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(54) Engine

(57) Engine with a crankshaft having a crankshaft axis supported by at least one crank journal bearing, and with an oil pump positioned in a vicinity of the crank journal bearing so as to at least partially overlap with said crank journal bearing in a direction of the crankshaft axis.

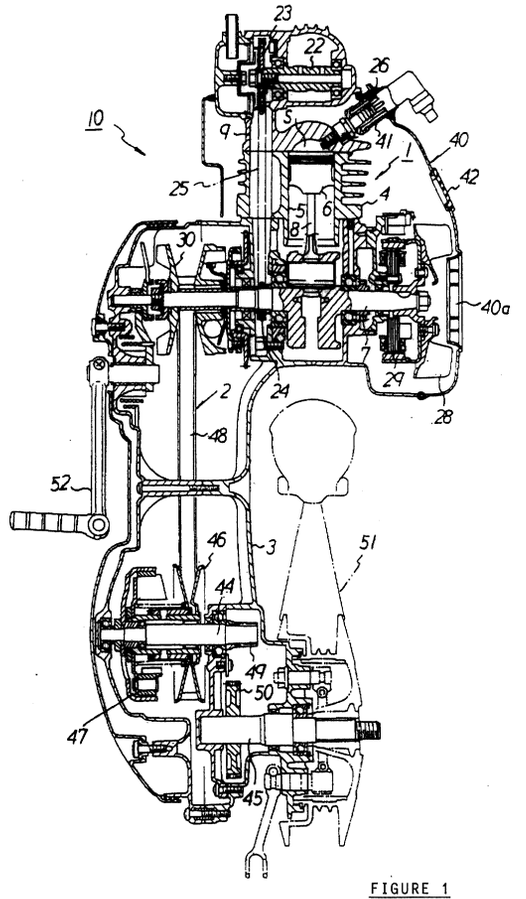

FIGURE 1

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Description

[0001] This invention relates to an engine with a crankshaft having a crankshaft axis supported by at least one crank journal bearing.

[0002] In four-stroke cycle engines wherein various parts are lubricated and cooled with oil, and an oil pump for circulating oil is rotated with the crankshaft. A conventional example of an oil pump positioning structure in a unit swing type of engine for motorcycles of a small-sized scooter shape is shown in FIGs. 5 and 6.

[0003] That is, FIGS. 5 and 6 show cross sections in the crankshaft end portion of four-stroke cycle engines. In the positioning structure shown in FIG. 5, an oil pump 132 attached to a crankcase 103 is positioned with a displacement in the direction of a crankshaft 107 from a crank journal bearing 127, a gear 136 attached to an end of the shaft 135 of the pump is made to directly engage with a gear 139 attached to the crankshaft 127, and the pump shaft 135 is driven for rotation by the rotation of the crankshaft 107 transmitted through the gears 139 and 136 to the pump shaft 135.

[0004] In the positioning structure shown in FIG. 6, an oil pump 232 attached to a crankcase 203 is positioned nearly the same as the crank journal bearing 227 in the crankshaft direction, an endless chain 240 is routed around between a sprocket 236 attached to an end of the pump shaft 235 and a sprocket 239 attached to the crankshaft 207, and the pump shaft 235 is driven for rotation by the rotation of the crankshaft 207 transmitted through the sprocket 239, the chain 240, and the sprocket 236 to the pump shaft 235.

[0005] However, the positioning structure shown in FIG. 5 has problems: In order to secure a required delivery rate of the oil pump 132, a certain gear ratio is required between the gears 136 and 139, which automatically determines the distance between the oil pump 132 and the crankshaft 107, which in turn means that the oil pump 132 cannot be positioned largely apart from the crankshaft 107 in the radial direction but must be positioned, to avoid interference with the crank journal bearing 127, with a displacement in the crankshaft direction from the crank journal bearing 127 as described above. As a result, the width of the engine increases, and the engine cannot be made small and compact.

[0006] While the conventional positioning structure shown in FIG. 6 can provide an advantage of relatively free selection of positioning of the oil pump 232, it is necessary to position the oil pump 232 radially largely apart from the crankshaft 207 because both sprockets 236, 239 have to be arranged on a plane. As a result, the problem here is that the radial dimension of the engine increases, and the engine cannot be made small and compact.

[0007] It is an objective of the present invention to provide an engine with a crankshaft having a crankshaft axis is supported by at least one crank journal bearing, wherein said engine has a compact structure.

[0008] According to a first aspect of the present invention said objective is solved by an engine with a crankshaft having a crankshaft axis supported by at least one crank journal bearing, and with an oil pump positioned in a vicinity of the crank journal bearing so as to at least partially overlap with said crank journal bearing in a direction of the crankshaft axis.

[0009] According to a second aspect of the present invention said objective is also solved by an engine with a crankshaft having a crankshaft axis supported by at least one crank journal bearing, wherein said crank journal bearing is supported on one side of a step portion of a crank case, and with an oil pump positioned in a vicinity of the crank journal bearing at a side opposing said one side of said step portion, said oil pump has a main part section spaced from said step portion.

[0010] Said engine is provided with an oil pump in the vicinity of the crank journal bearing supported by the step portion in order to provide a compact structure and with said space between the step portion and the main part section of the oil pump, any deflection of the step portion which may be caused by forces applied to the bearing are not transmitted to the main part section. Thus there is no need for specific reinforcement means or the like which may need additional space.

