

(19)



(11)

EP 3 109 421 A2

(12)

EUROPEAN PATENT APPLICATION

(43) Date of publication:
28.12.2016 Bulletin 2016/52

(51) Int Cl.:
F01L 1/344 ^(2006.01)

(21) Application number: **15195806.3**

(22) Date of filing: **23.11.2015**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
MA MD

• **Kia Motors Corporation**
Seoul 137-938 (KR)

(72) Inventors:
• **OH, Chung Han**
463-731 Seongnam-si, Gyeonggi-do (KR)
• **LIM, Hyun Kyu**
443-270 Suwon-si, Gyeonggi-do (KR)
• **KIM, Yun Seok**
448-537 Yongin-si, Gyeonggi-do (KR)

(30) Priority: **26.06.2015 KR 20150091600**

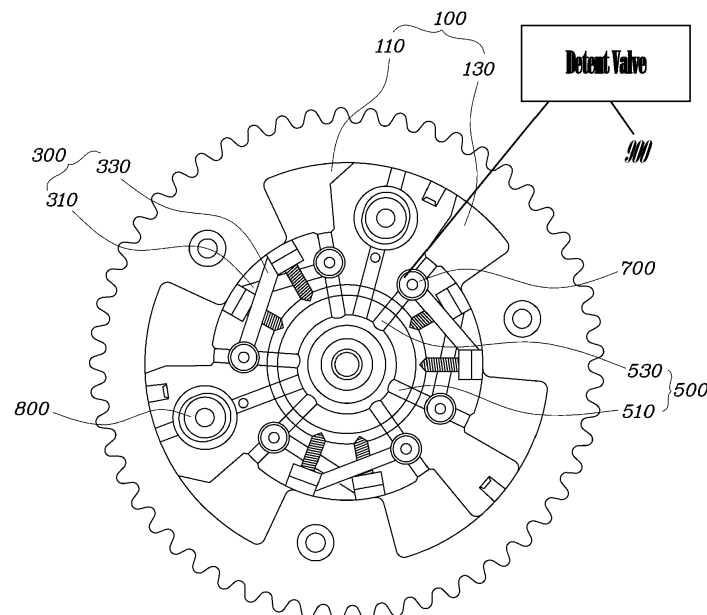
(71) Applicants:
• **Hyundai Motor Company**
Seoul 137-938 (KR)

(74) Representative: **Viering, Jentschura & Partner mbB**
Patent- und Rechtsanwälte
Am Brauhaus 8
01099 Dresden (DE)

(54) INTERMEDIATE PHASE ADJUSTMENT APPARATUS OF CVVT

(57) The present disclosure provides an intermediate phase adjustment apparatus of a CVVT (Continuous Variable Valve Timing). This apparatus includes a pressure adjusting means balancing pressure of chambers by selectively allowing oil to be moved from a chamber at rel-

atively high pressure to a chamber at relatively low pressure. One way to achieve this is by a pressure difference through an oil line, through which the oil can move in only one direction between the chambers.

**Fig. 1**

Description

FIELD

[0001] The present disclosure generally relates to an intermediate phase CVVT (Continuous Variable Valve Timing) particularly equipped with a variable oil pump in vehicles equipped with an intermediate phase 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. Recently, intermediate phase CVVT systems for removing limits in response and operation area of the existing CVVT systems are increasingly being used. Intermediate phase CVVTs control the position of a cam not at the most advanced (intake) position and the most delayed (exhaust) position, but 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.

[0004] In an 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 while the RPM of an engine reduces is called 'self-lock'.

[0005] The self-lock is a function that allows a CVVT 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.

[0006] However, when the valve timing reaches the most delayed or 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.

[0007] Further, when the valve timing reaches the most delayed 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.

[0008] 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 gen-

erated.

[0009] In particular, when a variable oil pump is used, oil pressure is largely changed in accordance with conditions of an engine, and this is because of hysteresis due to the variable oil pump. Accordingly, it is possible to set the intermediate phase by balancing the hydraulic pressure of chambers, but applying such a step may be difficult in practice.

[0010] 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

[0011] Accordingly, the present disclosure proposes an intermediate phase adjustment apparatus of a CVVT. In some embodiments, this apparatus always achieves self-lock regardless of the RPM of an engine and hydraulic conditions by setting an intermediate phase and balancing hydraulic pressure of chambers even if a variable oil pump is used.

