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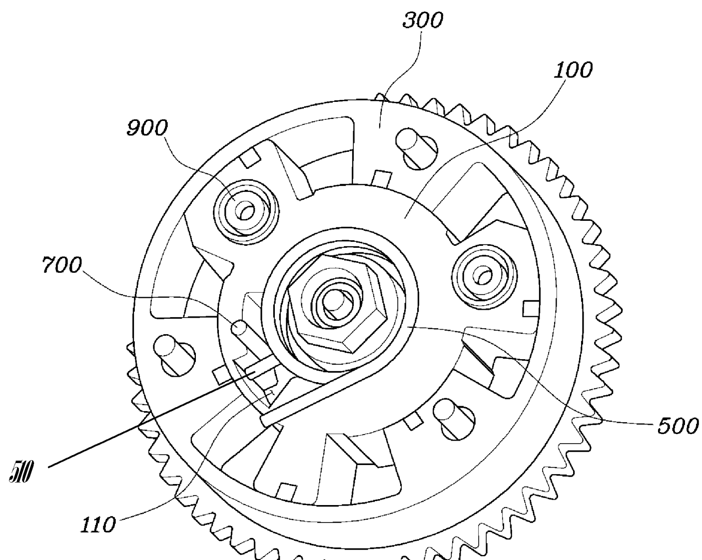
(54) ROTATION CONTROL APPARATUS OF CVVT

(57) The present disclosure provides generally for a rotation control apparatus of a CVVT (Continuous Variable Valve Timing) that includes an advanced-angle compensating unit. This unit may be disposed at a rotor to always apply torque in an advancing direction of the rotor between the rotor and a stator. This unit may achieve self-locking of a lock pin to provide rotational control of a CVVT

FIG. 4



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Description

FIELD

[0001] The present disclosure relates generally to a rotation control apparatus of continuous variable valve timing (hereafter, referred to as a CVVT).

BACKGROUND

[0002] The statements in this section merely provide background information related to the present disclosure and may not constitute prior art.

[0003] In general, a CVVT is applied to a vehicle to reduce exhaust gas and improve fuel efficiency and output.

[0004] The structure of a common CVVT will be described first with reference to FIG. 1 to help understanding of the present disclosure.

[0005] As shown in FIG. 1, the CVVT includes a cam position sensor 11 for detecting a rotational angle of a camshaft and a crank position sensor 12 for detecting a rotational angle of a crankshaft. A timing belt 14 driven by the crankshaft drives a variable valve timing unit 15 and a vane type is used for the variable valve timing unit 15.

[0006] An ECU (Electronic Control Unit) 13 controls valve timing of the cam in accordance with the position of the crank in response to signals from the cam position sensor 11 and the crank position sensor 12 and a control signal from the ECU 13 is sent to an oil flow valve 16 that is supplied with engine oil from an engine oil pump 16, so the cam is rotated.

[0007] When the oil control valve 16 allows the cam to rotate in response to a control signal from the ECU 13, the cam position sensor 11 detects the position of the camshaft and feeds it back to the ECU 13 and the ECU 13 estimates the amount of rotation of the cam on the basis of the fed-back position information of the camshaft and transmits a signal for controlling the position of the camshaft back to the oil control valve 16 on the basis of the estimated amount of rotation of the cam. Continuously variable control is performed on valve timing in accordance with this control logic.

[0008] On the other hand, in order to smoothly perform the feedback function, a control logic for the oil control valve 16 according to the crank position and the cam position is mapped to the ECU 13. Accordingly, when the mapped position of the camshaft and the cam position detected by the cam position sensor are different, the ECU controls the oil control valve 16, so the rotation of the camshaft is increased/decreased.

[0009] FIG. 2 is a graph showing a valve opening timing according to a crank angle. The ECU 13 controls valve control timings in an exhaust stroke and an intake stroke in accordance with a crank angle, and generally, it advances or retards the valve timings in the exhaust stroke and the intake stroke.

