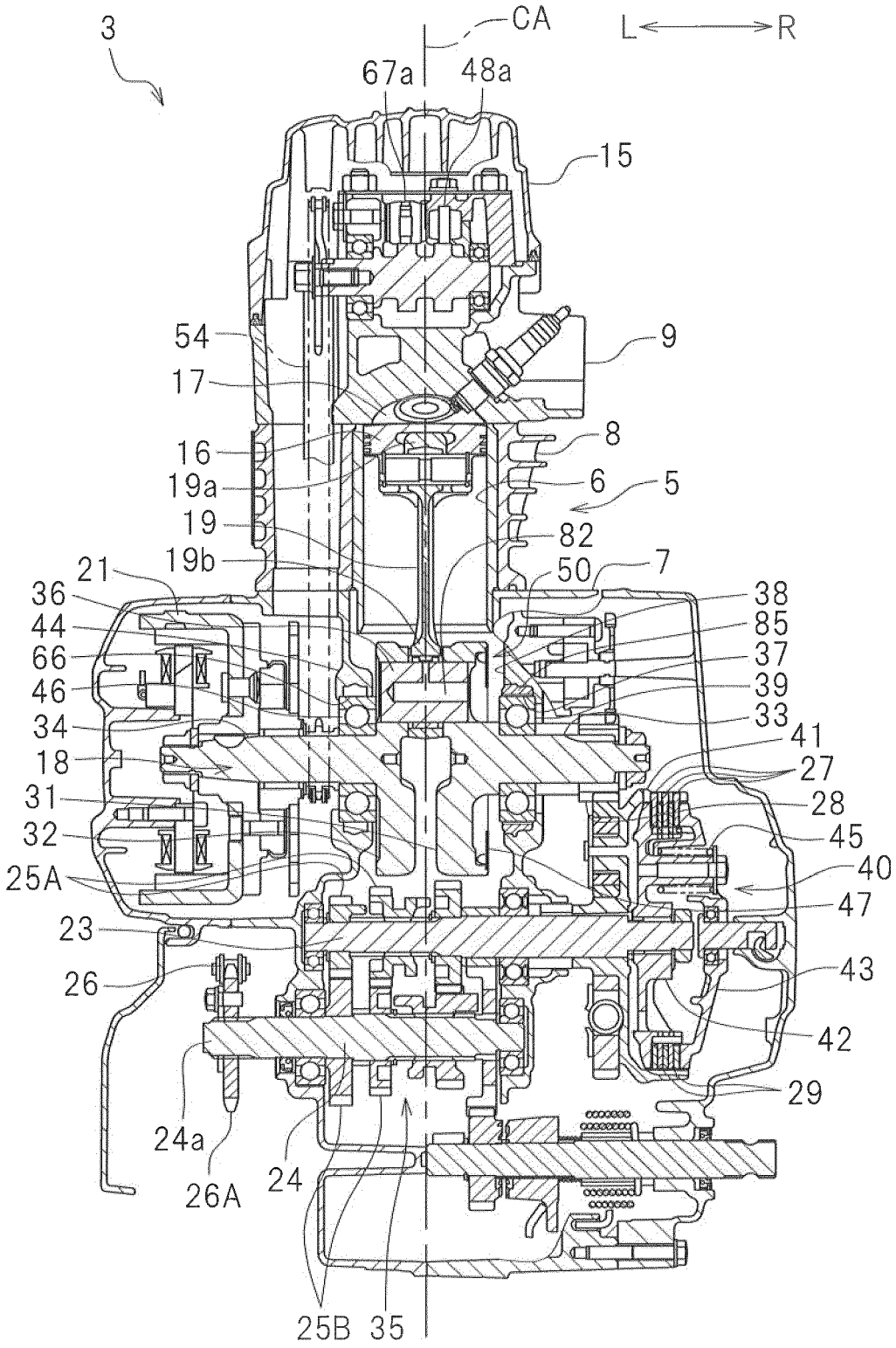


FIG.1

FIG.2


3
CA
L
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67a
48a
15
54
9
17
8
16
6
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19a
19
82
19b
7
50