[0012] The invention provides an intermediate phase adjustment apparatus of a CVVT according to claim 1. Further embodiments of the invention are described in the dependent claims.

[0013] According to one aspect of the present disclosure, there is provided an intermediate phase adjustment apparatus of a CVVT including a pressure adjusting means or member for balancing pressure of chambers by selectively allowing oil to be moved from a chamber at relatively high pressure to a chamber at relatively low pressure by a pressure difference through an oil line through which the oil can move in only one direction between the chambers.

[0014] The pressure adjusting means or member may be composed of the oil line and a diverter valve opening or closing the oil line.

[0015] An oil channel for supplying oil for operating the CVVT may be formed in the chamber, the diverter valve may be disposed between the oil line and the oil channel, and the oil line and the oil channel may be selectively opened or closed.

[0016] A detent valve for controlling the diverter valve may be connected to the diverter valve. When the detent valve generates hydraulic pressure and presses the diverter valve, the oil line may be blocked by the diverter valve, and when the hydraulic pressure by the detent valve is removed, the diverter valve may be returned by an elastic member connected to the diverter valve, so the oil channel is blocked.

[0017] Outlets for discharging oil to corresponding chambers may be formed at a first side of the oil line and check valves may be disposed at a second side of the oil line to prevent backward flow of oil.

[0018] The diverter valve may be disposed between the oil channel and the oil line for oil to flow into a specific chamber.

[0019] The diverter valve may be disposed in all the chambers.

[0020] The oil lines may be formed in all the chambers and connected to each other so that oil moves to pairs of chambers.

[0021] The oil lines may be formed in all the chambers and connected to each other so that oil moves to pairs of chambers, and the diverter valves may be disposed in all the chambers, selectively open and close the oil lines and the oil channels, and set the intermediate phase of the CVVT by balancing pressure of the chambers, thereby implementing self-lock.

[0022] According to one aspect of the present disclosure, there is provided an intermediate phase adjustment apparatus of a CVVT, in which advancing chambers and retarding chambers are provided in pairs, an advancing oil line and an advancing oil channel are formed in the advancing chambers, a retarding oil line and a retarding oil channel are formed in the retarding chambers, a diverter valve is disposed between the advancing oil lines and the advancing oil channels and between the retarding oil lines and the retarding oil channels, and when hydraulic pressure of the advancing chambers and the retarding chambers is not balanced, hydraulic pressure by a detent valve is removed and the diverter valve opens the oil lines, so oil moves from a chamber at relatively high pressure to a chamber at relatively low pressure, the hydraulic pressure is balanced, an intermediate phase is formed, and self-lock is always implemented.

[0023] According to the intermediate phase adjustment apparatus of a CVVT of the present disclosure, all of chambers are provided with a pressure adjusting means and self-lock is always implemented regardless of the RPM of an engine and hydraulic conditions. Therefore, malfunction or stop of an engine does not occur, even if the engine has a problem, so the engine can be stably operated.

BRIEF DESCRIPTION OF THE DRAWINGS

[0024] The above and other objects, features and other advantages of the present disclosure will be more clearly understood from the following detailed description when taken in conjunction with the accompanying drawings, in which:

FIG. 1 is a view showing an intermediate phase adjustment apparatus of a CVVT according to an embodiment of the present disclosure;

FIG. 2 is view showing supply of oil to an oil line shown in FIG. 1;

FIG. 3 is view showing supply of oil to an oil channel shown in FIG. 1; and

FIGS. 4 and 5 are views showing self-lock-possible periods according to the number of chambers formed in an oil line.

DETAILED DESCRIPTION

[0025] An intermediate phase adjustment apparatus of a CVVT according to exemplary embodiments of the present disclosure is described hereafter with reference to the accompanying drawings.

[0026] An intermediate phase adjustment apparatus of a CVVT (Continuous Variable Valve Timing) according to an embodiment of the present disclosure includes a pressure adjusting means or member that balances pressure of chambers 100 by selectively allowing oil to be moved from one chamber (e.g. 100) at relatively high pressure to another chamber (e.g. 100) at relatively low pressure by a pressure difference through an oil line 300 through which the oil can move in only one direction between the chambers. The pressure adjusting means is composed of the oil line 300 and a diverter valve 700 that opens and/or closes the oil line 300.