[0010] A CVVT system improves fuel efficiency by reducing a pumping loss by increasing valve overlap of intake and exhaust valves and a re-combustion effect of non-burned gas is achieved by internal exhaust gas recycling with optimization of the valve overlap, so exhaust gas is reduced.

[0011] As shown in FIG. 3, recently, intermediate phase CVVT systems remove limits in both response and operation area of the existing CVVT systems. These intermediate phase CVVTs control the position of a cam, not at the most advanced (intake) position and the most delayed (exhaust) position, but rather at an intermediate position, so response is quick and the use area of a cam can be increased, so fuel efficiency is improved and an exhaust gas is reduced.

[0012] In intermediate phase CVVT, a lock pin on the rotor is locked into a lock pin hole between the advance chamber and the delay chamber while the RPM of an engine is reduced, thereby preparing for later engine start. The action that the lock pin is automatically locked into the lock pin hole when the RPM of an engine is reduced is called 'self-lock'.

[0013] The self-lock is a function that allows a CVVT system to mechanically return to an accurate position without specific adjustment so that operational stability of an engine can be maintained in periods where the CVVT system is not used, that is, when the engine is idling or is started.

[0014] However, when the valve timing reaches the most or more retarded position without returning to the intermediate phase, and an engine of a vehicle is idling, a surge tank may not be vacuumized and the internal pressure of the surge tank may increase up to the atmospheric pressure, so the performance of a brake using the vacuum of the surge tank may be deteriorated.

[0015] Further, when the valve timing reaches the most retarded position without returning to the intermediate phase, excessive overlap of valve timing may be generated between an intake valve and an exhaust valve, so the operational stability of the engine decreases and vibration of the engine increases, and in some cases, the engine stops.

[0016] That is, so-called self-lock of a lock pin in an intermediate phase CVVT may not be automatically performed, so when the rotor and the lock pin are positioned at the most advanced position or the most retarded position, the engine stops and the brake system may not operate because negative pressure is not normally generated.

[0017] The foregoing is intended merely to aid in the understanding of the background of the present disclosure, and is not intended to mean that the foregoing is already known to those skilled in the art.

SUMMARY

[0018] Accordingly, the present disclosure proposes a rotation control apparatus of a CVVT that prevents poor self-lock.

[0019] The present disclosure provides, in one embodiment, that by returning to a predetermined intermediate phase position even after a phase is advanced or retarded, a lock pin can be accurately inserted into a lock pin hole.

[0020] Additionally, the present disclosure provides, in one embodiment, a specific advanced-angle compensating unit that can compensate torque of a rotor in advancing to solve the problem of ensuring an intermediate phase, because a CVVT can rotate against friction of a valve system while an engine is operated, particularly in advancing the intake.

[0021] According to one aspect of the present disclosure, there is provided a rotation control apparatus of a CVVT that includes: an advanced-angle compensating unit disposed at a rotor to always or continuously apply torque in an advancing direction of the rotor between the rotor and a stator, and achieving self-locking of a lock pin; and a stopper locking a side of the advanced-angle compensating unit and releasing the advanced-angle compensating unit after the advanced-angle compensating unit reaches a predetermined position.

[0022] The advanced-angle compensating unit may be a bias spring.

[0023] The advanced-angle compensating unit may have a first end connected to the rotor and a second end connected to the stator.

[0024] The stopper may be inserted in the rotor where the first end of the advanced-angle compensating unit is positioned.

[0025] A rotational groove allowing the first end of the advanced-angle compensating unit to rotate within a predetermined range may be formed on the rotor.

[0026] The advanced-angle compensating unit may be compressed, when the rotor rotates in a retarding direction, and the advanced-angle compensating unit may increase torque of the rotor with a compressive force when the rotor rotates in the advancing direction, and the locking pin may be continuously locked by a solenoid valve when the rotor rotates in the advancing direction.