[0011] Preferred embodiments of the present invention are laid down in the dependent claims.

[0012] In the following, the present invention is explained in greater detail with respect to several embodiments thereof in conjunction with the accompanying drawings, wherein:

FIG. 1 is a cross-sectional plan view of a unit swing type of engine;

FIG. 2 is a cross-sectional plan view of the four-stroke cycle engine portion of the unit swing type of engine;

FIG. 3 is a cross-sectional side view of the four-stroke cycle engine portion of the of the unit swing type of engine;

FIG. 4 is a cross-sectional view of the crankshaft end portion of the four-stroke cycle engine having an oil pump positioning structure;

FIG. 5 is a cross-sectional view of the crankshaft end portion of the four-stroke cycle engine showing a conventional oil pump positioning structure; and

FIG. 6 is a cross-sectional view of the crankshaft end portion of the four-stroke cycle engine showing another conventional oil pump positioning structure.

[0013] An embodiment of the engine will be hereinafter described in reference to the appended drawings.

[0014] The unit swing type of engine 10 shown in FIG. 1 is to be mounted on scooter type of motorcycles. The engine 10 is constituted as a single unit with; a forced air-cooled four-stroke cycle engine (hereinafter called simply an engine) 1, a transmitting mechanism including a V-belt type of transmission 2, etc., compactly assembled in a crankcase 3.

[0015] The constitution of the engine 1 is roughly described here.

[0016] As shown in FIG. 3, the engine 1 has a single cylinder 5 bored in a cylinder body 4 directed generally horizontally forward of the vehicle body of a scooter type of motorcycle. A piston 6 is slidably disposed in the cylinder 5. The piston 6 is connected through a connecting rod 8 to a crankshaft 7 disposed rotatably in the vehicle width direction.

[0017] A cylinder head 9 placed to cover the cylinder body 4 has an intake port 10 and an exhaust port 11 bored therein. The intake and exhaust ports 10 and 11 are opened and closed according to appropriate timing with intake and exhaust valves 12 and 13, so that gas is exchanged as required in the cylinder 5.

[0018] As shown in FIG. 3, the intake and exhaust valves 12 and 13 are inserted into and held slidably with valve guides 14 and 15 press-fitted into the cylinder head 9, and urged toward the closing side with springs 16 and 17, and their tops are in contact with one side ends of rocker arms 18 and 19. The rocker arms 18 and 19 are pivoted for swinging about their middle parts, about shafts 20 and 21. The other side ends of the rocker arms 18 and 19 are in contact with cams formed integrally with a camshaft 22.

[0019] As shown in FIG. 1, a chain sprocket 23 is attached to one end of the camshaft 22. An endless cam chain 25 is routed around between the chain sprocket 23 and another sprocket 24 attached to the middle part of the crankshaft 7.

[0020] The rotation of the crankshaft 7 is transmitted through the sprocket 24, the cam chain 25, and the chain sprocket 25 to the camshaft 22. When the camshaft 22 is driven at a specified speed (half the speed of the crankshaft 7), the intake and exhaust valves 12 and 13 are driven with the rocker arms 18 and 19 to open and close the intake and exhaust ports 10 and 11 according to appropriate timing. In this way, gas is exchanged in the cylinder 5 as required.

[0021] As shown in FIG. 1, an ignition plug 26 is screwed into the cylinder head 9 and the electrode portion of the ignition plug 26 is located in a corner of a combustion chamber S formed with the cylinder head 9.

[0022] As shown in FIG. 2 in detail, the crankshaft 7 is rotatably supported with paired right and left crank journal bearings 27. A cooling fan 28 is attached to one (right) end of the crankshaft 7. A dynamo 29 is disposed inside the cooling fan 28. To the other (left) end of the crankshaft 7 is attached a drive pulley 30 as a component of the V-belt type of transmission 2. As shown in FIG. 3 in detail, an intake pipe 31 continuing to the intake port 10 is attached to the upper part of the cylinder head 9. A carburetor and an air cleaner (both not shown) are connected to the intake pipe 31. An exhaust pipe (not shown) is attached to the exhaust port 11 which is open to the lower part of the cylinder head 9. An exhaust muffler (not shown) is connected to the exhaust pipe.

[0023] In the four-stroke cycle engine 1, oil is circulated with an oil pump 32 shown in FIG. 4 to lubricate and cool various parts of the engine. A positioning structure of the oil pump 32 will be described in reference to FIG. 4.

[0024] The oil pump 32 is of a gear-driven trochoid type driven with the crankshaft 7 and constituted with a cogwheel 34 housed in a pump main part 33, and a large diameter gear 36 attached to an end of a pump shaft 35 projecting out of the pump main part 33. The pump main part 33 comprises main part section 33a housing said cogwheel 34 and made by die casting. Said pump main part 33 further comprises a sheet metal plate 33b placed on the main part section 33a and secured to it with screws 37.

[0025] The oil pump 32 or its main part 33, constituted as described above is secured with bolts (not shown) to the crankcase 3 in the same position in the crankshaft direction as the crank journal bearings 27.

