OIL PUMP MODULE HAVING AN OIL PUMP MODULE HOUSING

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Appl. No.: 13/102,491
Filed: May 6, 2011

Foreign Application Priority Data
May 20, 2010 (DE) 102010022134.1

Publication Classification
Int. Cl. F01M 1/02 (2006.01)
U.S. Cl. 123/196 R

ABSTRACT
An oil pump module is provided that has an oil pump module housing. The oil pump module is situated in an oil pan of an internal combustion engine below a crankshaft. Moving parts of an oil pump and an angular momentum balance shaft are situated in the oil pump module housing. A rotor of the oil pump is situated on a rotor shaft, which is separate from the angular momentum balance shaft, in the oil pump module housing. The rotor shaft is mechanically connected via a spur gear transmission in the oil pump module housing to the angular momentum balance shaft.
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CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims priority to German Patent Application No. 102010022134.1, filed May 20, 2010, which is incorporated herein by reference in its entirety.

TECHNICAL FIELD

[0002] The technical field relates to an oil pump module having an oil pump module housing. The oil pump module is situated in an oil pan of an internal combustion engine below a crankshaft. All moving parts of an oil pump and an angular momentum balance shaft are situated in the oil pump module housing.

BACKGROUND

[0003] A combined oil pump and angular momentum balance module for installation in an oil sump of a reciprocating piston engine is known from the publication U.S. Pat. No. 6,601,557 B1, a rotating angular momentum balance shaft carrying balance weights on diametrically opposing ends, in order to balance the unbalanced angular momentum forces of the reciprocating piston engine. In addition, it is known from U.S. Pat. No. 6,205,970 B1 that the oil pump housing can be formed together with the housing of angular momentum balance shafts, in order to thus reduce the number of the components and the production time of the assembly. A schematic outline of such an oil pump module in an internal combustion engine is shown in FIG. 1. Furthermore, FIG. 4 shows a cross-section through the oil pump according to the prior art, whose rotor is fixed rotationally fixed on one of two angular momentum balance shafts.

[0004] FIG. 3 shows a schematic outline of the known oil pump module 2, in which, for a four-cylinder engine having the cylinders 31, 32, 33, and 34, only the connecting rods are shown in the schematic outline, which cooperate via plain bearings 16 with a crankshaft 6 and cooperate in the engine compartment 17, which is symbolized here as a block having a dash-three-dot line.

[0005] Outside the engine compartment 17, the crankshaft 6 has a gear ring 28 of a chain drive 13, which drives a first angular momentum balance shaft 29 below the crankshaft 6 having two balance weights 23 and 24 via a drive chain gearwheel 12. On this first angular momentum balance shaft 29, a spur gear transmission 11 having a transmission ratio 1:1 is situated, which drives a second angular momentum balance shaft 35, on which a rotor 9 of an oil pump 7 is situated in an oil pan 4, an intake opening 14 of the oil pump 7 being immersed in an oil sump. Since the angular momentum balance shafts 29 and 35 rotate at the same speed as the crankshaft 6 and are fixed in a rotationally-fixed manner on the angular momentum balance shaft 35 of the rotor 9, the oil pump 7 operates at the same speed as the crankshaft 6.

[0006] In addition, FIG. 4 shows a cross-section through the part of the oil pump module 2 according to the prior art, in which the oil pump 7 having its rotor 9 is situated. The rotor 9 is fixed on the second angular momentum balance shaft 35, on which the balance weights 23 and 24 are also situated. The angular momentum balance shaft 35 is mounted on plain bearings 36 and 37, the plain bearing 36 being situated between the rotor 9 of the oil pump 7 and a spur gear 38 of the spur gear transmission 11 and a second plain bearing 37 being situated between a first front balance weight 23 and a second rear balance weight 24.

[0007] This known oil pump module 2 is situated with its oil pump housing 3 at an angle α below the crankshaft in such a manner that the intake opening 14 of the oil pump 7 lies in an oil sump 15 and the balance weights 23 and 24 rotate above a level 39. Although in FIG. 4 the oil pump housing 40 is flanged on a housing 41 of the second angular momentum balance shaft 35, the prior art of this document discloses at the beginning that the housing 40 and 41 may be formed as the oil pump module housing 3. Nonetheless, the disadvantage remains that the speed of the rotor 9 of the oil pump 7 is disadvantageously connected to the speed of the angular momentum balance shaft 35.