[0027] Since load of the advanced-angle compensating unit is increased over a cam torque difference from the most retarded state to the self-lock, and since the advanced-angle compensating unit is prevented from rotating by the stopper when the rotor reaches the self-lock position by the advanced-angle compensating unit, it is possible to prevent poor self-lock and ensure more stable operation of the CVVT by ensuring a predetermined accurate intermediate phase.

[0028] Further areas of applicability will become apparent from the description provided herein. It should be understood that the description and specific examples are intended for purposes of illustration only and are not intended to limit the scope of the present disclosure.

BRIEF DESCRIPTION OF THE DRAWINGS

[0029] In order that the disclosure may be well understood, there will now be described various forms thereof, given by way of example, reference being made to the accompanying drawings, in which:

FIG. 1 is a view showing a known configuration of a CVVT;

FIG. 2 is a graph showing valve opening timings according to rotational angles of a crankshaft of a CVVT;

FIG. 3 is a graph showing valve opening timings according to rotational angles of a crankshaft of an intermediate phase CVVT;

FIG. 4 is a view showing a rotation control apparatus of a CVVT according to an embodiment of the present disclosure;

FIG. 5 is a view showing a locking state when the lock pin of the rotation control apparatus of FIG. 4 is fixed; and

FIG. 6 is a view showing a most retarded state of the rotation control apparatus of FIG. 4.

DETAILED DESCRIPTION

[0030] A rotation control apparatus of a CVVT according to exemplary embodiments of the present disclosure is described hereafter with reference to the accompanying drawings.

[0031] As shown in the Figures 4-6, a rotation control apparatus of a CVVT (Continuous Variable Valve Timing) according to an embodiment of the present disclosure includes: an advanced-angle compensating unit 500 that is disposed at a rotor 100 to always apply torque in an advancing direction of the rotor 100 between the rotor 100 and a stator 300 and achieves self-locking of a lock pin 900; and a stopper 700 that locks a side of the advanced-angle compensating unit 500 and releases the advanced-angle compensating unit 500 after the advanced-angle compensating unit 500 reaches a predetermined position.

[0032] According to the present disclosure, the advanced-angle compensating unit 500 is disposed at a rotor 100 to always apply torque in an advancing direction of the rotor 100 between the rotor 100 and the stator 300 and achieves self-locking of a lock pin 900.

[0033] As shown in FIG. 3, the advanced-angle compensating unit 500 is a coil (e.g. a metal wire or strip) wound several times, particularly, it may be a bias spring. The advanced-angle compensating unit 500 has a first end 510 connected to the rotor 100 (for movement therewith, such as rigidly attached, fixed or immovably connected) and a second end connected to the stator 300 (such as rigidly attached, fixed or immovably connected), such that the compensating unit 500 applies an elastic force in the advancing direction so that an advancing chamber can always be expanded. The stopper 700 is inserted in the rotor 100 where the first end 510 of the advanced-angle compensating unit 500 is positioned, and it may have a cylindrical shape such as a pin. A rotational groove 110 for the first end of the advanced-angle compensating unit 500 to rotate within a predetermined range is formed on the rotor 100.

[0034] The advanced-angle compensating unit 500 is compressed when the rotor 100 rotates in a retarding direction, and it increases torque of the rotor 100 with its compressive force when the rotor 100 rotates in the advancing direction. Further, when the rotor 100 rotates in the advancing direction, the lock pin 900 is continuously locked by a solenoid valve.

[0035] That is, when the rotor 100 rotates in the retarding direction, the advanced-angle compensating unit 500 is wound and keeps an elastic force therein, and when the rotor 100 rotates in the advancing direction, the torque of the rotor 100 is increased by the kept elastic force. Accordingly, it is possible to preclude the problem that rotation in the advancing direction is not smoothly made due to torque of a camshaft and friction force of a valve system, and hence the lock pin 900 may be actuated at any time.

