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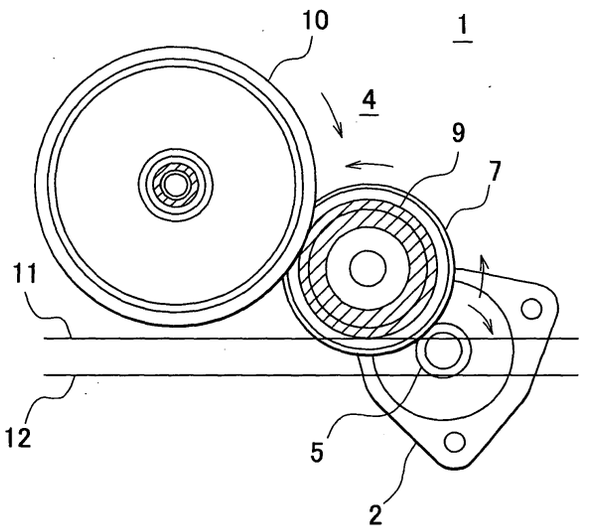
(54) Engine starter for vehicle

(57) An engine starter (1) for a vehicle is equipped with a starter motor (2); a gear group (4) structured from a plurality of gears, which transmits the rotation of the starter motor (2) to a crankshaft (3); and clutch means (8) provided between the starter motor (2) and the crankshaft (3), which permits the transmission of rotation from the starter motor (2) to the crankshaft (3), but prevents the transmission of rotation from the crankshaft (3) to the starter motor (2). The engine starter (1) for a vehicle is characterized in that a first gear portion (9, 10), among the plurality of gears structuring the gear group (4), disposed so as to enable the transmission of rotation from the clutch means (8) to the crankshaft (3), is provided in a position where no contact is made with a maximum oil level position (11), which is a position of the crank chamber where lubricating oil is stored for lubricating gears in the gear group (4) when the lubricating oil amount in the crank chamber reaches a predetermined maximum lubricating oil amount.

FIG. 1



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Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The invention relates to an engine starter for a vehicle.

2. Description of the Related Art

[0002] As a known engine starter for a vehicle, a type of starter is disclosed in Japanese Patent Laid-Open Publication No. 2000-120514 in which a gear group for a starter system is provided between an output shaft and a crankshaft of a starter motor, and a portion of the gears included in the starter system gear group are constantly meshed to rotate with the crankshaft, due to the provision of a one-way clutch among the starter system gear group.

[0003] However, in the starter described above, the positional relationship between each gear of the starter system gear group and the level of lubricating oil stored in an oil pan at a lower portion of a crank chamber is not considered. In this case, each gear of the starter system gear group is arranged such that a crank gear on the crankshaft is positioned at a lowermost position. Therefore, assuming that lubrication is performed by raking up the lubricating oil in the oil pan with the crank gear, the crank gear must be at least in contact with, if not semi- or fully immersed in, the lubricating oil. However, if the crank gear rotating with the crankshaft is at least in contact with the lubricating oil, friction drag between the crank gear and the lubricating oil continuously acts as a resistance to the rotation of the crankshaft, thus increasing engine friction loss.

[0004] Furthermore, all gears included in the starter system gear group are not in contact with the lubricating oil when the crank gear is disposed above the lubricating oil level. Therefore, cost-increasing measures such as providing an oil pump or adding an oil channel for lubrication become necessary. In particular, as long as the internal combustion engine is operating, the gears between the crankshaft and the one-way clutch are meshed with each other and rotate with the crankshaft, making proper lubrication essential.

SUMMARY OF THE INVENTION

[0005] It is an object of the invention to provide an engine starter for a vehicle that has no possibility of increasing resistance to the rotation of a crankshaft and, preferably, allows lubricating oil to be appropriately supplied to a gear group of a starter system using the rotation of a gear for starting.

[0006] According to an aspect of the invention, an engine starter for a vehicle is equipped with a starter motor; a gear group structured from a plurality of gears, which transmits the rotation of the starter motor to a crankshaft; and clutch means provided between the starter motor and the crankshaft, which permits the transmission of rotation from the starter motor to the crankshaft, but prevents the transmission of rotation from the crankshaft to the starter motor. The engine starter for a vehicle is characterized in that a first gear portion, among the plurality of gears structuring the gear group, disposed so as to enable the transmission of rotation from the clutch means to the crankshaft, is provided in a position where no contact is made with a maximum oil level position, which is a position of the crank chamber where lubricating oil is stored for lubricating gears in the gear group when the lubricating oil amount in the crank chamber reaches a predetermined maximum lubricating oil amount.

