A lubricating oil supply device for an internal combustion engine in which a lubricating oil pump is provided to one end of a balancer shaft, but an oil conduit is not required to be provided to the balancer shaft. The lubricating oil pump is connected to one end of the balancer shaft. An intake oil conduit for directing lubricating oil to the lubricating oil pump is disposed inside a wall thickness of a crankcase. A discharge oil conduit for directing lubricating oil pressurized in the lubricating oil pump to the in-shaft oil conduit is disposed within the wall thickness of the crankcase.
LUBRICATING OIL SUPPLY DEVICE FOR INTERNAL COMBUSTION ENGINE

FIELD OF THE INVENTION

[0001] The present invention relates to a lubricating oil supply device suitable for a general-purpose engine.

BACKGROUND OF THE INVENTION

[0002] In an internal combustion engine, lubricating oil pressurized by a lubricating oil pump is fed to a rotating support part of a rotating member to make rotational movement smoother.

[0003] In an internal combustion engine in which a lubricating oil pump has been disposed in an oil reservoir, the oil reservoir is arranged in the bottom of the crankcase. The lubricating oil pump is disposed so as to be immersed in the oil reservoir. A driving gear is integrally formed on the crankshaft. A driven gear is driven by the driving gear. The lubricating oil pump is driven by the driven gear.

[0004] There is a need to omit the driving gear and the driven gear in order to reduce the size of the engine and to reduce the number of components.

[0005] In view of the above, there are known general-purpose engines in which the driving gear and the driven gear have been omitted, as disclosed in Japanese Utility Model Application Laid-Open Publication No. 05-014505 (JP-U 05-014505 A), for example.

[0006] FIG. 6 hereof shows an oil pump disposed inside the crankcase disclosed in JP-U 05-014505 A.

[0007] As shown in FIG. 6, one end of a balancer shaft 104 is supported by a sidewall 102 of a crankcase 101 via a bearing 103. A pump shaft 105 is mechanically connected to one end of the balancer shaft 104, an inner rotor 107 of a lubricating oil pump 106 is connected to the pump shaft 105, and an outer rotor 108 is fitted onto the inner rotor 107.

[0008] A long oil conduit 109 is provided to the balancer shaft 104 from one end along the shaft axis. Lubricating oil is drawn through an intake port 111 into the lubricating oil pump 106 and is discharged from the lubricating oil pump 106. The discharged lubricating oil is sent to target lubrication areas of the engine from a discharge port 112 by way of the oil conduit 109.

[0009] The driving gear and driven gear described above are not required because the lubricating oil pump 106 is connected to one end of the balancer shaft 104.

[0010] However, the long oil conduit 109 must be provided to the balancer shaft 104. The balancer shaft 104 is a delicate member of an unbalanced shape so that unbalanced elements of the crankshaft can be negated. Providing a long oil conduit 109 to such a balancer shaft 104 dramatically increases manufacturing costs, increases the difficulty of designing the shape of the balancer shaft 104, and results in dramatically higher design costs.

[0011] In view of the above, there is a need for a lubricating oil supply device for an internal combustion engine in which the lubricating oil pump is provided to one end of a balancer shaft, but an oil conduit is not required to be provided to the balancer shaft.

SUMMARY OF THE INVENTION

[0012] It is an object of the present invention to provide a lubricating oil supply device for an internal combustion engine in which a lubricating oil pump is provided to one end of a balancer shaft, but an oil conduit is not required to be provided to the balancer shaft.

[0013] According to an aspect of the present invention, there is provided a lubricating oil supply device for an internal combustion engine, comprising: a crankcase; a crankshaft and a balancer shaft, both housed in the crankcase; an in-shaft oil conduit, provided in the crankshaft, for directing supplied lubricating oil to a crankshaft bearing, wherein the lubricating oil supply device further comprises: a lubricating oil pump, connected to one end of the balancer shaft, for drawing in and pressurizing the lubricating oil pooled in the crankcase, an intake oil conduit, disposed within a wall thickness of the crankcase, for directing the lubricating oil pumped in the crankcase to the lubricating oil pump; and a discharge oil conduit, disposed within the wall thickness of the crankcase, for directing the lubricating oil pressurized by the lubricating oil pump to the in-shaft oil conduit.

[0014] It thus becomes possible to provide a lubricating oil supply device for an internal combustion engine in which the lubricating oil pump is provided to one end of the balancer shaft, but an oil conduit is not required to be provided to the balancer shaft.

[0015] Preferably, the lubricating oil pump is disposed within a wall thickness of the crankcase. It is therefore possible to reduce the size of the lubricating oil supply device.