[0036] When the rotor 100 rotates in the advancing direction, the torque of the rotor 100 is increased by the advanced-angle compensating unit 500 and the lock pin 900 can be locked into a lock pin hole 910, so it is possible to prevent the problem that an engine stops and a brake system is not operated by poor negative pressure, because an intermediate phase cannot be ensured in the related art.

[0037] The elastic force kept in accordance with the length and diameter of the advanced-angle compensating unit 500 is selected at an appropriate level in consideration of the friction force of an engine valve system and the pressure of engine oil, as will be understood by those skilled in the art.

[0038] However, when only the advanced-angle compensating unit 500 is provided, theoretically, there is no problem in ensuring an intermediate phase, but it may be difficult to ensure an accurate intermediate phase in actual manufacturing of a vehicle due to differences in engines, parts, cam torque, and the advanced-angle compensating unit 500, so poor self-lock may still result. Accordingly, the stopper 700 is optionally provided, and preferably disposed at a side of the advanced-angle compensating unit 500 to prevent rotation beyond the intermediate phase. The stopper 700 prevents the advanced-angle compensating unit 500 from being further pressed by driving torque of the camshaft after the CVVT ensures an accurate intermediate phase by means of the advanced-angle compensating unit 500, thereby ensuring a predetermined intermediate phase and preventing poor self-lock.

[0039] The operation of the rotation control apparatus of a CVVT of the present disclosure having the configuration described above is described with reference to FIGS. 5 and 6.

[0040] FIG. 5 is a view showing a locking state when the lock pin 900 of FIG. 4 is fixed. The rotor 100 and the lock pin 900 that has advanced beyond an intermediate phase are rotated in the retarding direction by driving torque of the camshaft, and when the rotor 100 reaches the intermediate phase while rotating, self-lock in which the lock pin 900 is locked into the lock pin hole 910 is automatically performed by a solenoid valve.

[0041] On the contrary, FIG. 6 is a view showing the most retarded state of FIG. 4, in which in order to change from the most retarded state to the self-lock position, the lock pin 900 of the rotor 100 that has been rotated beyond the intermediate phase is rotated in the advancing direction, thereby achieving self-lock. However, even if the same number of rotations of the engine and the same oil pressure as that of the related art are supplied to an advancing chamber, the torque of the rotor 100 is increased by the elastic force kept by the most retarded state of FIG. 4 that has been wound in advance, so the rotor 100 can more easily rotate to the intermediate phase against the torque of the camshaft and the friction force of the valve system. Thus the lock pin 900 may be locked into the lock in hole 910 by the solenoid, and accordingly, self-lock is achieved. The stopper 700 prevents the advanced-angle compensating unit 500 from being continuously pressed beyond the intermediate phase, so it is possible to ensure an accurate intermediate phase and preclude poor self-lock. That is, when the advanced-angle compensating unit 500 reaches a position where self-lock is achieved, the advanced-angle compensating unit 500 is not further pressed by the stopper 700, so the force rotating the cam is removed by the advanced-angle compensating unit 500.

[0042] That is, by increasing load of the advanced-angle compensating unit 500 over a cam torque difference from the most retarded state to the self-lock, and by stopping the advanced-angle compensating unit 500 with the stopper 700 when a parking position is reached, the CVVT is not further rotated in the advancing direction, so an accurate intermediate phase can be achieved and poor self-lock is prevented.

[0043] Therefore, according to the rotation control apparatus of a CVVT, since load of the advanced-angle compensating unit is increased over a cam torque difference from the most retarded state to the self-lock and the advanced-angle compensating unit is prevented from rotating by the stopper when the rotor reaches the self-lock position by the advanced-angle compensating unit, it is possible to prevent poor self-lock and ensure more stable operation of the CVVT by ensuring a predetermined accurate intermediate phase.

[0044] Although embodiments of the present disclosure have been described for illustrative purposes, those skilled in the art will appreciate that various modifications, additions and substitutions are possible, without departing from the scope and spirit of the disclosure as disclosed in the accompanying claims.

