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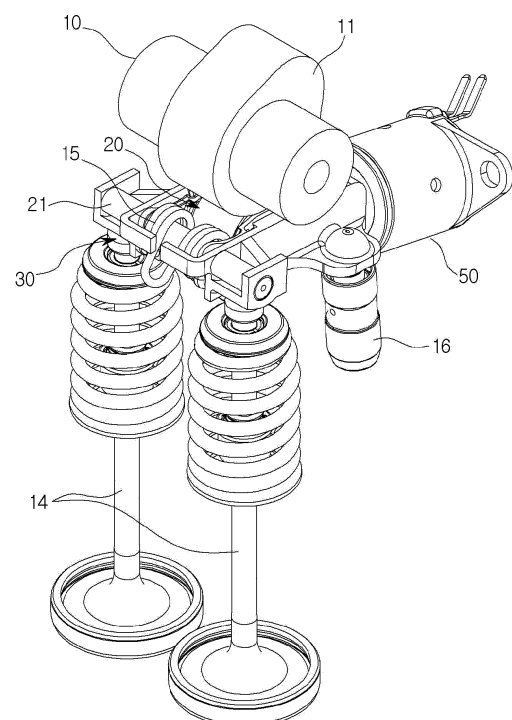
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(54) **VARIABLE VALVE LIFT ACTUATOR OF ENGINE**

(57) A variable valve lift actuator includes a first body rotating within a preset angle range through rotation of a cam coupled to a camshaft, a second body coupled to or decoupled from the first body to open or close a valve through the rotation of the cam, a latching pin provided retractably forward the first body through the second body to couple or decouple the first body to or from the second body, a driving module to retractably actuate the latching pin, a rotation shaft provided on the valve such that the first body is rotatable, and a return spring to return the first body rotated by the cam to an original position thereof. A deactivation control operation of the valve is to deactivate a cylinder by the latching pin by decoupling the first and second bodies from each other at a low-speed and low-load state of an engine.

FIG. 1



Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to a variable valve lift actuator of an engine, and more particularly to a variable valve lift actuator of an engine, capable of controlling a lift amount of a valve according to driving conditions of a vehicle.

2. Description of the Related Art

[0002] A valve mechanism applied to a vehicle engine supplies fuel-air mixture to a combustion chamber and discharges combustion gas according to strokes of the vehicle engine.

[0003] Recently, variable valve mechanisms have been developed to optimize an inflow of the fuel-air mixture and a discharge efficiency of the combustion gas by varying an opening rate or an opening phase of a valve depending on operating areas of an engine which are divided according to operating conditions of the engine, that is, the rotation speed and the load of the engine, and applied to the engine.

[0004] Accordingly, the variable valve mechanisms for the vehicle engine can enhance the performance of the engine, such as the fuel efficiency, the torque, or the power of the engine, and reduce an amount of discharged gas.

[0005] The variable valve mechanism for the vehicle engine includes a variable valve timing unit to change an opening/closing time of a valve, a variable valve lift unit to change an open degree of the valve, and a variable valve actuation angle unit to change an actuation angle of the valve.

[0006] Among them, the variable valve lift unit is used to enhance the power and the fuel efficiency of the vehicle at middle and low-speed modes, and classified into rock arm, pivot, tappet, and bucket-type variable valve lift units.

[0007] Applicant of the present invention has multiple disclosures including patent documents (Korean Patent Registration Nos. 10-1084739 and 10-1084741 (issued on Nov. 22, 2011) and Korean Unexamined Patent Publication No. 10-2012-0088363 (filed on Aug. 8, 2012) related to the variable valve lift unit.

[0008] However, according to the variable valve lift mechanism of the related art, the displacement of an intake valve is always constant regardless of the load of the vehicle, so that an engine speed has a limitation in representing the optimal efficiency.

[0009] Meanwhile, conventionally, although hydraulic pressure is used to deactivate a valve, the structure of the variable valve lift unit becomes complicated, so that the workability may be degraded.

[0010] In addition, when the hydraulic pressure is used,

the viscosity of hydraulic oil reacts sensitively to the temperature, so that the hydraulic pressure may be changed. Accordingly, the variable valve lift unit erroneously operates so that the precision may be degraded when controlling the lift amount of the valve.