[0027] As shown in FIGS. 1 to 3, an oil channel 500 for supplying oil for operating the CVVT is formed in the chamber 100 and the diverter valve 700 is disposed between the oil line 300 and the oil channel 500, so the oil line 300 and the oil channel 500 are selectively opened or closed. A detent valve 900 for controlling the diverter valve 700 is connected to the diverter valve 700. When the detent valve 900 generates hydraulic pressure and presses the diverter valve 700, the oil line 300 is blocked by the diverter valve 700, and when the hydraulic pressure by the detent valve 900 is removed, the diverter valve 700 is returned by an elastic member 710 connected to the diverter valve 700, so the oil channel 500 is blocked. In particular, since the oil line 300 needs to allow oil to move in only one direction, outlets 311 and 331 for discharging oil to corresponding chambers 100 are formed at a first side of the oil line 300 and check valves 313 and 333 are disposed at a second side to prevent backward flow of oil.

[0028] The diverter valve 700 is disposed between the oil channel 500 and the oil line 300 for oil to flow into the chambers 100. In detail, the diverter valve 700 is disposed between an advancing oil line 310 and an advancing oil channel 510 for oil to flow into an advancing chamber 110, one of the advancing oil line 310 and the advancing oil channel 510 are selected by the diverter valve 700 in accordance with the detent valve 900 supplies hydraulic pressure, and oil is supplied to the advancing chamber 110. The diverter valve 700 is formed in all the advancing chambers 110 and retarding chambers 130. In an embodiment of the present disclosure, three chambers 100 each composed of a pair of advancing chamber 110 and retarding chamber 130 are exemplified, but the number of the chambers 100 may be freely changed in accordance with the environment or design.

[0029] The oil lines 300 are formed in all chambers 100 and connected to each other so that oil moves to pairs of chambers 100. The diverter valves 700 are disposed in all the advancing chambers 110 and the retarding chambers 130 and selectively open/close the oil lines

300 and the oil channels 500 to set the intermediate phase of the CVVT by balancing the pressure of the chambers 100, so self-lock can be always achieved regardless of a problem with an engine, the RPM of the engine, and hydraulic conditions.

[0030] In this configuration, in more detail, pairs of advancing chamber 110 and retarding chamber 130 are provided in the intermediate phase CVVT, the advancing oil line 310 and the advancing oil channel 510 are formed in the advancing chambers 110, and the retarding oil line 330 and the retarding oil channel 530 are formed in the retarding chamber 130. The diverter valve 700 is disposed between the advancing oil line 310 and the advancing oil channel 510 and between the retarding oil line 330 and the retarding oil channel 530. If hydraulic pressure is not balanced between the advancing chamber 110 and the retarding chamber 130, the hydraulic pressure by the detent valve 900 is removed and the diverter valve 700 opens the oil line 300 and oil moves from the chamber 100 at relatively high pressure to the chamber 100 at relatively low pressure, so the hydraulic pressure is balanced, and an intermediate phase is obtained and self-lock is always achieved regardless of the RPM of an engine or hydraulic conditions.

[0031] In the present disclosure, an intermediate phase CVVT is equipped with a variable oil pump (not shown). When a variable oil pump is used, changes in oil pressure according to conditions of an engine are large by hysteresis due to the variable oil pump. Accordingly, when engine has a problem and the CVVT is not controlled, the intermediate phase should be obtained and a lock pin 800 should be locked in order to prevent malfunction or stop of the engine, but self-lock may be applied to only some of three chambers due to limits in manufacturing cost and layout in the cam torque balance type of intermediate phase CVVTs of the related art. Accordingly, a pressure adjusting means for adjusting balance of an advancing chamber and a retarding chamber is provided in only some of chambers, but when excessive oil pressure is applied to the other chambers without the pressure adjusting means, the chambers with the pressure adjusting means have difficulty in moving to the intermediate position against the excessive hydraulic pressure of the chambers with the pressure reducing means. Accordingly, in the present disclosure, a pressure adjusting means is preferably provided for all the advancing chambers 110 and the retarding chambers 130 of the CVVT so that self-lock is always achieved regardless of the RPM of an engine and hydraulic conditions.