[0008] Therefore, at least one object is to overcome the disadvantage in the prior art and to provide an oil pump module in which the speed of the oil pump rotor is not coupled to the speed of the angular momentum balance shafts. In addition, other objects, desirable features and characteristics will become apparent from the subsequent summary and detailed description, and the appended claims, taken in conjunction with the accompanying drawings and this background.

SUMMARY

[0009] According to an embodiment, an oil pump module having an oil pump module housing is provided. The oil pump module is situated in an oil pan of an internal combustion engine below a crankshaft. All moving parts of an oil pump and an angular momentum balance shaft are situated in the oil pump module housing. A rotor of the oil pump is situated on a rotor shaft, which is separate from the angular momentum balance shaft, in the oil pump module housing. The rotor shaft is mechanically connected via a spur gear transmission in the oil pump module housing to the angular momentum balance shaft.

[0010] Through the rotor shaft, which is independent and/ or separate from the angular momentum balance shaft, it is possible to supply the rotor of the oil pump with an optimized speed. The speed can be above or below the speed of the crankshaft. A volume-flow-regulated vane pump can be used as the oil pump, in which an eccentricity between the vane housing and the rotor shaft can be regulated as a function of the oil pressure in a main oil gallery of the engine via a corresponding hydraulic return line. A further regulating chamber can be switched on in the oil pump module housing via an electromechanical oil control valve, whereby the volume flow can be reduced and the oil pressure can be decreased. All moving parts required for this purpose are integrated in the oil pump module housing of the oil pump module.

[0011] In a further embodiment, it is provided that a drive chain gearwheel is situated on the rotor shaft outside the oil pump module housing, which is mechanically connected via a chain drive to the crankshaft. The rotor shaft is thus advantageously supplied directly by the transmission of the chain drive with an optimum rotor speed, which is independent of the speed required for the angular momentum balance shafts. Furthermore, it is provided that an intake opening of the oil pump of the oil module is immersed in an oil sump of the oil pan.

[0012] As already mentioned above, a two-stage oil pump having a main regulating chamber and an expansion regulat-
ing chamber is situated in the oil pump module housing. In addition to the plain bearings of the engine and further components, the plain and/or roller bearings in the oil pump module housing are also supplied by this two-stage oil pump. The oil pump module has a drive shaft, on which the drive chain gearwheel is situated in a rotationally-fixed manner outside the oil pump module housing. The drive shaft has a drive gearwheel of the spur gear transmission to the angular momentum balance shaft between two shaft bearings inside the oil pump module housing. This drive gearwheel of the spur gear transmission is designed in such a manner that, together with an output gearwheel situated on the angular momentum balance shaft, it ensures a step-up or step-down transmission which causes the angular momentum balance shaft to rotate at the same speed as the crankshaft with a three-cylinder motor or at twice the speed with a four-cylinder motor.

[0013] The two balance weights, which are situated on the angular momentum balance shaft between two shaft bearings, compensate for the unbalance of the torque impulses of an internal combustion engine having reciprocating pistons. For this purpose, the angular momentum balance shaft is situated as an output shaft having an output gearwheel in relation to the rotor shaft having drive gearwheel in the oil pump module housing. As a result, the output gearwheel of the angular momentum balance shaft meshes with the drive gearwheel of the rotor shaft of the oil pump in this oil pump module housing and not vice versa as in the prior art.

[0014] Furthermore, the transmission ratio of the spur gear transmission situated in the oil pump module housing is designed in such a manner that, in consideration of the transmission ratio of the chain drive situated outside the oil pump module housing, the speed of the angular momentum balance shaft is equal to or twice as high as the speed of the crankshaft. A possibility is thus provided using this oil pump module of providing the speed of the rotor of the oil pump varying in relation to the speed of the crankshaft to the angular momentum balance shaft, so that a step-up or step-down transmission ratio of the chain drive defines the rotor speed of the rotor of the oil pump.