[0026] When the oil pump 32 is to be attached to the crankcase 3, the pump main part 33 is positioned close to the crank journal bearing 27 with part of the periphery of the pump main part 33 used as an assembly reference. Said crank case 3 supports said crank journal bearing 27 and said oil pump 32. A step portion 3a is extends from the crank case 3. Said crank journal bearing 27 is supported on one side of said step portion 3a and said oil pump (32) is provided at the opposing side of said step portion 3a. The step portion 3a extends in the direction of the crankshaft axis. A space is provided between the side of the step portion 3a which is facing the oil pump 32 and the main part section 33a of said oil pump 32.

[0027] The plate shaped member 33b which is provided between said main part section 33a and said crank case 3 extends along said crank case 3 with regard to a radial direction of the crank shaft 7. Said plate shaped member 33b serves as an assembly reference for the oil pump 32 in the radial direction of the crank shaft 7. That is to say, part of the periphery of the sheet metal plate 33b of the pump main part 33 is brought into butting contact with the step portion 3a of the supporting portion of the crankcase 3 supporting the crank journal bearing 27.

[0028] Since said plate shaped member 33b extends further in the radial direction than the main part section 33a housing the cogwheel 34 the space mentioned above is provided in a predetermined manner. Thus, with said space between the step portion 3a and the main part section 33a of the oil pump32, any deflection of the step portion 3a which may be caused by forces applied to the bearing 27 are not transmitted to the main

part section 33a. Therefore, the function of the cogwheel 34 is not influenced by such forces and there is no need for specific reinforcement means or the like of the oil pump 32. Without such reinforcement means the oil pump 32 can by made more compact and light in weight. As the pump main part 33 is positioned in this way, it is secured with bolts (not shown) close to the crank journal bearing 27 of the crankcase 3.

[0029] A small diameter gear 39 attached near the crank journal bearing 27 of the crankshaft 7 engages with the gear 36 of the oil pump 32.

[0030] The entire engine 1 constituted as described above is enclosed with an air shroud 40 made of a plastic material, as shown in Figs. 1 and 2. Part of the air shroud 40 opposite the cooling fan 28 is provided with a round, cooling air introducing opening 40a coaxially with the crankshaft 7. As shown in FIG. 2 the air shroud 40 is provided, at its front part, with a plug hole 40b which is open to the obliquely side direction and, behind it, with a round hole 40c for checking the top dead center. As shown in FIG. 1, an ignition plug 26 is passed through the plug hole 40b and covered with a plug cap 41 fitted from outside. A rubber cap 42 is removably fitted to the round, top dead center checking hole 40c. The air shroud 40 is attached to the crankcase 3 using plural screws 43.

[0031] Next will be described the constitution of the transmission mechanism of the unit swing type of engine 10.

[0032] As shown in FIG. 1, in the rear part of the crankcase 3 are rotatably disposed a driven shaft 44, an intermediate shaft (not shown), and an output (wheel) shaft 45, parallel to each other. A driven pulley 46 and a centrifugal clutch 47 are attached to the driven shaft 44. An endless V-belt 48 is fitted around between the driven pulley 46 and the drive pulley 30 to constitute the V-belt type of automatic transmission 2. A small diameter gear 49 is formed integrally with one (right) end of the driven shaft 44.

[0033] A driven gear and a drive gear of a large and a small diameters respectively are attached to an intermediate shaft (not shown). The driven gear of the intermediate shaft meshes with the drive gear 49. The drive gear (not shown) of the intermediate shaft meshes with the large diameter driven gear 50 attached to the output shaft 45. A rear wheel 51 of the scooter type of motorcycle is attached to the end of the output shaft 45 protruding out of a side of the transmission case 3. A kick lever 52 for kick-starting is shown in FIG. 1.

[0034] Next will be described the function of the unit swing type of engine 10 constituted as described above.

[0035] When the engine 1 of the unit swing type of engine 10 is started as the kick lever 52 or a starter button (not shown) is operated and the crankshaft 7 rotates, the cooling fan 28 and the dynamo 29 both attached coaxially to the crankshaft 7 rotate together. At the same time, the rotation of the crankshaft 7, while its speed is automatically changed with the V-belt type of automatic transmission 2, is transmitted to the centrifugal clutch 47.

[0036] The centrifugal clutch 47 becomes operative when its rotation speed exceeds a specified value and transmits rotation to the driven shaft 44. The rotation of the driven shaft 44, with its speed reduced through the drive gear 49 and a driven gear (not shown) provided on the intermediate shaft, is transmitted to the intermediate shaft. The rotation of the intermediate shaft, with its speed further reduced through a drive gear (not shown) and the driven gear 50, is transmitted to the output shaft 45. The output shaft 45 and a rear wheel 51 attached to the output shaft 45 are driven to rotate and propel the scooter type of motorcycle.

[0037] On the part of the engine 1, cooling air is introduced through the cooling air introducing inlet 40a bored in the side wall of the air shroud 40 into the interior of the air shroud 40 as the cooling fan 28 is rotated as described above, and the cooling air flows through the interior of the air shroud 40 and cools various parts of the engine 1 including the cylinder body 4 and the cylinder head 9.