Claims

1. A rotation control apparatus of a Continuous Variable Valve Timing (CVVT), the apparatus comprising:

   a stator;
   a rotor positioned for rotation relative to the stator and having an advancing direction and a lock pin;
   an advanced-angle compensating unit disposed at the rotor and having a side, the advanced-angle compensating unit operable to apply torque in the advancing direction of the rotor between the rotor and the stator, the advanced-angle compensating unit operable to achieve self-locking of the lock pin; and
   a stopper locking the side of the advanced-angle compensating unit and releasing the advanced-angle compensating unit after the advanced-angle compensating unit reaches a predetermined position.

2. The apparatus of claim 1, wherein the advanced-angle compensating unit is a bias spring.

3. The apparatus of claim 1 or 2, wherein the advanced-angle compensating unit has a first end connected to the rotor.

4. The apparatus of any one of claims 1 to 3, wherein the advanced-angle compensating unit has a second end connected to the stator.

5. The apparatus of claim 3 or 4, wherein the stopper is inserted in the rotor at the first end of the advanced-angle compensating unit.

6. The apparatus of any one of claims 3 to 5, wherein the rotor comprises a rotational groove forming a predetermined range such that the first end of the advanced-angle compensating unit rotates within the predetermined range.

7. The apparatus of claim 1 wherein the advanced-angle compensating unit has a first end connected to the rotor and a second end connected to the stator, the stopper being inserted in the rotor at the first end of the advanced-angle compensating unit, the rotor comprising a rotational groove forming a predetermined range such that the first end of the advanced-angle compensating unit rotates within the predetermined range.

8. The apparatus of any one of claims 1 to 7 further comprising a solenoid valve to perform locking, and the rotor having a retarding direction.

9. The apparatus of claim 8, wherein the advanced-angle compensating unit is compressed when the rotor rotates in the retarding direction, and the advanced-angle compensating unit increases torque of the rotor with a compressive force when the rotor rotates in the advancing direction, and
   the locking pin is continuously locked by the solenoid valve when the rotor rotates in the advancing direction.

10. The apparatus of claim 9 wherein the locking pin is automatically locked.

11. The apparatus of any one of claims 1 to 10, wherein the advanced-angle compensating unit always applies torque in the advancing direction of the rotor.

12. The apparatus of any one of claims 1 to 10, wherein the advanced-angle compensating unit continuously applies torque in the advancing direction of the rotor.