[0015] In a further embodiment, for a three-cylinder engine, the speed of the rotor of the oil pump is provided as lower than the speed of the crankshaft of the three-cylinder engine. This oil pump module is therefore preferably used in a vehicle having an internal combustion engine which has three cylinders.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] The present invention will hereinafter be described in conjunction with the following drawing figures, wherein numerals denote like elements, and:

[0017] FIG. 1 shows a schematic outline of an oil pump module according to an embodiment;

[0018] FIG. 2 shows a schematic outline of an oil pump module according to FIG. 1 in cooperation with the crankshaft of an internal combustion engine;

[0019] FIG. 3 shows a schematic outline of an internal combustion engine having an oil pump module according to the prior art; and

[0020] FIG. 4 shows a schematic cross-section through a subarea of an oil pump module 2 according to FIG. 3.

DETAILED DESCRIPTION

[0021] The following detailed description is merely exemplary in nature and is not intended to limit application and uses. Furthermore, there is no intention to be bound by any theory presented in the preceding background or summary or the following detailed description.

[0022] FIG. 1 shows a schematic outline of an oil pump module 1 according to an embodiment of the application. The oil pump module 1 has an oil pump module housing 3, in which all moving parts of an oil pump 7 and an angular momentum balance shaft 8 are situated. A rotor 9 of the oil pump 7 is situated on a rotor shaft 10, which is separate from the angular momentum balance shaft 8, and is implemented as the drive shaft 18, in the oil pump module housing 3. The rotor shaft 10 is mechanically connected via a spur gear transmission 11 in the oil pump module housing 3 to the angular momentum balance shaft 8.

[0023] In other words, the rotor shaft 10, as the drive shaft 18, drives the angular momentum balance shaft 8 having its balance weights 23 and 24. For this purpose, the angular momentum balance shaft 8, as the output shaft 27, has an output gearwheel 22 of the spur gear transmission 11. While the rotor shaft 10, as the drive shaft 18, is driven by the crankshaft via a drive chain gearwheel 12, which is situated outside the oil pump housing 3, and a chain drive 13, the angular momentum balance shaft mounted in the shaft bearings 25 and 26 rotates at a speed which is specified by the spur gear transmission 11.

[0024] The spur gear transmission 11 can therefore have a transmission ratio which is not equal to 1:1 and thus compensates for a transmission ratio of the chain drive 13, so that the required smooth running between angular momentum balance shaft 8 and crankshaft of the internal combustion engine is ensured. In addition, the spur gear transmission 11 ensures a rotational direction reversal of the angular momentum balance shaft in relation to the rotational direction of the crankshaft.

[0025] The advantage of this oil pump module is, on the one hand, that the speed of the rotor 9 of the oil pump 7 can be designed individually and optimally. On the other hand, a compact oil pump module housing 3 is possible, which is assembled from two oil pump module housing halves, for example, whereby the costs for separate oil pump housing and housing for the angular momentum balance shaft housing may be reduced, since fewer parts are possible, on the one hand, and a lower weight is also possible, on the other hand. Through the spur gear transmission, which is situated in the oil pump module housing, not only is the difference between the speed for the rotor shaft and the crankshaft compensated for again, but also the required rotational direction reversal for the angular momentum balance shaft is also achieved simultaneously.

[0026] While the shaft mounting of the drive shaft by a bearing 19 is situated between the drive chain gearwheel 12, which is situated outside the oil pump module housing 3, and the drive gearwheel 21 of the spur gear transmission 11, the second shaft bearing 20 of the drive shaft 18 is located between the drive gearwheel 21 of the spur gear transmission 11 and the oil pump 7. Two shaft bearings 25 and 26 are provided for the mounting of the angular momentum balance shaft 8, between which the output gearwheel 22 of the spur gear transmission 11 and the two balance weights 23 and 24 are situated.