[0038] In the engine 1, as the oil pump 32 is driven with the crankshaft 7, oil is circulated with the oil pump 32 to lubricate and cool various parts. That is, the rotation speed of the crankshaft 7 is reduced through the gears 36 and 39 with a specified ratio and transmitted to the pump shaft 35 of the oil pump 32. As the pump shaft 35 is driven to rotate, oil is drawn into the oil pump 32, oil pressure is raised with the oil pump 32 to a specified value, and the oil of raised pressure is delivered out of the oil pump 32 to lubricate and cool various parts.

[0039] In this embodiment described above, since the oil pump 32 is positioned the same in the crankshaft direction as one of the crank journal bearing 27, it is possible to reduce the engine width and make the engine 1 small and compact.

[0040] Use of the inexpensive gear-driven type of oil pump 32 makes it possible to reduce the cost of the engine 1. Changing the oil delivery rate of the oil pump 32 by choosing different gear ratios between the gears 36 and 39 makes it possible to use the same pump main part 33 of the oil pump 32 on several different engines in common. This further educes the cost.

[0041] In this embodiment, part of the periphery of the pump main part 33 (or part of the sheet metal plate 33b) of the oil pump 32 is used as an assembly reference for positioning the pump main part 33 close to the crank journal bearing 27. As a result, radial dimension of the engine 1 is reduced to make the engine 1 further small and compact.

[0042] As is clear from the above description, the oil pump is positioned the same as the crank journal bearing in the crankshaft direction and a constitution is employed in which the gear attached to the pump shaft is made to mesh with the gear attached to the crankshaft to transmit the rotation of the crankshaft through those gears to the pump shaft. As a result, it is possible to use

an inexpensive, gear-driven type of oil pump, and to use the same pump main part on different types of engines. This reduces costs, and further makes the engine small and compact.

[0043] The engine described above comprises an oil pump positioning structure, wherein an oil pump is positioned the same as a crank journal bearing in the crankshaft direction, a gear attached to the shaft of the oil pump and a gear attached to the crankshaft are made to engage with each other, and the rotation of the crankshaft is transmitted to the pump shaft through the gears. Thus, said oil pump positioning structure for four-stroke cycle engines that makes it possible to reduce costs by the use of inexpensive gear-driven type of oil pump and by the use of the same pump main part on several different engines, and to make the engine small and compact by reducing the engine width.

[0044] Therefore, since the oil pump is positioned the same as the crank journal bearing in the crankshaft direction, the engine width can be reduced to make the engine small and compact. And the use of the inexpensive gear-driven type of oil pump makes it possible to use the same pump main part on plural number of engines of different engine displacements in common to reduce costs.

[0045] In the oil pump positioning structure for a four-stroke cycle engine, the main part of the pump is positioned in the vicinity of the crank journal bearing with part of the periphery of the pump main part used as an assembly reference. Since the pump main part is positioned close to the crank journal bearing with part of the pump main part periphery used as an assembly reference, the radial dimension of the engine is reduced and the engine can be made further small and compact.

[0046] The above mentioned embodiment teaches an engine with a crankshaft 7 having a crankshaft axis supported by at least one crank journal bearing 27, and with an oil pump 32 positioned in a vicinity of the crank journal bearing 27 so as to at least partially overlap with said crank journal bearing 27 in a direction of the crankshaft axis.

[0047] The crank case 3 of said engine is provided to support said crank journal bearing 27 and said oil pump 32. Said crank case 3 comprises a step portion 3a extending in the direction of the crankshaft axis, wherein said crank journal bearing 27 is supported on one side of said step portion 3a and said oil pump 32 is provided at a further side opposing said one side of said step portion 3a with regard to a radial direction of the crankshaft 7. Said oil pump 32 has a main part section 33a spaced from said step portion 3a in the radial direction of the crankshaft 7.

[0048] Furthermore, the above mentioned embodiment also teaches an engine with a crankshaft 7 having a crankshaft axis supported by at least one crank journal bearing 27, wherein said crank journal bearing 27 is supported on one side of a step portion 3a of a crank case 3, and with an oil pump 32 positioned in a vicinity of the crank journal bearing 27 at a side opposing said one side of said step portion 3a, said oil pump 32 has a main part section 33a spaced from said step portion 3a.

[0049] In the engine of the embodiment said main part section 33a houses a cogwheel 34 of the oil pump 32. Said oil pump 32 has a plate shaped member 33b provided between said main part 33a section and said crank case 3 and said plate shaped member 33b is attached to said main part section 33a.

[0050] A part of a periphery of the oil pump 32 serves as an assembly reference. In particular, a part of a peripheral section of the plate shaped member 33b abuts the step portion 3a of the crank case 3 to serves as an assembly reference.

[0051] Said crank case 3 has a case portion extending from said step portion 3a in a radial direction with regard to crankshaft 7, wherein said oil pump 32 is attached to said case portion.

[0052] Said oil pump 32 is driven by said crankshaft 7 and said oil pump 32 comprises a pump shaft 35 and a first gear 36 is attached to said pump shaft 35 and a second gear 39 is attached to the crankshaft 7, wherein said first and second gear 36,39 are engaged with each other to transmit a drive force of the crankshaft 7 to the pump shaft 35.

Claims

1. Engine with a crankshaft (7) having a crankshaft axis supported by at least one crank journal bearing (27), and with an oil pump (32) positioned in a vicinity of the crank journal bearing (27) so as to at least partially overlap with said crank journal bearing (27) in a direction of the crankshaft axis.