[0016] Desirably, the lubricating oil pump comprises an inner rotor having a plurality of teeth, and an outer rotor having a greater number of teeth than the number of teeth of the inner rotor, and a seal plate is disposed between a bearing for rotatably supporting one end of the balancer shaft and the inner and outer rotors. Therefore, the lubricating oil compressed by the inner rotor and the outer rotor does not exceed the permitted amount and leak to the balancer shaft side.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] A preferred embodiment of the present invention will be described in detail below, by way of example only, with reference to the accompanying drawings, in which:

[0018] FIG. 1 is a cross-sectional view showing an internal combustion engine according to an embodiment of the present embodiment;

[0019] FIG. 2 is a cross-sectional view taken along line 2-2 of FIG. 1;

[0020] FIG. 3 is a cross-sectional view taken along line 3-3 of FIG. 1;

[0021] FIG. 4 is a view illustrating an operation of a lubricating oil pump;

[0022] FIG. 5 is a cross-sectional view of a crankcase; and

[0023] FIG. 6 is a schematic view showing a conventional lubricating oil supply device.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0024] As shown in FIG. 1, a crankshaft 12 and a balancer shaft 13 are provided mutually parallel to each other inside a crankcase 11 of an internal combustion engine 10.

[0025] The crankshaft 12 is supported at either end by a ball bearing 15 disposed in a case lid 14 for enclosing the crankcase 11 and a plain bearing 16 disposed in the crankcase 11. The ball bearing may be a roller bearing or a ball-and-roller bearing.

[0026] The balancer shaft 13 is a rotating component having an unbalanced shape such as that shown by the imaginary
line so as to be capable of offsetting unbalanced elements of the crankshaft 12. The balancer shaft 13 is supported at both ends by a ball bearing 17 provided to the case lid 14, and a ball bearing 18 provided to the crankcase 11. The case lid 14 can be detached from the crankcase 11 by loosening a bolt 19. A large-diameter first driving gear 21 and a small-diameter second driving gear 22 are integrally formed on the crankshaft 12 in the vicinity of the ball bearing 15. A first driven gear 23 is integrally formed on the balancer shaft 13, and the first driven gear 23 is driven by the first driving gear 21.

A lubricating oil pump 25 is mechanically connected to one end of the balancer shaft 13 (the end away from the case lid 14). The image storage unit 26 is arranged on the axis of the balancer shaft 13. The structure and operation of the lubricating oil pump 25 will be described later, but the lubricating oil pump 25 forcibly feeds lubricating oil to an annular groove 27 provided to the plain bearing 16, and to a crankshaft bearing 29 to which the large end portion of a connecting rod 28 is connected.

The crankshaft 12 and the crankcase 11 are sealed by an oil seal 31 and the crankshaft 12 and the case lid 14 are sealed by an oil seal 32. Therefore, there is no concern that oil will leak to the exterior.

A flywheel 33 is mounted on one end of the crankshaft 12, and smooth rotation of the crankshaft 12 is assured by the flywheel 33 together with the balancer shaft 13.

Next, the overall structure of the internal combustion engine will be described.

As shown in FIG. 2, the internal combustion engine 10 is provided with a crankcase 11, a cylinder portion 34 that extends diagonally upward from the crankcase 11, a cylinder liner 35 fitted into the cylinder portion 34, a piston 36 movably accommodated in the cylinder liner 35, a connecting rod 28 extending from the piston 36, a cylinder head 37 for closing off an opening of the cylinder portion 34, a crankshaft 12 accommodated in the crankcase 11, a camshaft 38 accommodated in the crankcase 11 in a position close to the cylinder portion 34 and below the crankshaft 12, a balancer shaft 13 accommodated in the crankcase 11 close to the side opposite from cylinder portion 34 and below the crankshaft 12, and a lubricating oil pump 25 arranged on the other side the balancer shaft 13, as well as a gear set and valve operating mechanism 40 (described next).

The first driving gear 21 and the second driving gear 22 having a smaller diameter than the first driving gear 21 are provided to the crankshaft 12. The first driven gear 23meshes with the large-diameter first driving gear 21 and the balancer shaft 13 and lubricating oil pump 25 are driven by the first driven gear 23.

A large-diameter second driving gear 41 meshes with the small-diameter second driving gear 22, and the camshaft 38 is driven by the second driven gear 41. The camshaft 38 is the drive source of the valve operating mechanism 40.

In other words, the valve operating mechanism 40 is composed of the camshaft 38, a pushrod 43 pushed upward by a cam 42 of the camshaft 38, a rocker arm 45 pivotally supported by the cylinder head 37 and used for opening a valve 44 when made to pivot by the pushrod 43, and a valve spring 46 for closing the valve 44. The valve 44 can be opened and closed by the valve operating mechanism 40 in corresponding fashion to the position (the rotational angle of the crankshaft 12) of the piston 36.

Next, the lubricating oil supply device, in which the main component is the lubricating oil pump 25, will be described with reference to FIG. 3, which is a view rotated 180° from the viewpoint of FIG. 2.

The lubricating oil supply device 47 has a lubricating oil pump 25, and an intake oil conduit 48 and discharge oil conduit 49 of the lubricating oil pump 25, as shown in FIG. 3. Specifically, the intake oil conduit 48 is connected to an oil intake section 51 of the lubricating oil pump 25. The discharge oil conduit 49 extends from an oil discharge section 52 of the lubricating oil pump 25 and is connected to the annular groove 27 of the plain bearing 16 (FIG. 1). The annular groove 27 is connected to the crankshaft bearing 29 by a oil conduit 53 provided inside the shaft (FIG. 1).