21
38
36
85
44
37
66
39
46
33
34
41
18
27
31
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42
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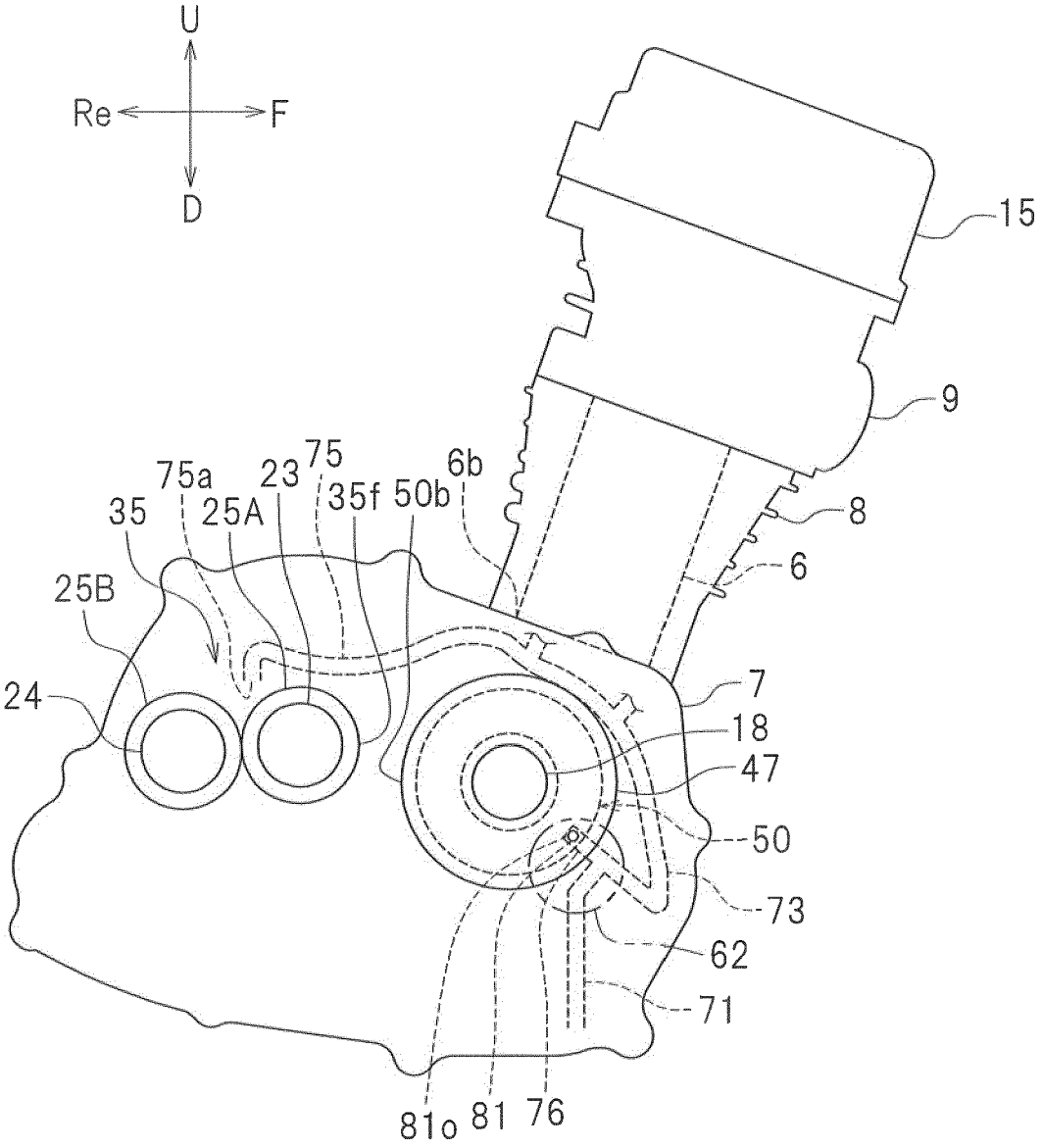
24a
26A
24
25B
35