2. Engine according to claim 1, wherein a part of a periphery of the oil pump (32) serves as an assembly reference.

3. Engine according to claim 1 or 2, wherein a crank case (3) is provided to support said crank journal bearing (27) and said oil pump (32), said crank case (3) comprises a step portion (3a) extending in the direction of the crankshaft axis, wherein said crank journal bearing (27) is supported on one side of said step portion (3a) and said oil pump (32) is provided at a further side opposing said one side of said step portion (3a) with regard to a radial direction of the crankshaft (7).

4. Engine according to claim 3, wherein said oil pump (32) has a main part section (33a) spaced from said step portion (3a) in the radial direction of the crankshaft (7).

5. Engine with a crankshaft (7) having a crankshaft axis supported by at least one crank journal bearing

(27), wherein said crank journal bearing (27) is supported on one side of a step portion (3a) of a crank case (3), and with an oil pump (32) positioned in a vicinity of the crank journal bearing (27) at a side opposing said one side of said step portion (3a), said oil pump (32) has a main part section (33a) spaced from said step portion (3a).

6. Engine according to claim 4 or 5, wherein said main part section (33a) houses a cogwheel (34) of the oil pump (32).

7. Engine according to at least one of the claims 4 to 6, wherein said oil pump (32) has a plate shaped member (33b) provided between said main part (33a) section and said crank case (3) and said plate shaped member (33b) is attached to said main part section (33a).

8. Engine according to claim 7, wherein a part of a peripheral section of the plate shaped member (33b) abuts the step portion (3a) of the crank case (3) to serves as an assembly reference.

9. Engine according to at least one of the claims 4 to 8, wherein said crank case (3) has a case portion extending from said step portion (3a) in a radial direction with regard to crankshaft (7), wherein said oil pump (32) is attached to said case portion.

10. Engine according to at least one of the claims 1 to 9, wherein said oil pump (32) is driven by said crankshaft (7) and said oil pump (32) comprises a pump shaft (35) and a first gear (36) is attached to said pump shaft (35) and a second gear (39) is attached to the crankshaft (7), wherein said first and second gear (36,39) are engaged with each other to transmit a drive force of the crankshaft (7) to the pump shaft (35).

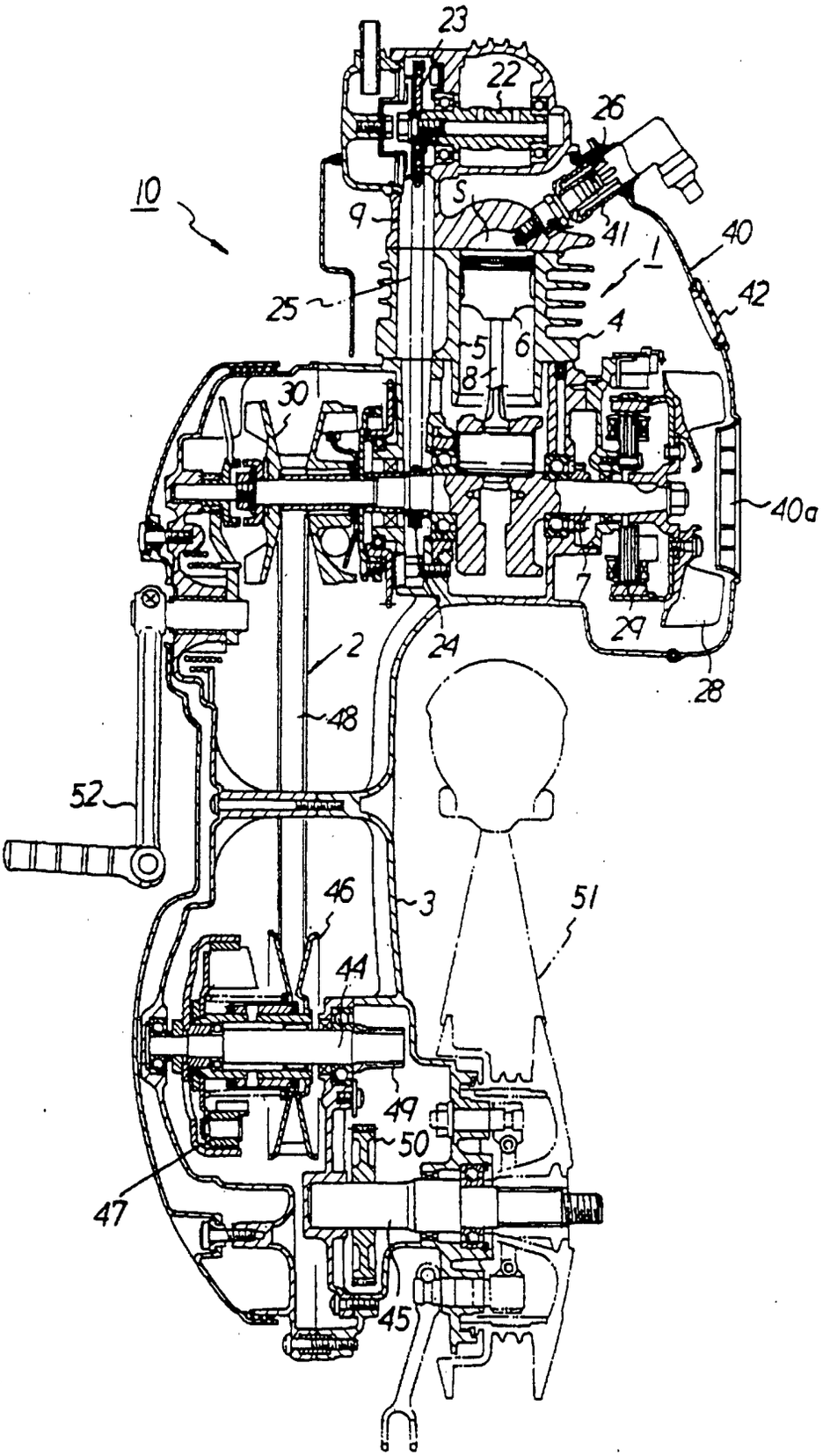
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FIGURE 1