FIG. 1

Prior Art

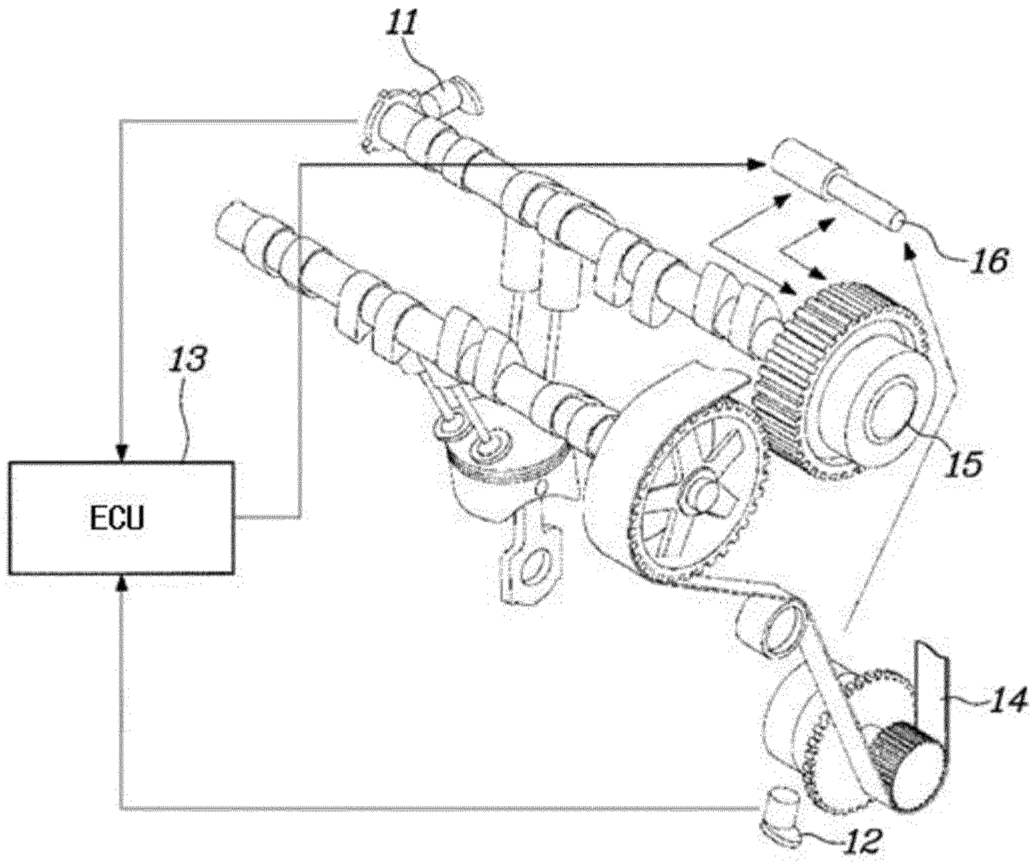

FIG. 2

Prior Art