[0007] According to this aspect of the invention, gears disposed between the crankshaft and the clutch means rotate with the crankshaft. However, the gears do not come in contact with the lubricating oil at the maximum oil level position of the crank chamber, and thus no friction drag between the gears and the lubricating oil is created. Consequently, an increase in friction loss of the engine can be prevented, because there is no possibility of friction drag being continuously created between the gear group for starting and the lubricating oil during engine operation. In addition, a gear in the first gear group may be disposed at a position where the tooth top thereof does not reach the maximum oil level position.

[0008] Furthermore, at least one gear of a second gear portion, among the plurality of gears structuring the gear group, which is disposed between the starter motor and the clutch means, may be provided in a position where contact is made with a minimum oil level position of the crank chamber which is a position of the crank chamber when the lubricating oil amount in the crank chamber reaches a predetermined minimum lubricating oil amount.

[0009] In this manner, gears between the starter motor and the clutch means rotate when the starter motor rotates, but are not rotated and driven by the crankshaft. Consequently, lubricating oil is raked up in connection with the rotation of a gear disposed at a position where contact is made with the oil surface at the minimum oil level position during operation of the starter motor. Thus, lubricating oil is scattered to each location of the gear group so that lubricating oil is supplied to gears between the crankshaft and the clutch means. On the other hand, once the engine is started and the starter motor stops, the gears that are at least in contact with, if not semi- or fully immersed in, the lubricating oil are stopped, and there is no possibility of friction drag being continuously added to the crankshaft.

[0010] In addition, the gear group may be structured such that rotation of an output shaft of the starter motor is successively decreased and transmitted to the crankshaft, and provided in a position where a starter gear attached to the output shaft of the starter motor comes

in contact with the minimum oil level position. In this case, since the starter gear is rotating at a maximum speed, lubricating oil can be sufficiently raked up through at least the contact of the starter gear with the lubricating oil, if not the semi- or full immersion of the starter gear therein, thus enabling extensive scattering of lubricating oil.

[0011] Furthermore, the first gear portion may be structured with a crank gear provided on the crankshaft, and an intermediate gear provided on a support shaft parallel with the crankshaft, which is provided with the clutch means and meshed with the crank gear, and the second gear portion may be structured with a starter gear attached to the output shaft of the starter motor, and a driven gear provided on the support shaft and meshed with the starter gear.

[0012] Moreover, the maximum oil level position and the minimum oil level position may be determined based upon restrictions on the vehicle and engine sides, respectively. For example, in the case of a specific component (such as a connecting rod) present in the engine that should not come in contact with the lubricating oil surface, the maximum oil level position is determined such that the component does not contact the lubricating oil surface even when the vehicle is inclined to the maximum extent allowed in the vehicle specification. On the other hand, in the case of a component that must be at least in contact with, if not semi- or fully immersed in, the lubricating oil (such as an intake port of a lubricating oil pump and a strainer connected thereto), the minimum oil level position is determined such that the component is at least in contact with, if not semi- or fully immersed in, the lubricating oil even when the vehicle is inclined to the maximum extent allowed in the vehicle specification. In addition, the maximum and minimum oil level positions can be determined in consideration of various conditions required due to structural constraints of the engine and the vehicle.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] FIG. 1 is a drawing showing a starter viewed from the direction of an axis of a gear according to an embodiment of the invention.

[0014] FIG. 2 is a drawing showing the starter of FIG. 1 with a partial cutaway in the axial direction of the gear.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0015] FIGS. 1 and 2 show an engine starter for a vehicle according to an embodiment of the invention. Note that the vehicle engine is a reciprocating engine that converts the reciprocating motion of a piston into a rotational motion. A starter 1 is equipped with a starter motor 2, and a gear group 4 for transmitting the rotation of the starter motor 2 to an engine crankshaft 3. The gear group 4 is equipped with a starter gear 5 driven by an output shaft 2a of the starter motor 2; a driven gear 7 provided so as to mesh with the starter gear 5 on a support shaft 6 provided parallel with the crankshaft 3 and the starter motor 2; an intermediate gear 9 coaxially provided on the support shaft 6 via a one-way clutch 8 serving as clutch means; and a crank gear 10 provided on the crankshaft 3 so as to mesh with the intermediate gear 9. The gear ratios between the starter gear 5 and the driven gear 7, and the intermediate gear 9 and the crank gear 10 are set such that rotation of the motor is decrease and transmitted toward the crankshaft 3 side from the output shaft 2a side of the starter motor 2 through the respective gears. Accordingly, the rotation is successively decreased and transmitted to the crankshaft 3 through the gear group 4.

[0016] The driven gear 7 is integrally rotatable with the support shaft 6. The one-way clutch 8 transmits rotation from the driven gear 7 to the intermediate gear 9, and prevents the transmission of rotation from the intermediate gear 9 to the driven gear 7. The gear group 4 is housed in an oil pan (not shown) provided in the lower portion of a crank chamber of the engine. A maximum oil level position 11 and a minimum oil level position 12 for lubricating oil are set in the oil pan.