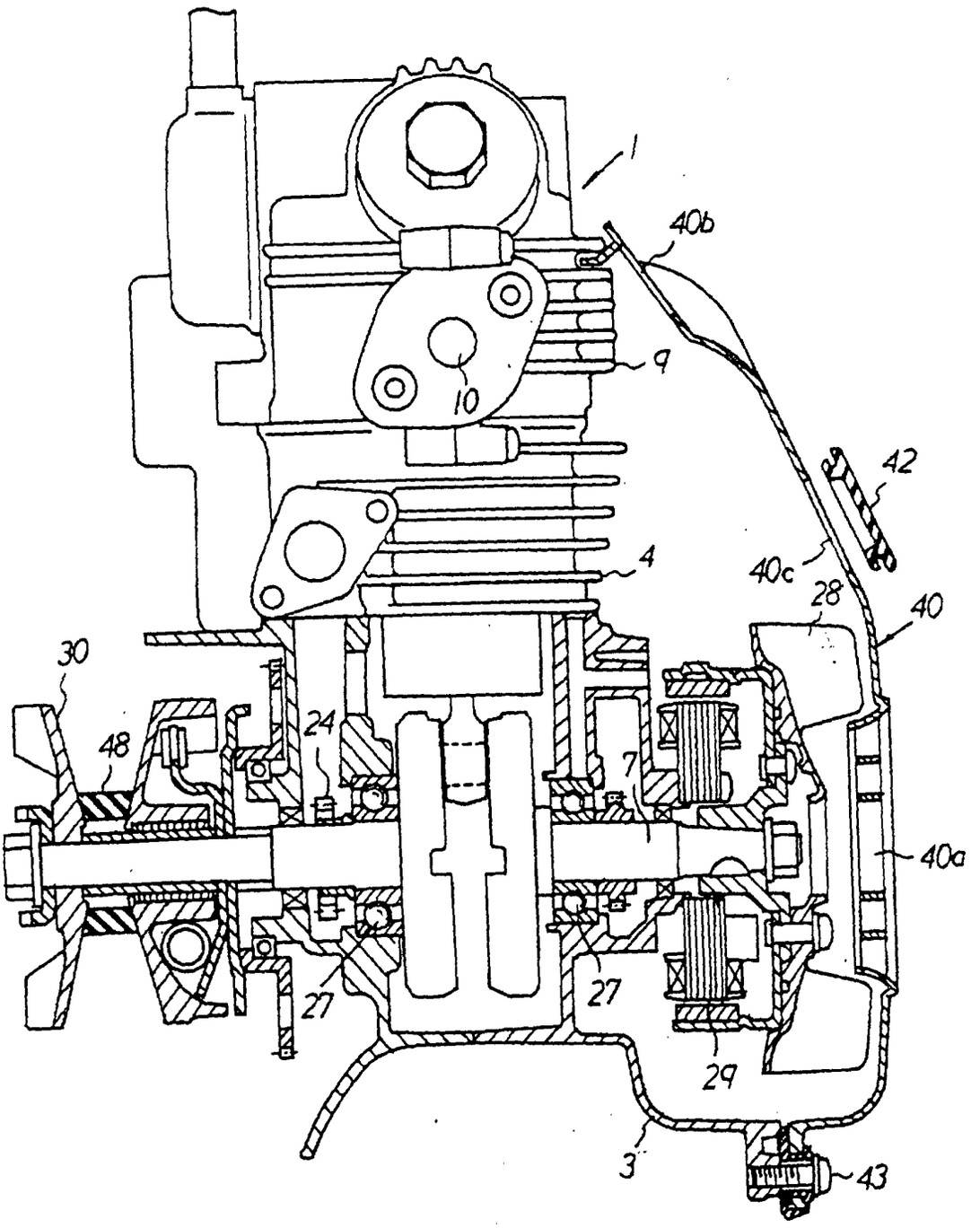

FIGURE 2

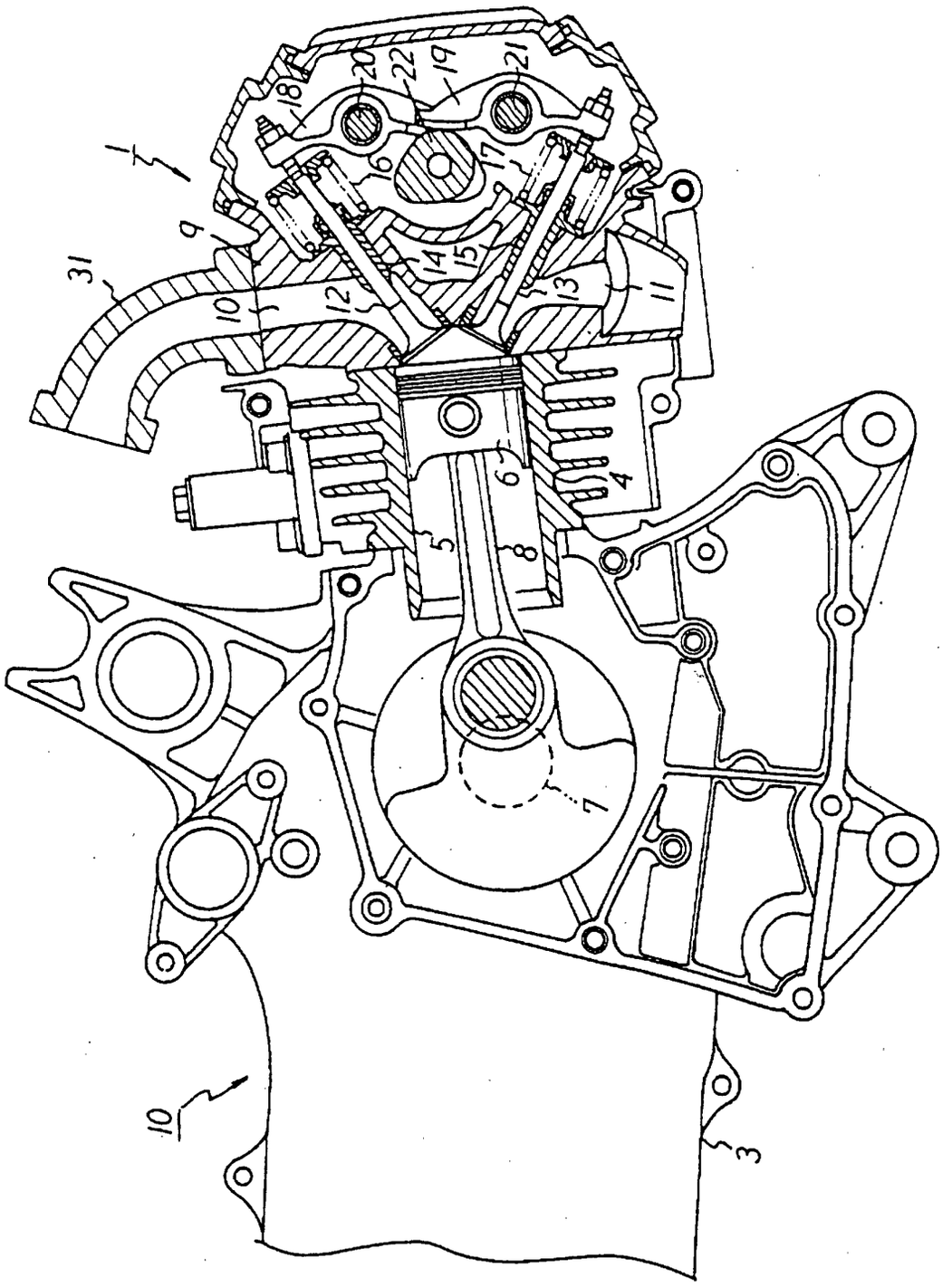