[0011] In order to solve the above problem, the applicant of the present invention has disclosed a variable valve lift technology of an engine, capable of improving the efficiency of the engine by performing a deactivation control operation and a variable two-stage control operation of high and low speed modes in which some cylinders are deactivated at a low-speed and low-load state of the engine and whole cylinders are activated at high-speed and high-load state through following patent documents 4 and 5 (Korean Patent Publication No. 10-2012-0088363 (published on Aug. 08, 2012) and Korean Patent Registration No. 10-1465635 (issued on Nov. 27, 2014).

[0012] However, according to patent documents 4 and 5, as a compressive spring is provided to return the rotation motion of the first body, an additional head machining work is required in the first body.

[0013] Therefore, according to patent documents 4 and 5, the workability of the manufacturing work is degraded due to the additional head machining work, and the variable valve lift unit may be not applied to an engine of an actual vehicle.

[0014] In addition, according to the patent documents 4 and 5, as the rotation motion of the cam is transferred to a sliding type of first body to control the lift amount of the valve, power loss may be caused due to the friction between the first body and the cam, thereby degrading the fuel efficiency of a vehicle.

[0015] Further, according to the patent documents 4 and 5, as a pivot point serving as the rotation center of the first body is provided at a driving module side, the weight and the inertial are increased, so that dynamic characteristics may be degraded.

[0016] In addition, according to the patent documents 4 and 5, as an additional latching spring is mounted to provide the resilience to the latching pin, the number of components is increased, the workability is degraded, and the manufacturing cost is increased.

SUMMARY OF THE INVENTION

[0017] The present invention is made in order to solve the problems occurring in the related art, and an object of the present invention is to provide a variable valve lift actuator of an engine, capable of controlling a lift amount of a valve according to driving conditions of a vehicle.

[0018] Another object of the present invention is to provide a variable valve lift actuator of an engine, capable of deactivating some cylinders at a low-speed and low-load state of a vehicle.

[0019] Still another object of the present invention is to provide a variable valve lift actuator of an engine, capable of improving workability in a manufacturing work,

and improving dynamic characteristics by decreasing weight and inertia.

[0020] In order to accomplish the above objects of the present invention, there is provided a variable valve lift actuator including a first body to rotate at an angle within a preset angle range through rotation motion of a high speed cam coupled to a camshaft, a second body coupled to the first body or decoupled from the first body to rotate at an angle within a preset angle range such that a valve is open or closed through the rotation motion of the high speed cam when the second body is coupled to the first body, a latching pin provided retractably forward the first body through the second body such that the first body is coupled to the second body or decoupled from the second body, a driving module to retractably actuate the latching pin, a rotation shaft provided on the valve while traversing both sidewalls of the first and second bodies such that the first body is rotatable, and a return spring fitted around the rotation shaft to provide restoring force for the first body such that the first body rotated by the high speed cam returns to an original position thereof. A deactivation control operation of the valve is performed to deactivate a cylinder by operating the latching pin to decouple the first body from the second body at a low-speed and low-load state of an engine.

[0021] In addition, there is provided a variable valve lift actuator including a first body to rotate at an angle within a preset angle range through rotation motion of a high speed cam coupled to a camshaft, a second body coupled to the first body or decoupled from the first body to rotate through the rotation motion of a high speed cam when being coupled to the first body, and to rotate through rotation motion of low speed cams provided at both sides of the high speed cam when being decoupled from the first body such that a lift amount of a valve is controlled, a latching pin provided retractably forward the first body through the second body such that the first body is coupled to the second body or decoupled from the second body, a driving module to retractably actuate the latching pin, a rotation shaft provided on the valve while traversing both sidewalls of the first and second bodies such that the first body is rotatable, and a return spring fitted around the rotation shaft to provide restoring force for the first body such that the first body rotated by the cam returns to an original position thereof. The lift amount of the valve is variably controlled in two stages of high and low speed modes of the valve based on operating conditions of the engine.

[0022] As described above, according to the variable valve lift actuator of the engine of the present invention, the deactivation control operation of the valve to deactivate some cylinders and the variable two-stage control operation at the high-speed mode and low-speed mode can be performed according to the operating conditions of the engine.

[0023] In other words, according to the present invention, the first and second bodies are coupled to or decoupled from each other using the latching pin to realize the

opening and closing operation and the deactivation control operation of the valve, so that some cylinders can be deactivated at the low-speed and low-load state of the engine.

5 **[0024]** Therefore, according to the present invention, the fuel consumption can be minimized at the low-speed and low-load state of the engine to improve the efficiency of the engine and maximize the fuel efficiency of the vehicle.