[0032] This configuration is shown in FIGS. 2 and 3. FIG. 2 shows movement of oil in a default condition in which a CVVT is not controlled due to a problem with an engine, in which, first, hydraulic pressure by a detent valve 900 is removed, and the retarding oil line 300 for oil to move from the advancing chamber 110 and the retarding chamber 130 and the advancing oil line 310 for oil to move from the retarding chamber 130 to the advancing chamber 110 are connected to each other. In

this process, the advancing oil channel 510 and the retarding oil channel 530 are closed by the diverter valves 700. Accordingly, when the CVVT is shaken by a change in cam torque, the oil in the chamber 100 at relatively high pressure moves to the chamber 100 at relatively low pressure, so pressure is balanced and the intermediate phase is ensured. The check valves 311 in the oil lines 300 prevent backflow of oil to the chambers 100 through the oil lines 300 even if the oil pressure of the corresponding chamber 100 has been increased.

[0033] In contrast, FIG. 3 shows movement of oil when an engine is in a normal state, in which the hydraulic pressure by the diverter valve 700 is removed, and oil is supplied to the advancing oil channel 510 of the advancing chamber 110 and the retarding oil channel 530 of the retarding chamber 130. In this process, the advancing oil line 310 and the retarding oil line 330 are closed by the diverter valves 700. Accordingly, when the CVVT is shaken by a change in cam torque, the internal hydraulic pressure of the chambers 100 is balanced and the intermediate phase is ensured.

[0034] FIGS. 4 and 5 are graphs showing self-lock-possible periods according to the number of chambers 100 with a pressure adjusting means, that is, FIG. 4 is a graph when pressure adjusting means are provided for two chambers and FIG. 5 is a graph when pressure adjusting means are provided for all of three chambers. Although the case when pressure adjusting means are provided for two chambers is compared, it is obvious that the self-lock-impossible period increases when the pressure adjusting means is provided for one or no chamber, so the case when the pressure reducing means are provided for two chamber is representatively selected and compared.

[0035] As clearly shown in FIGS. 4 and 5, the self-lock function is removed due to excessive oil pressure of the chamber without the pressure adjusting means in FIG. 4, so it is impossible to advance the phase. Further, the amount of change in hydraulic pressure due to hysteresis of an oil pump is too large. However, in FIG. 5, since all the chambers 100 are provided with a pressure adjusting means, the chambers 100 are not influenced by external oil pressure and hysteresis of an oil pump. Accordingly, self-lock is normally implemented in the entire period.

[0036] As described above, according to one form of the intermediate phase adjustment apparatus of a CVVT of the present disclosure, all of chambers are provided with a pressure adjusting means and self-lock is always implemented regardless of the RPM of an engine and hydraulic conditions. Therefore, malfunction or stop of an engine does not occur, even if the engine has a problem, so the engine can be stably driven.

[0037] 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. An intermediate phase adjustment apparatus of a Continuous Variable Valve Timing, the apparatus comprising:

a pressure adjusting means comprising a plurality of chambers having a first chamber and a second chamber, each chamber containing oil, the pressure adjusting means comprising an oil line and balancing pressure of the chambers by selectively allowing oil to be moved from the first chamber at relatively high pressure to the second chamber at relatively low pressure by a pressure difference through the oil line through which the oil moves in only one direction between the first and second chambers.

2. The apparatus of claim 1, wherein the pressure adjusting means comprises a diverter valve opening or closing the oil line.

3. The apparatus of claim 2, wherein each chamber forms an oil channel for supplying oil for operating the Continuous Variable Valve Timing, the diverter valve is disposed between the oil line and the oil channel, and the oil line and the oil channel are selectively opened or closed.

4. The apparatus of claim 2 or 3, further comprising an elastic member and a detent valve operable to control the diverter valve and being connected to the diverter valve, the apparatus having a first state in which the detent valve generates hydraulic pressure and presses the diverter valve, and the oil line is blocked by the diverter valve, the apparatus having a second state in which the hydraulic pressure by the detent valve is removed, and the diverter valve is returned by the elastic member connected to the diverter valve so the oil channel is blocked.

5. The apparatus of one of claims 2-4, wherein the pressure adjusting means comprises a plurality of outlets for discharging oil to corresponding chambers, the oil line having a first side forming a first outlet, and the oil line having a second side comprising check valves to prevent backward flow of oil.

6. The apparatus of one of claims 2 to 5 in combination with claim 3, wherein the diverter valve is disposed between the oil channel and the oil line for oil to flow into one chamber.