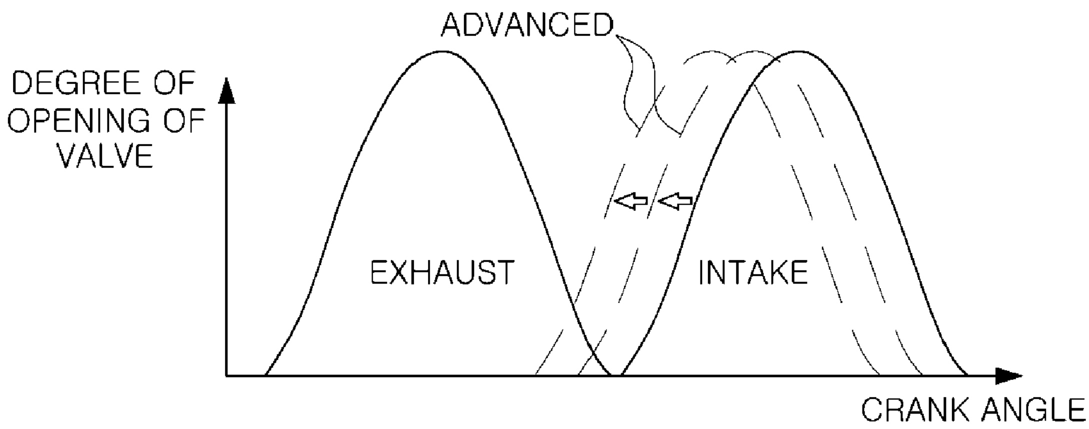

FIG. 3

Prior Art

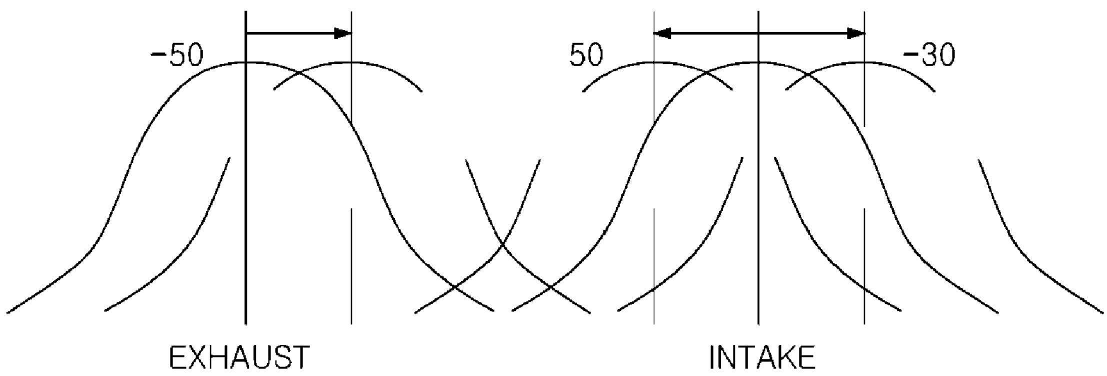

FIG. 4