FIGURE 3

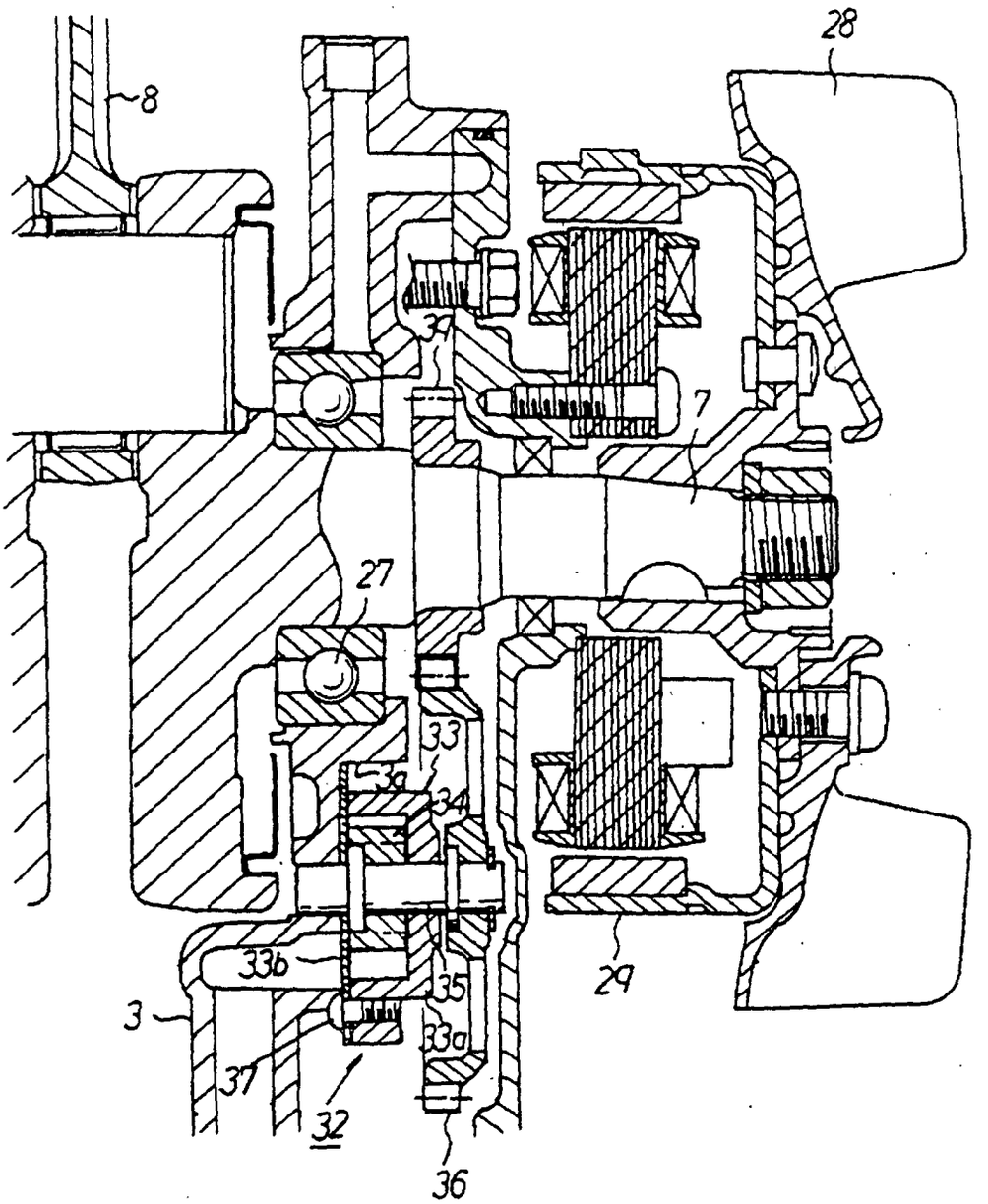

FIGURE 4