FIG.3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9
8
6
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75
75a
23
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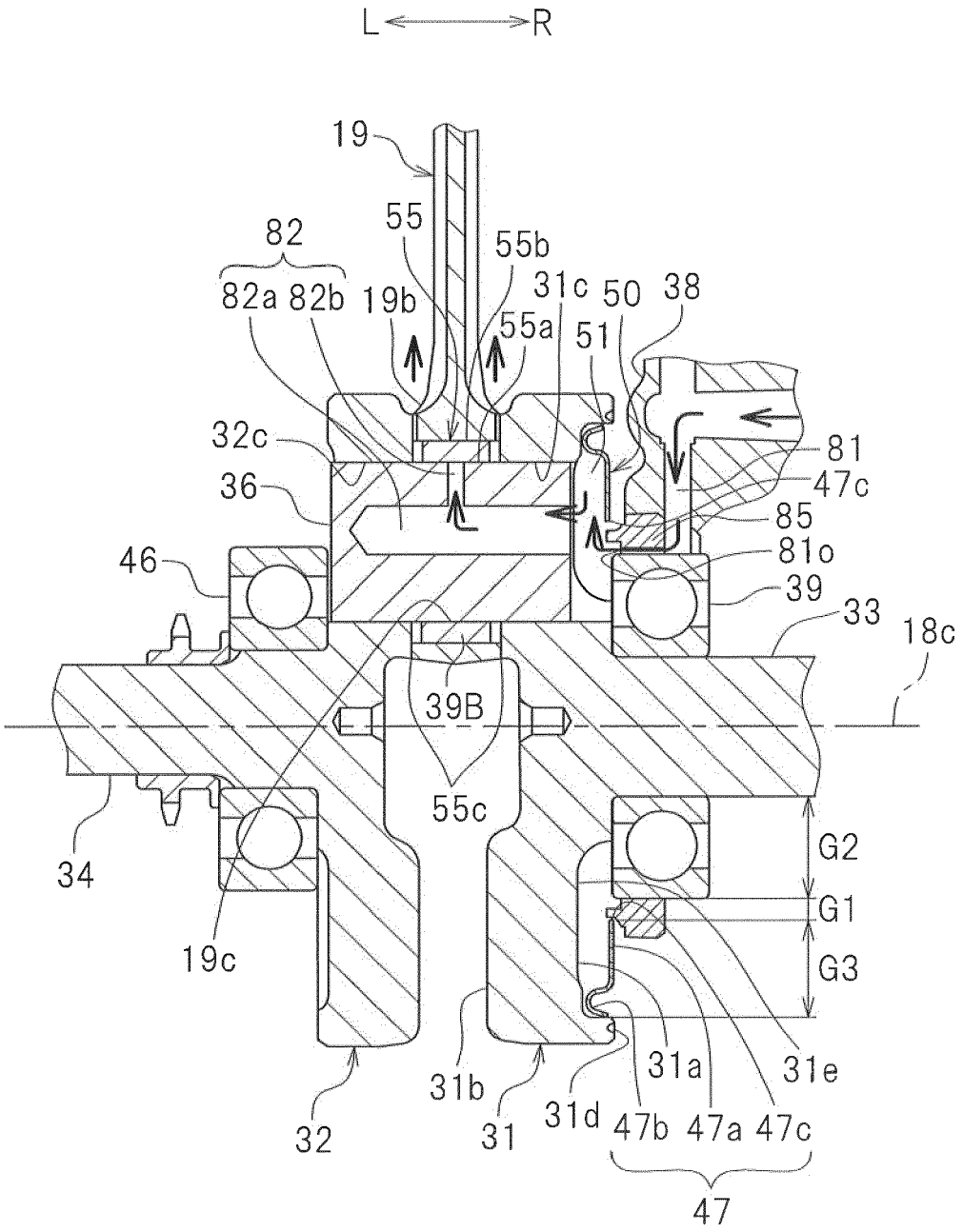
81o
81
76