7. The apparatus of one of claims 2 to 6, wherein one diverter valve is disposed in all of the chambers.

8. The apparatus of one of claims 1 to 7, wherein each pair of chambers includes one oil line such that a

plurality of oil lines are formed in all the chambers, all oil lines being connected to each other so that oil moves to pairs of chambers.

9. The apparatus of one of claims 2 to 8, wherein each pair of chambers includes one oil line such that a plurality of oil lines are formed in all the chambers, all oil lines being connected to each other so that oil moves to pairs of chambers, and respective diverter valves are disposed in all the chambers and selectively open and close the corresponding oil lines and the corresponding oil channels to set the intermediate phase of the Continuous Variable Valve Timing by balancing pressure of the chambers to implement self-lock.

10. The apparatus of one of claims 1 to 9, wherein the pressure adjusting means comprises a plurality of first chambers and of second chambers provided as advancing chambers and retarding chambers, respectively, which are provided in pairs.

11. The apparatus of claim 10, wherein the apparatus further comprises an advancing oil line and an advancing oil channel are formed in the advancing chambers, a retarding oil line and a retarding oil channel are formed in the retarding chambers, a plurality of diverter valves wherein one diverter valve is disposed between each advancing oil line and each advancing oil channel, and another diverter valve being disposed between each retarding oil line and each retarding oil channel, each diverter valve operable by way of a detent valve; and when hydraulic pressure of the advancing chambers and the retarding chambers is unbalanced, hydraulic pressure by the detent valve is removed and the respective diverter valve opens the respective oil line, so oil moves from a first chamber at relatively high pressure to a second chamber at relatively low pressure, when the hydraulic pressure is balanced, an intermediate phase is formed, and self-lock is implemented.