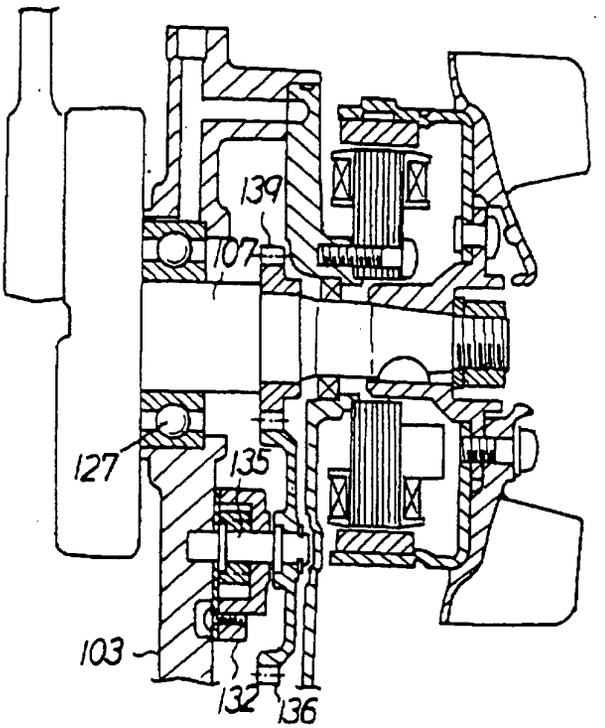

FIGURE 5

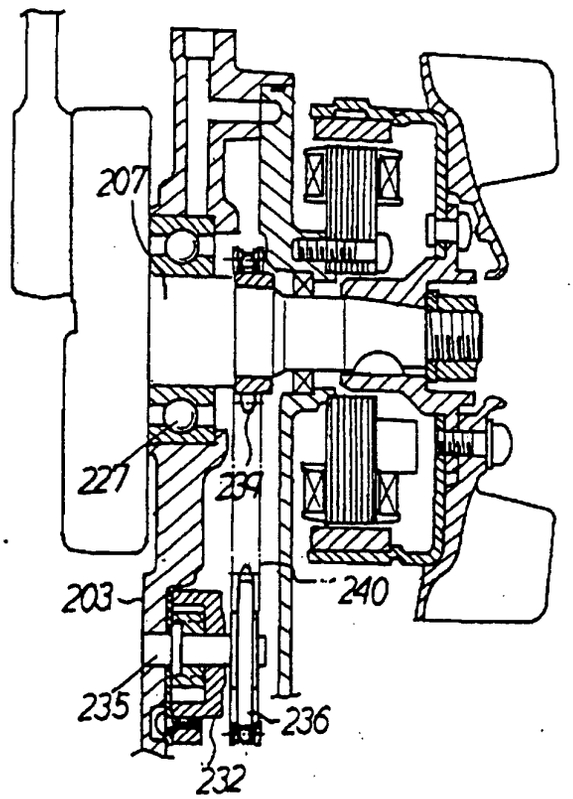

FIGURE 6