Next, the structure and operation of the lubricating oil pump 25 will be described.

As shown in FIG. 4(a), the lubricating oil pump 25 is preferably a trochoid pump composed of a pump shaft 26, an inner rotor 56 having a plurality (four, in this example) of teeth 55 and caused to rotate in the counterclockwise direction in the drawing, an outer rotor 58 having a plurality (five, in this example) of inner teeth 57 in greater number than the inner rotor 56 and caused to rotate by the inner rotor 56, and a pump housing section 59 for rotatably accommodating the outer rotor 58. The pump housing section 59 is a part of the crankcase.

Since the number of teeth differs between the inner rotor 56 and the outer rotor 58, a pump space 61 is formed as indicated by the shading in FIG. 4(a). The pump space 61 is increased in FIG. 4(b). The increased volume creates a suction effect, and the lubricating oil is drawn into the pump space 61 via the oil intake section 51. In FIG. 4(c), the pump space 61 moves from the oil intake section 51 to the oil discharge section 52, and in FIG. 4(d), the lubricating oil is discharged from the pump space 61 to the oil discharge section 52.

In other words, the pump space 61 varies in volume. Lubricating oil is drawn in as the volume increases and discharged as the volume decreases.

An advantageous layout of the lubricating oil supply device 47 as the main component of the lubricating oil pump 25 shall now be described with reference to FIG. 5.

The lubricating oil pump 25 is accommodated within the wall thickness of the crankcase 11, as shown in FIG. 5. Additionally, the intake oil conduit 48 for directing the lubricating oil pooled in the crankcase 11 to the lubricating oil pump 25 is disposed within the wall thickness of the crankcase 11, and the discharge oil conduit 49 for directing the lubricating oil pressurized in the lubricating oil pump 25 to the in-shaft oil conduit 53 (FIG. 3) is disposed within the wall thickness of the crankcase 11.

The intake oil conduit 48 and discharge oil conduit 49 may be arranged diagonally or orthogonally within the wall thickness of the crankcase 11. For example, the intake oil conduit 48 may be composed of a rectilinear passage 62 drilled through the bottom surface of the crankcase 11 and extended to the oil intake section 51, a through hole 63 that passes from an intermediate point of the rectilinear passage 62 to the oil pool of the crankcase 11, and a steel ball (or plug) for closing off the unnecessary portion of the rectilinear passage 62. Such a configuration makes it possible to readily form the intake oil conduit 48 and discharge oil conduit 49 within the wall thickness of the crankcase 11.
It is apparent from FIG. 5 that the lubricating oil pump 25 is provided to one end of the balancer shaft 13, but an oil conduit does not need to be provided to the balancer shaft 13. In the present invention, the balancer shaft 13 is easier to manufacture, and the balancer shaft 13 more readily designed, than with the conventional technique of providing an oil conduit to the balancer shaft.

The lubricating oil compressed by the inner rotor 56 and the outer rotor 58 is sealed in by a seal plate 65 disposed between the ball bearing 18, and the inner rotor 56 and outer rotor 58. Therefore, there is no concern that the lubricating oil will exceed the permitted amount and leak to the ball bearing 18 side.

The lubricating oil pump 25 is preferably a trochoid pump, but may also be a gear pump, a vane pump, or in another desired configuration.

The lubricating oil supply device of the present invention can be widely used in internal combustion engines, but is also advantageous for small general-purpose engines in which there is great need for reduced weight and smaller size.

Obviously, various minor changes and modifications of the present invention are possible in light of the above teaching. It is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

What is claimed is:

1. A lubricating oil supply device for an internal combustion engine, comprising: a crankcase; a crankshaft and a balancer shaft, both housed in the crankcase; an in-shaft oil conduit, provided in the crankshaft, for directing supplied lubricating oil to a crankshaft bearing, wherein the lubricating oil supply device further comprises:
   - a lubricating oil pump, connected to one end of the balancer shaft, for drawing in and pressurizing the lubricating oil pooled in the crankcase,
   - an intake oil conduit, disposed within a wall thickness of the crankcase, for directing the lubricating oil pooled in the crankcase to the lubricating oil pump; and
   - a discharge oil conduit, disposed within the wall thickness of the crankcase, for directing the lubricating oil pressurized by the lubricating oil pump to the in-shaft oil conduit.

2. The lubricating oil supply device of claim 1, wherein the lubricating oil pump is disposed within the wall thickness of the crankcase.

3. The lubricating oil supply device of claim 1, wherein the lubricating oil pump comprises an inner rotor having a plurality of teeth, and an outer rotor having a greater number of teeth than the number of teeth of the inner rotor, and a seal plate is disposed between a bearing for rotatably supporting one end of the balancer shaft and the inner and outer rotors.

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