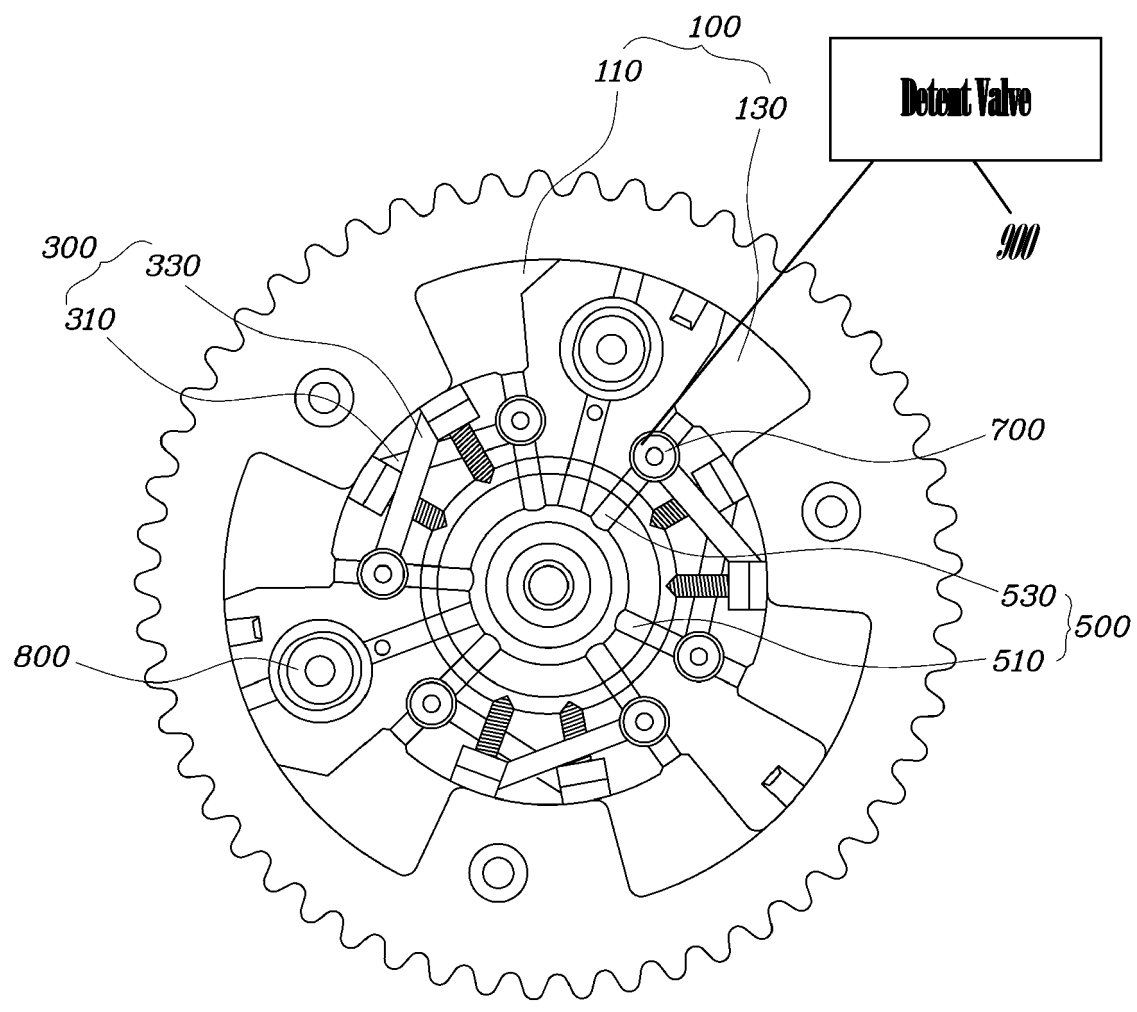


Fig. 1

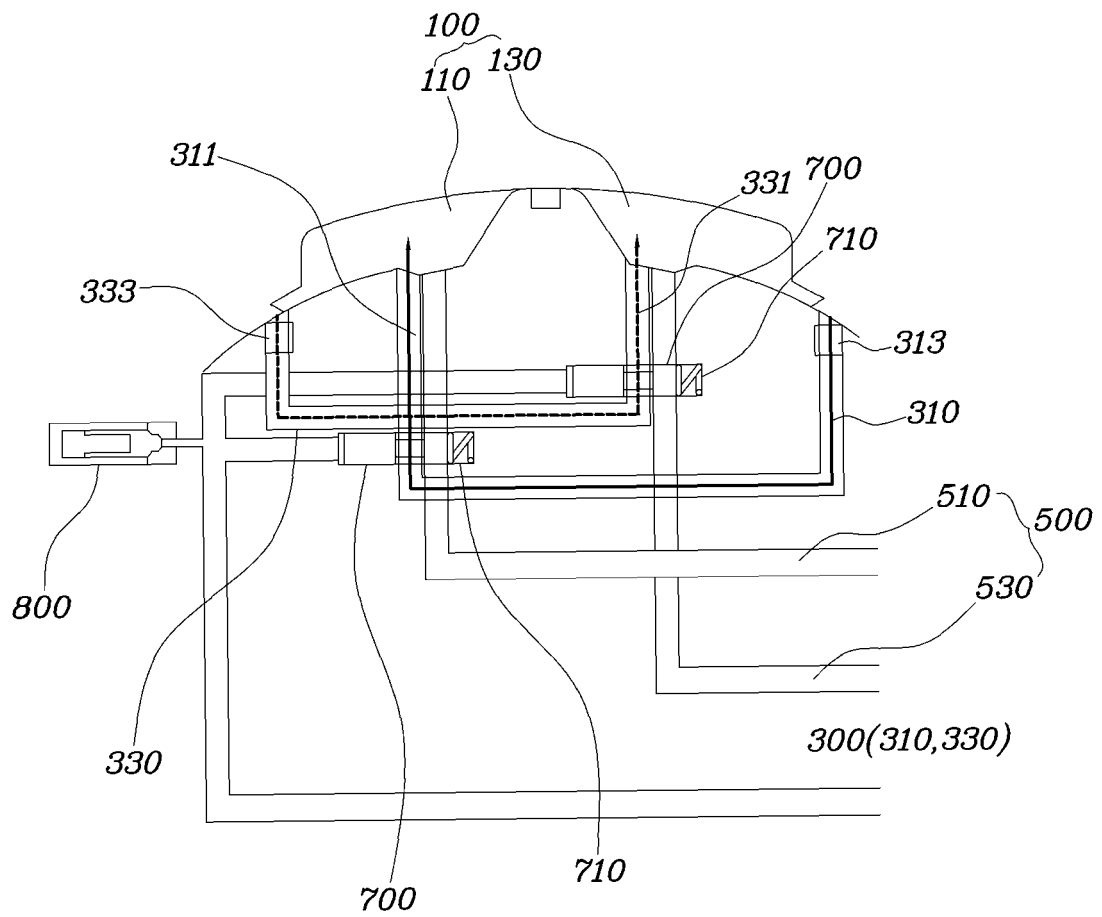