[0017] The maximum oil level position 11 and the minimum oil level position 12 are respectively determined by structural constraints of the engine started by the starter 1 or the vehicle in which the starter 1 is installed. The maximum oil level position 11 is set such that, for example, a connecting rod that connects the crankshaft 3 and the piston does not contact the lubricating oil. The minimum oil level position 12 is set such that, for example, a strainer of a lubricating oil pump disposed at the bottom of the oil pan is semi- or fully immersed in the lubricating oil, even when the vehicle is inclined at a maximum degree within an allowable range. In addition, other factors including the shape of the engine bottom portion, the position of a gear rotating a balance shaft for negating engine vibration, and the incline of the engine mounted in the vehicle are also considered when determining the maximum oil level position 11 and the minimum oil level position 12.

[0018] Each of the gears 5, 7, 9, and 10 structuring the gear group 4 in the starter 1 are arranged as follows with respect to the maximum oil level position 11 and the minimum oil level position 12 described above.

[0019] First, the starter gear 5 is disposed such that at least one portion thereof is positioned lower than the minimum oil level position 12. Next, a tip diameter of the crank gear 10 is set such that the crank gear 10 is separated above the maximum oil level position 11. In addition, the shaft core position and the tip diameter of the intermediate gear 9 are respectively set such that the entire gear is separated above the maximum oil level position 11. Furthermore, the diameter of the driven gear 7 is set such that the driven gear 7 is coaxial with the intermediate gear 9 and meshes with the starter gear 5. As described above, through the arrangement of the

gears 5, 7, 9 and 10, the intermediate gear 9 and the crank gear 10 disposed between the one-way clutch 8 and the crankshaft 3 do not come in contact with the lubricating oil surface, even when the oil level of the lubricating oil in the oil pan reaches the maximum oil level position 11. On the other hand, the starter gear 5 disposed between the starter motor 2 and the one-way clutch 8 comes in contact with the oil surface of the lubricating oil, even if the oil surface falls to the minimum oil level position 12. The lower end of the tip circle of the driven gear 7 is between the maximum oil level position 11 and the minimum oil level position 12, therefore it separates from and is at least in contact with, if not semi- or fully immersed in, the lubricating oil in accordance with changes in the oil level position of the lubricating oil.

[0020] According to the starter 1 with the above structure, when starting the engine, the rotation of the starter motor 2 is successively transmitted to the starter gear 5, the driven gear 7, the one-way clutch 8, the intermediate gear 9, and the crank gear 10 to rotate and drive the crank shaft 3. Since the starter gear 5 rakes up lubricating oil at this time, lubricating oil spatters around the gear group 4 in mist form so that the lubricating oil is also supplied to the intermediate gear 9 and the crank gear 10, which are positioned above the oil level of the lubricating oil. Consequently, it is not necessary to provide a separate mechanism for supplying lubricating oil to the gears 9, 10 in particular. Furthermore, since the starter gear 5 rotates at the highest speed among the gear group 4, the effect of raking up lubricating oil is high, and the lubricating oil can be extensively scattered.

[0021] When the engine is started and the output shaft 2a of the starter motor 2 is stopped, the crank gear 10 and the intermediate gear 9 continue to be rotated and driven by the crankshaft 3. However, the one-way clutch 8 blocks transmission of that rotation, so that the driven gear 7 and the starter gear 5 are stopped in a manner similar to the output shaft 2a of the starter motor 2. Therefore, even if the starter gear 5 and the driven gear 7 are at least in contact with, if not semi- or fully immersed in, the lubricating oil, friction drag between the gears 5, 7 and the lubricating oil does not act as resistance to the rotation of the crankshaft 3, and there is no possibility of an increase in engine friction loss caused by contact between the gear group 4 and the lubricating oil.

[0022] The invention is not limited to the embodiment described above, and may be implemented in various embodiments. For example, the lower end of the tip circle of the driven gear 7 may be arranged lower than the minimum oil level position 12 in place of or in addition to the starter gear 5. As long as at least one gear disposed between the starter motor 2 and the one-way clutch 8 is arranged so as to contact the oil surface of the lubricating oil at the minimum oil level position, the lubricating oil can be supplied to each location using the rotation of the gear during starting. In addition, the arrangement and number of gears structuring the gear group 4 may be modified as appropriate within the scope substantially identical to the technical concept of the invention.