FIG.4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50
38
55a
51
32c
81
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47c
85
46
81o
39
33
18c
39B
55c
34
G2
G1
G3
19c
31b
31a
31e
31
31d
47b
47a
47c
32
47

FIG.5

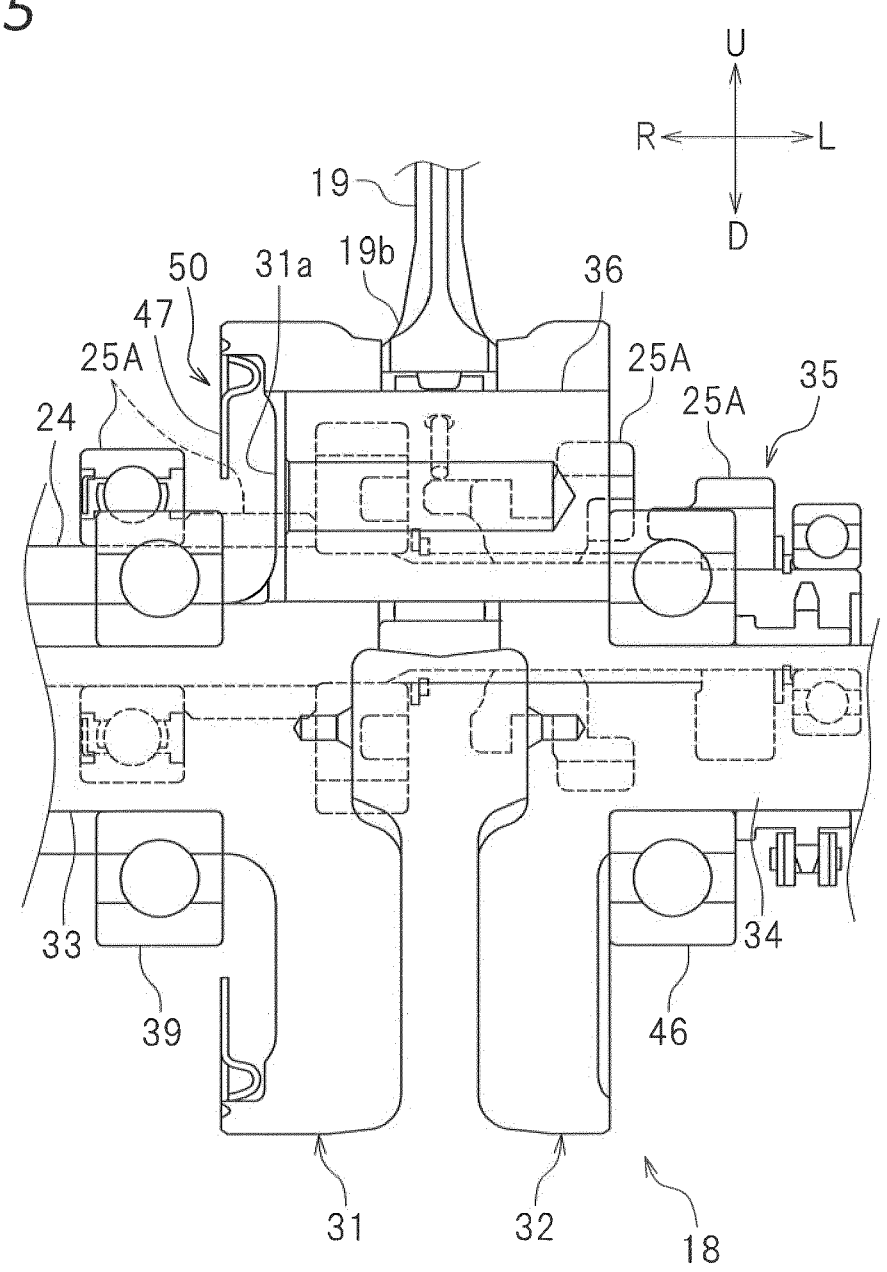
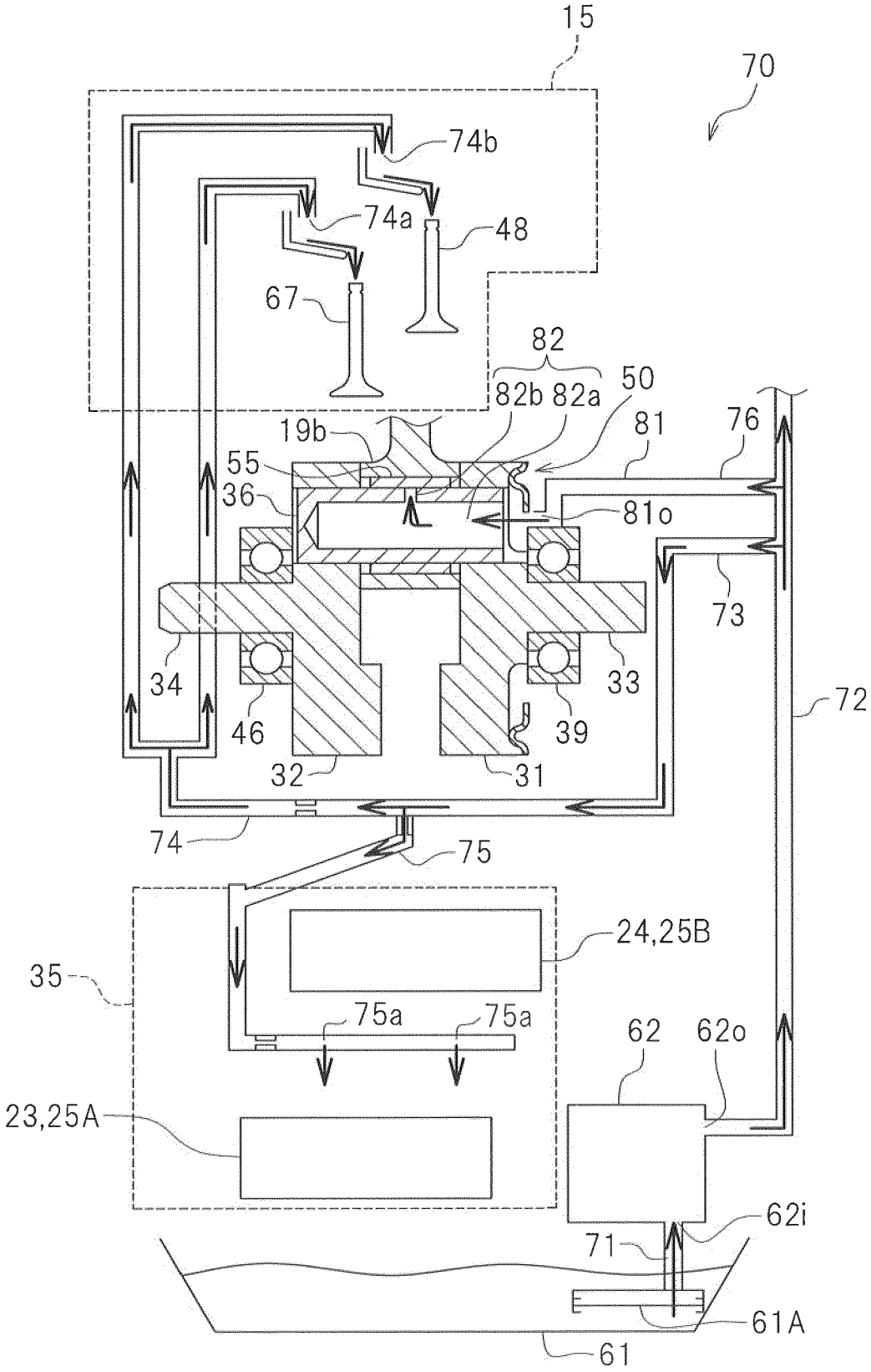