Fig. 2

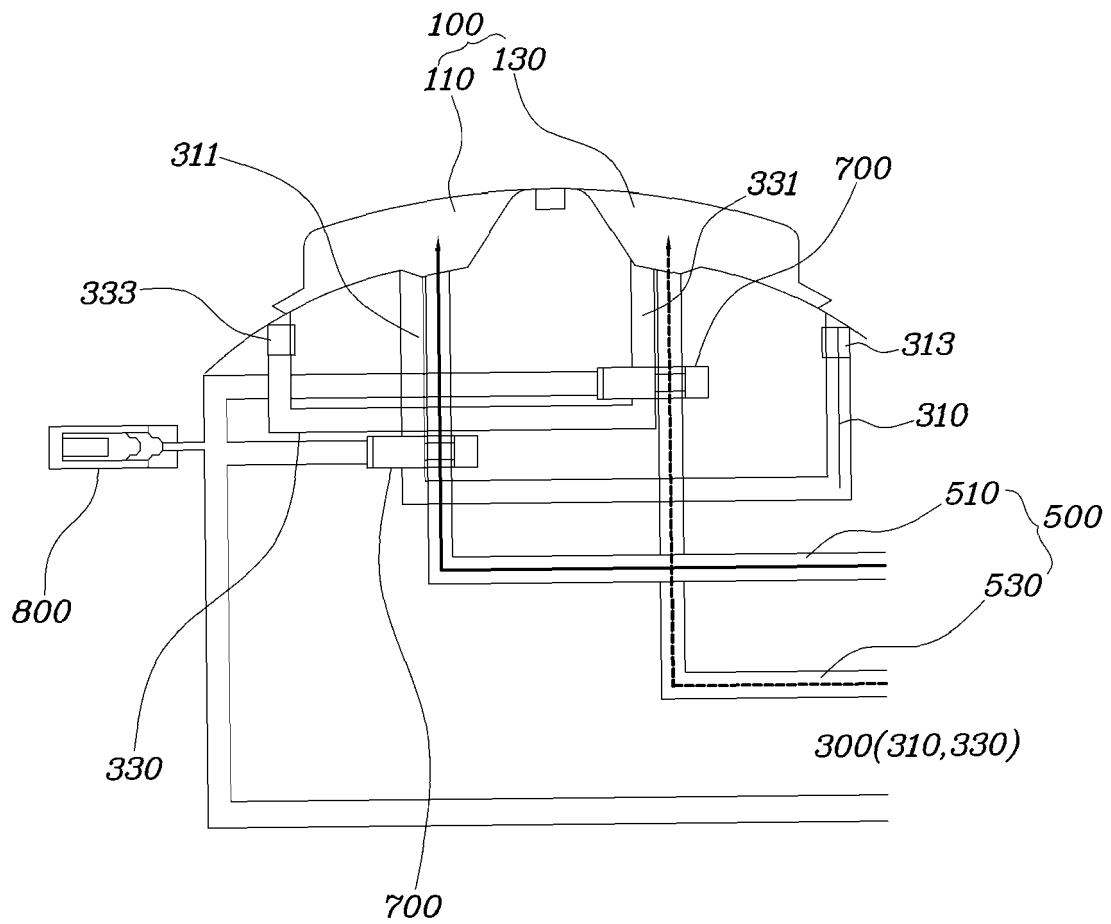


Fig. 3