Claims

1. An engine starter (1) for a vehicle comprising a starter motor (2); a gear group (4) structured from a plurality of gears, which transmits a rotation of the starter motor (2) to a crankshaft (3); and clutch means (8) provided between the starter motor (2) and the crankshaft (3), which permits a transmission of rotation from the starter motor (2) to the crankshaft (3), but prevents the transmission of rotation from the crankshaft (3) to the starter motor (2), **characterized in that**

   a first gear portion (9, 10), among the plurality of gears structuring the gear group (4), disposed so as to enable the transmission of rotation from the clutch means (8) to the crankshaft (3), is provided in a position where no contact is made with a maximum oil level position (11), which is a position of the crank chamber where lubricating oil is stored for lubricating gears in the gear group (4) when the lubricating oil amount in the crank chamber reaches a predetermined maximum lubricating oil amount.

2. The engine starter (1) for a vehicle according to claim 1, **characterized in that**

   a gear among the first gear portion (9, 10) is disposed at a position where a tooth top thereof does not reach the maximum oil level position (11).

3. The engine starter (1) for a vehicle according to claim 1 or 2, **characterized in that**

   at least one gear of a second gear portion (5, 7), among the plurality of gears structuring the gear group (4), which is disposed so as to enable the transmission of rotation from the starter motor (2) to the clutch means (8), is provided in a position where contact is made with a minimum oil level position (12) which is a position of the crank chamber when the lubricating oil amount in the crank chamber reaches a predetermined minimum lubricating oil amount.

4. The engine starter (1) for a vehicle according to claim 3, **characterized in that**

   the gear group (4) is structured such that rotation of an output shaft (2a) of the starter motor (2) is successively decreased and transmitted to the crankshaft (3), and provided in a position where a starter gear (5) attached to the output shaft (2a) of the starter motor (2) comes in contact with the minimum oil level position (12).

5. The engine starter (1) for a vehicle according to claim 3, **characterized in that**

the first gear portion (9, 10) comprises a crank gear (10) provided on the crankshaft (3), and an intermediate gear (9) provided on a support shaft (6) parallel with the crankshaft (3), which is provided with the clutch means (8) and meshed with the crank gear (10), and

the second gear portion (5, 7) comprises a starter gear (5) attached to the output shaft (2a) of the starter motor (2), and a driven gear (7) provided on the support shaft (6) and meshed with the starter gear (5).

6. The engine starter (1) for a vehicle according to any one of claims 1 to 5, **characterized in that**

the maximum oil level position (11) and the minimum oil level position (12) are determined based upon restrictions on the vehicle and engine sides, respectively.

FIG. 1

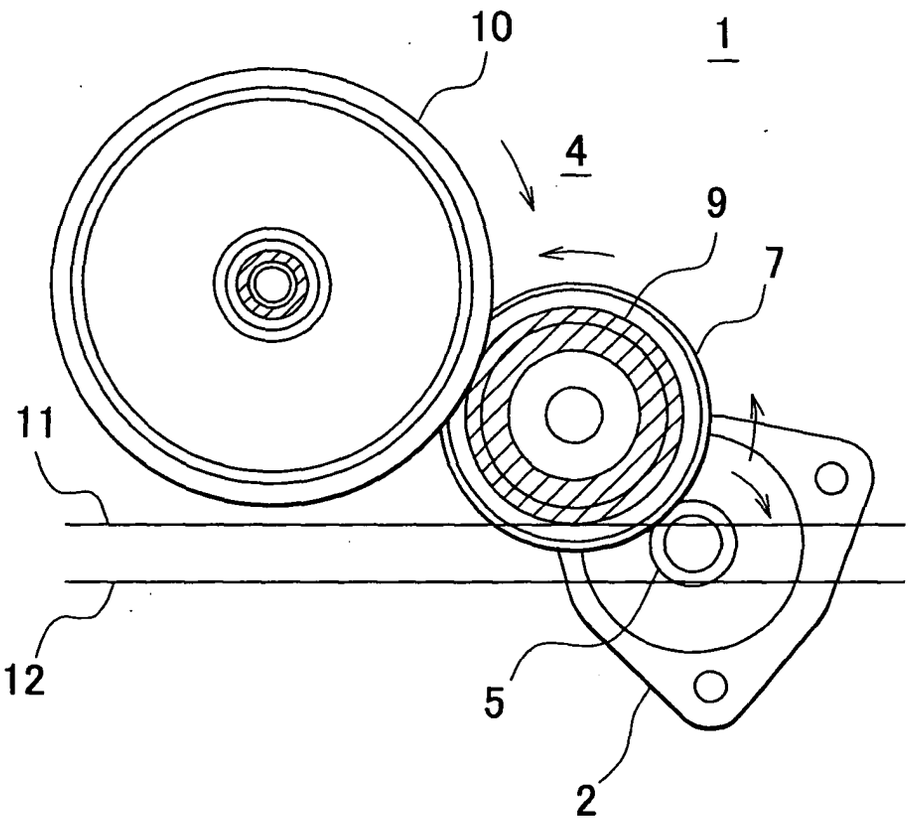

FIG. 2