FIG.6


15
70
74b
74a
48
67
82
82b
82a
50
19b
81
76
55
36
81o
73
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33
72
46
39
32
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62o
23,25A
62i
71
61A
61

FIG.7

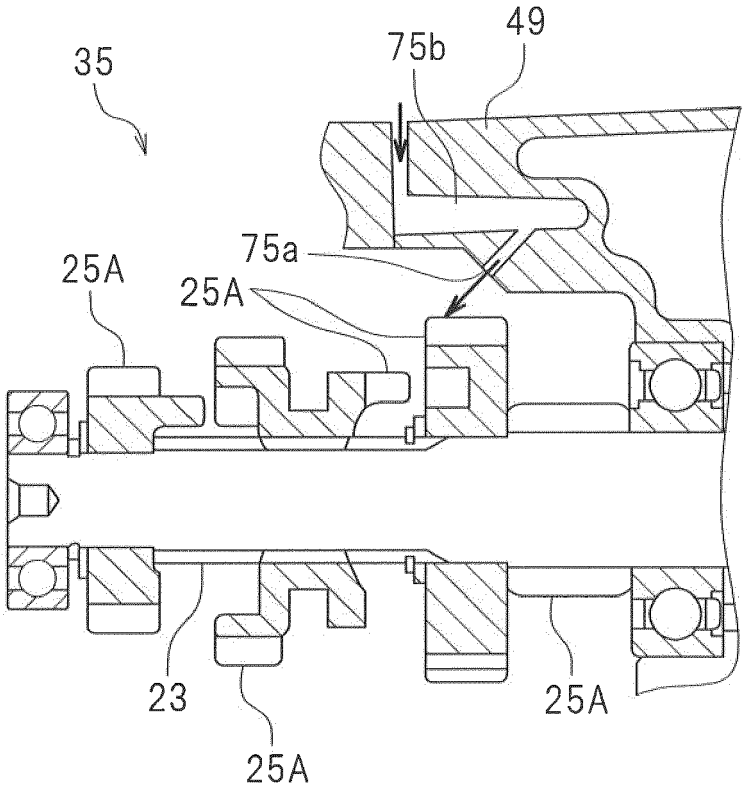
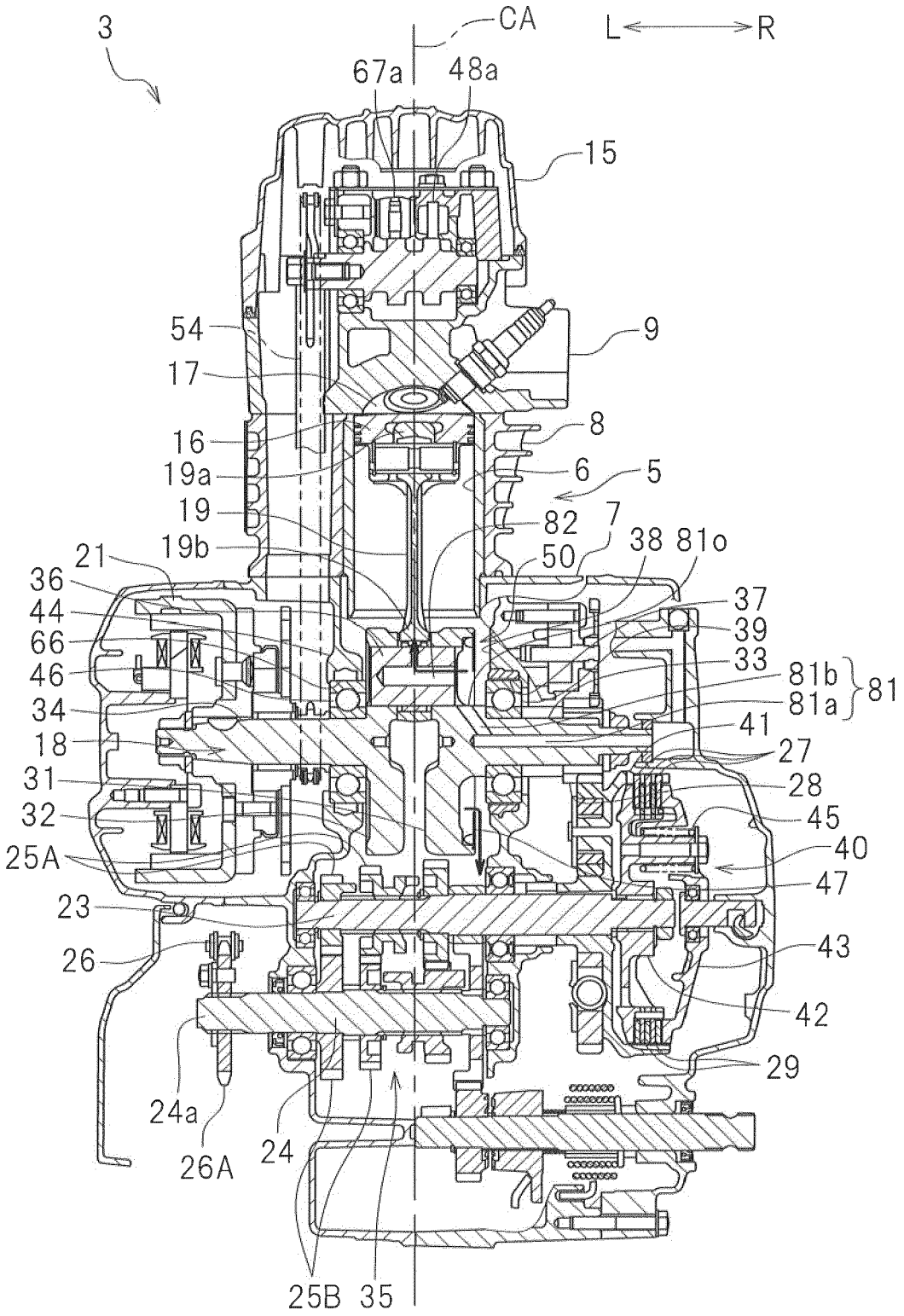