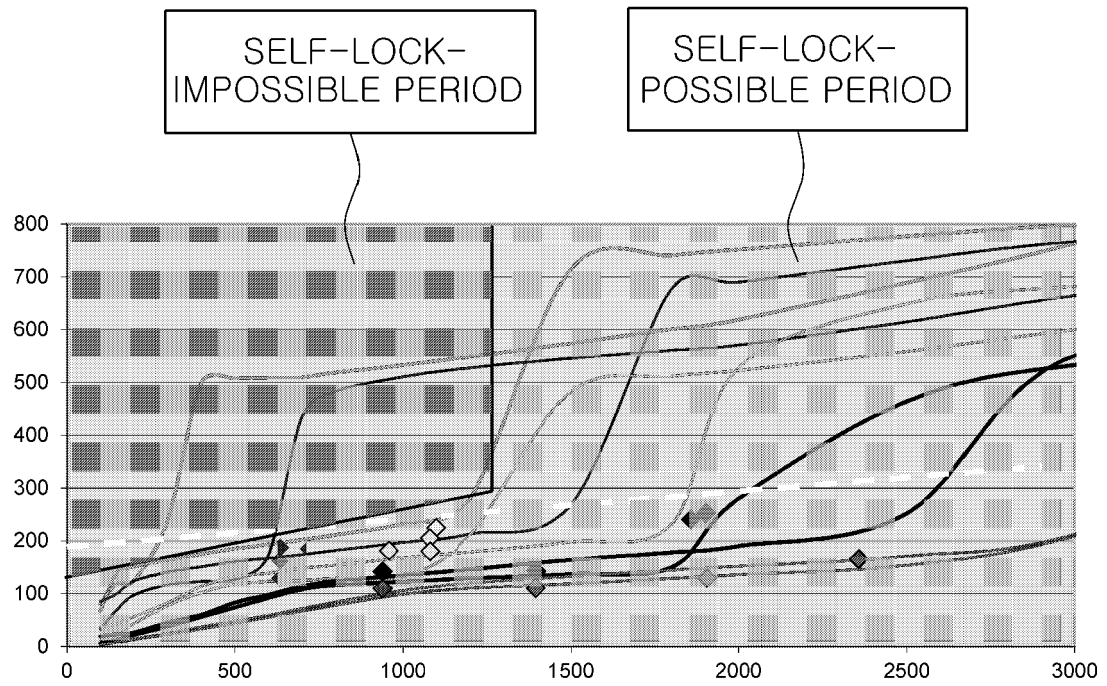


Fig. 4

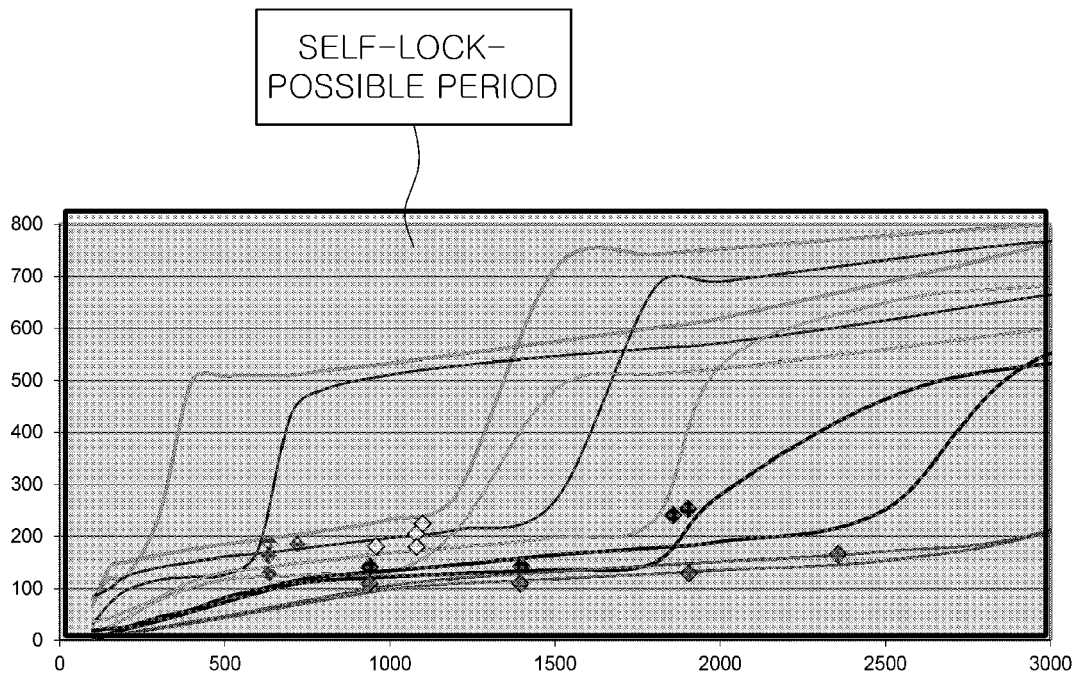


Fig. 5