[0027] FIG. 2 shows a schematic outline of an oil pump module 1 according to FIG. 1 in cooperation with a crankshaft 6 of the three-cylinder engine 30, which has three cylinders 31, 32, and 33, of which only the connecting rods are shown,
which cooperate with plain bearings 16 of the crankshaft 6. Outside the crankshaft housing, a chain gearwheel 28 is situated on the crankshaft 6, which is connected via a chain drive 13 to the drive chain gearwheel 12 for the rotor shaft 10. While the area of the engine compartment 17 of the internal combustion engine 5 is enclosed by a dash-three-dot line, the chain drive 13 outside the engine compartment 17 is marked by a dash-four-dot line. The oil pump module 1 in the pump housing 3 marked by a dot-dash line corresponds to FIG. 1. Components having the same functions as in FIG. 1 being identified by the same reference numerals and not being explained further separately. It is once again clear from FIG. 2 that an arbitrary step-up or step-down transmission for the drive of the rotor 9 in the pump 7 is possible using the chain drive 13, particularly because an equalization of the speed to the speed of the crankshaft 6 is possible for the angular momentum balance shaft 8 through the spur gear transmission 11 with rotational direction reversal to the crankshaft 6. 

While at least one exemplary embodiment has been presented in the foregoing summary and detailed description, it should be appreciated that a vast number of variations exist. It should also be appreciated that the exemplary embodiment or exemplary embodiments are only examples, and are not intended to limit the scope, applicability, or configuration in any way. Rather, the foregoing summary and detailed description will provide those skilled in the art with a convenient roadmap for implementing an exemplary embodiment, it being understood that various changes may be made in the function and arrangement of elements described in an exemplary embodiment without departing from the scope as set forth in the appended claims and their legal equivalents.

What is claimed is:

1. An oil pump module, comprising:
   - an oil pump module housing;
   - an oil pump;
   - a plurality of moving parts of the oil pump situated in the oil pump module housing;
   - an angular momentum balance shaft situated in the oil pump module housing;
   - a rotor shaft that is separate from the angular momentum balance shaft;
   - a rotor of the oil pump that is situated on the rotor shaft in the oil pump module housing; and
   - a spur gear transmission in the oil pump module housing mechanically connecting the rotor shaft to the angular momentum balance shaft.

2. The oil pump module according to claim 1, further comprising a drive chain gearwheel that is mechanically connected via a chain drive to the crankshaft and situated on the rotor shaft outside the oil pump module housing.

3. The oil pump module according to claim 1, wherein an intake opening of the oil pump of the oil pump module is immersed in an oil sump of the oil pan.

4. The oil pump module according to claim 1, wherein the oil pump is a two-stage oil pump configured to supply plain bearings in an engine compartment.

5. The oil pump module according to claim 2, wherein the oil pump module comprises a drive shaft on which the drive chain gearwheel is situated in a rotationally-fixed manner outside the oil pump module housing, and the drive shaft comprises a drive gearwheel of the spur gear transmission to the angular momentum balance shaft between two shaft bearings inside the oil pump module housing.

6. The oil pump module according to claim 2, further comprising two balance weights are situated between two shaft bearings on the angular momentum balance shaft that compensate for an unbalance due to torque pulses of the internal combustion engine.

7. The oil pump module according to claim 1, wherein the angular momentum balance shaft is situated as an output shaft having output gearwheel in relation to the rotor shaft having drive gearwheel in the oil pump module housing.

8. The oil pump module according to claim 7, wherein the output gearwheel of the angular momentum balance shaft is configured to mesh with the drive gearwheel of the rotor shaft of the oil pump in the oil pump module housing.

9. The oil pump module according to claim 2, wherein a transmission ratio of the spur gear transmission that is situated in the oil pump module housing is configured such that in consideration of the transmission ratio of the crankshaft situated outside the oil pump module housing, a speed of the angular momentum balance shaft is equal to a second speed of the crankshaft for three-cylinder engines and is twice as high as the second speed of the crankshaft for four-cylinder engines.

10. The oil pump module according to claim 2, wherein a step-down transmission ratio of the chain drive defines a rotor speed of the rotor of the oil pump.

11. The oil pump module according to claim 2, wherein a step-up transmission ratio of the chain drive defines a rotor speed of the rotor of the oil pump.

12. The oil pump module according to claim 1, wherein for a four-cylinder engine, a speed of the rotor of the oil pump is less than a second speed of the crankshaft of the three-cylinder engine.

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