FIG.8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81b
81
46
81a
34
41
18
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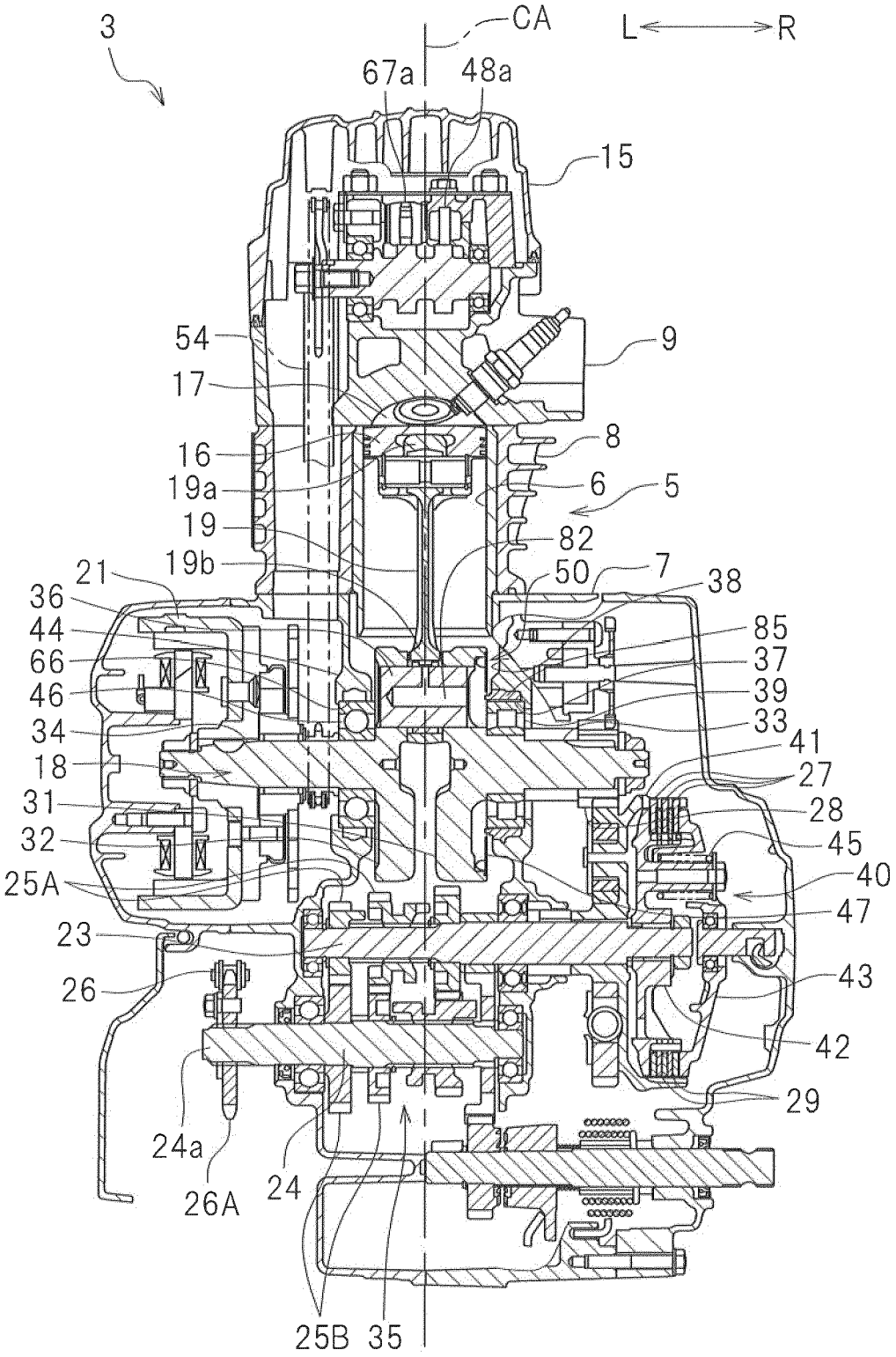
26A
24
25B
35