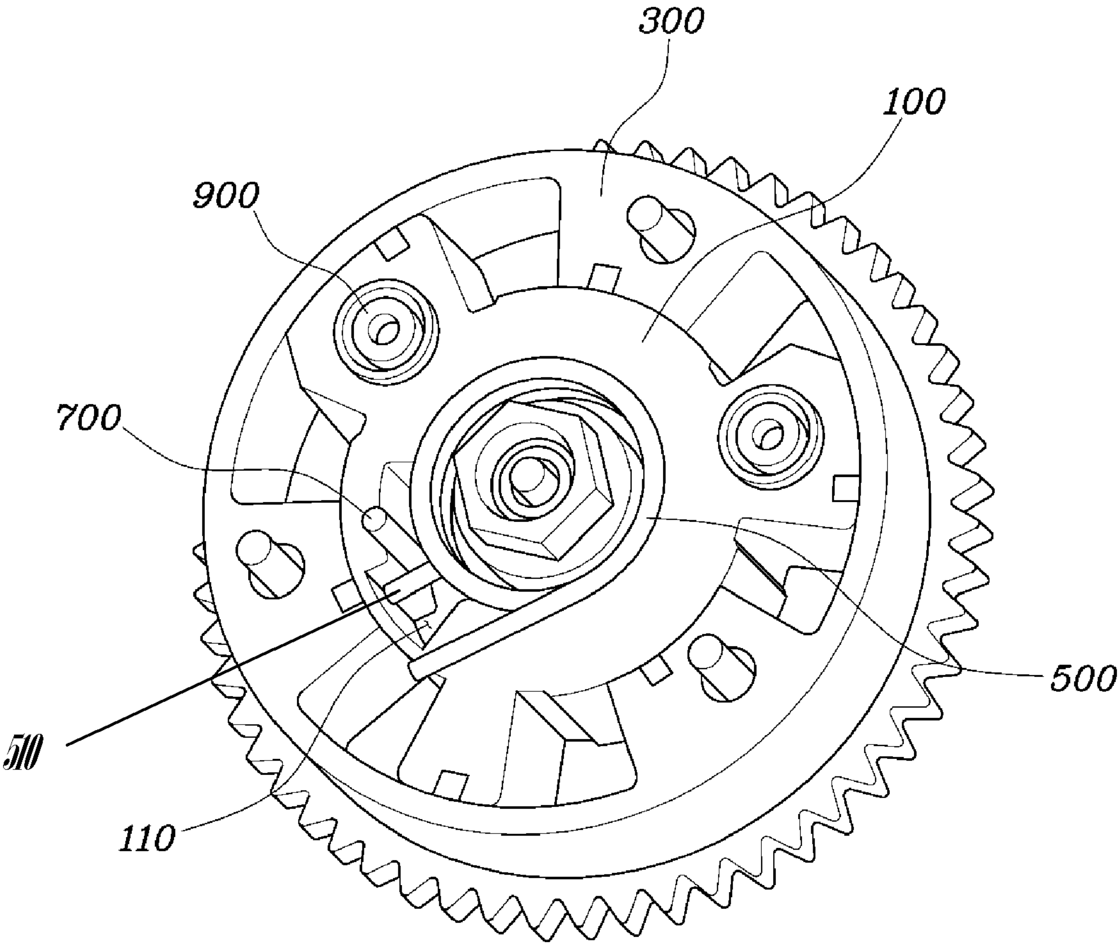

FIG. 5

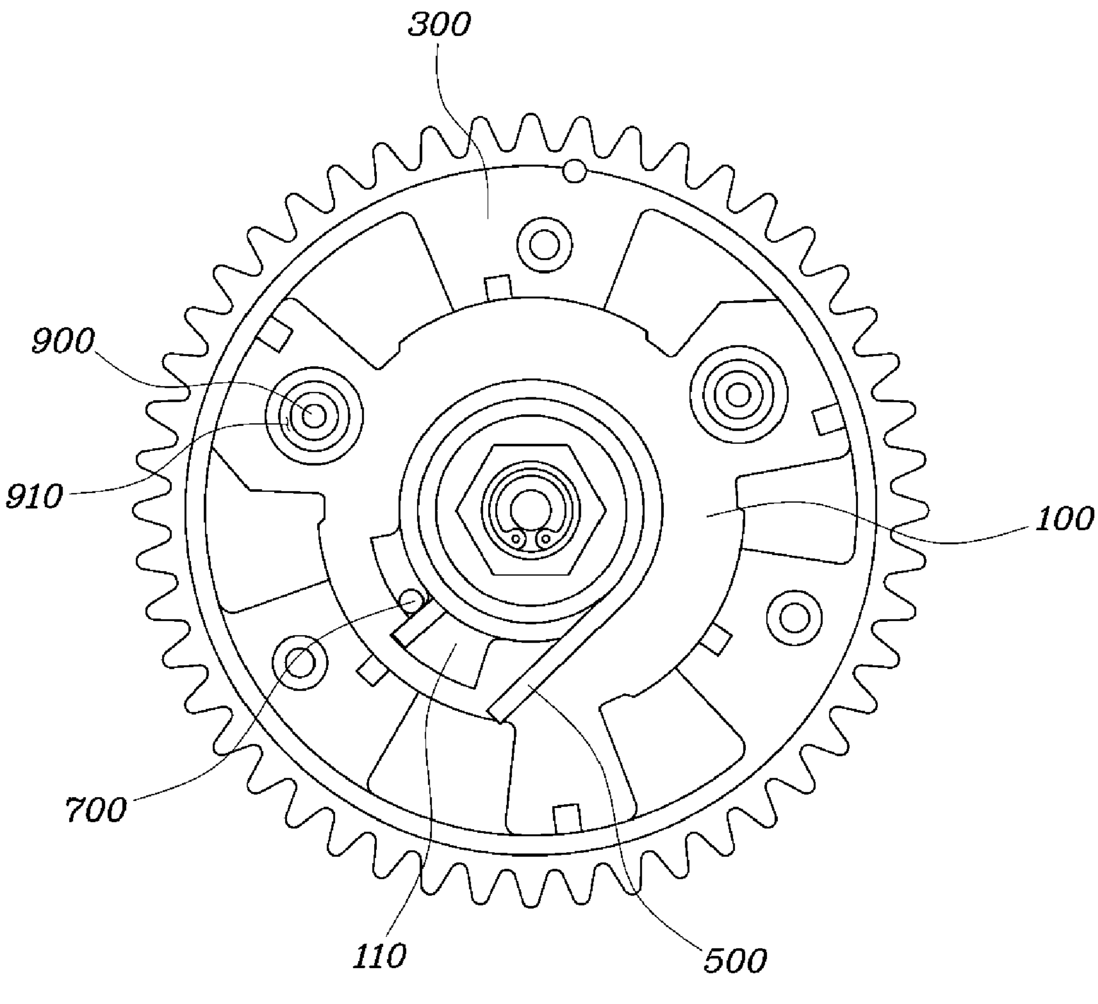

FIG. 6