FIG.9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33
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32
45
25A
40
47
23
26
43
42
29
24a
26A
24
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EUROPEAN SEARCH REPORT

Application Number
EP 16 19 9052

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A,D	JP 2014 070568 A (HONDA MOTOR CO LTD) 21 April 2014 (2014-04-21) * the whole document *	1,3,5,6	INV. F01M1/06 F01M11/02
A	JP 2010 151003 A (HONDA MOTOR CO LTD) 8 July 2010 (2010-07-08) * abstract; figures 1,2 *	1	
A	JP 2011 144705 A (HONDA MOTOR CO LTD) 28 July 2011 (2011-07-28) * abstract; figures 1-4 *	1	
A	US 2010/242895 A1 (TAKIGUCHI CHIKASHI [JP] ET AL) 30 September 2010 (2010-09-30) * abstract * * page 6, paragraph 92 - page 7, paragraph 99; figure 5 *	1	

TECHNICAL FIELDS SEARCHED (IPC)

F01M

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	23 May 2017	Van Zoest, Peter

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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A : technological background
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EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 16 19 9052

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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23-05-2017

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
JP 2014070568 A	21-04-2014	BR 102013025004 A2	01-09-2015
		CN 203685341 U	02-07-2014
		JP 5923020 B2	24-05-2016
		JP 2014070568 A	21-04-2014
JP 2010151003 A	08-07-2010	NONE	
JP 2011144705 A	28-07-2011	NONE	
US 2010242895 A1	30-09-2010	CN 101852112 A	06-10-2010
		JP 5290029 B2	18-09-2013
		JP 2010236521 A	21-10-2010
		KR 20100109386 A	08-10-2010
		US 2010242895 A1	30-09-2010

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2014070568 A **[0003]**