10 **[0025]** In addition, according to the present invention, since the return spring is mounted at both sides of the first body to return the first body to the original position thereof, the head machining work of the first body, which is required when the compressive spring is mounted in contact with a lower portion of the first body according to the related art, can be omitted.

15 **[0026]** Therefore, according to the present invention, as the head machining work of the first body, which is required as the compressive spring is employed in the related art, is omitted, the workability can be improved, and the configuration of the variable valve lift actuator can be simplified, so that the variable valve lift actuator can be easily applied to the engine of an actual vehicle.

20 **[0027]** Further, according to the present invention, as a pivot point serving as the rotation center of the first body is provided at the side of the valve, the weight and the inertial are decreased, so that dynamic characteristics may be improved.

25 **[0028]** According to the present invention, the first and second bodies have respective rollers thereof to receive rotational force in contact with the cam, thereby minimizing power loss resulting from the friction with the cam, so that the fuel efficiency of the vehicle can be improved.

30 **[0029]** Further, according to the present invention, the latching spring to provide the restoring force for the latching pin is omitted, and the latching pin is integrally coupled to the T-shaped front end portion of the solenoid to move forward and backward the latching pin. Accordingly, the operability of the latching pin can be improved in a latching operation, and the number of components can be reduced, so that the manufacturing cost can be saved.

35 **[0030]** In addition, according to the patent documents 4 and 5, as an additional latching spring is mounted to provide the resilience to the latching pin, the number of components is increased, the workability is degraded, and the manufacturing cost is increased.

BRIEF DESCRIPTION OF THE DRAWINGS

50 **[0031]**

FIG. 1 is a perspective view showing a variable valve lift actuator of an engine according to a first embodiment of the present invention.

55 FIG. 2 is an exploded perspective view showing the variable valve lift actuator of the engine shown in FIG. 1.

FIG. 3 is a partially exploded sectional surface view

showing a carrier in which the variable valve lift actuator of the engine shown in FIG. 1 is mounted. FIGS. 4 and 5 are views showing the operating state of a variable valve lift actuator of an engine according to the first embodiment of the present invention. FIG. 6 is a perspective view showing a variable valve lift actuator of an engine according to the second embodiment of the present invention. FIG. 7 is an exploded perspective view showing the variable valve lift actuator of the engine shown in FIG. 6. FIGS. 8 and 9 are views showing the operating state of the variable valve lift actuator of the engine according to the second embodiment of the present invention. FIG. 10 is a perspective view showing the variable valve lift actuator of an engine according to the third embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0032] Hereinafter, a variable valve lift actuator of an engine according to an exemplary embodiment of the present invention will be described in detail with reference to accompanying drawings.

[0033] The variable valve lift actuator of the engine according to the present invention is configured to perform a deactivation control operation of activating or deactivating a cylinder according to driving conditions of a vehicle and a variable two-stage control operation of controlling a lift amount of a valve in two stages of high and low speeds.

[0034] Hereinafter, according to the present invention, the configuration of realizing the deactivation control operation of the valve will be described according to a first embodiment, and the configuration of realizing the variable two-stage control operation of variably controlling the valve in two stages will be described according to a second embodiment based on the configuration of the first embodiment.

[0035] To this end, it is noted that one cam may be mounted on a camshaft of the engine in the case that the deactivation control operation is realized, and a high speed cam and low-speed cams provided at both sides of the high speed cam may be mounted on the camshaft of the engine in the case that the variable two-stage control operation is realized.

[0036] Hereinafter, terms indicating directions, such as leftward, rightward, forward, rearward, upward, and downward, are defined based on drawings.

[Embodiment 1]

[0037] FIG. 1 is a perspective view showing the variable valve lift actuator of an engine according to a first embodiment of the present invention, and FIG. 2 is an exploded perspective view showing the variable valve lift actuator of the engine shown in FIG. 1. FIG. 3 is a partially

exploded sectional surface view showing a carrier in which the variable valve lift actuator of the engine shown in FIG. 1 is mounted.

[0038] As shown in FIGS. 1 and 2, the variable valve lift actuator of the engine according to the first embodiment of the present invention includes a first body 20 rotated at an angle within a preset angle range by rotating a cam coupled to a camshaft, a second body 30 to maintain a valve 14 in an opening state or closing state based on the coupling state of the first body 20, a latching pin 40 provided retractably forward of the first body 20 so that the first body 20 is coupled to or decoupled from the second body 30, and a driving module 50 to retractably actuate the latching pin 40.

[0039] In addition, in the variable valve lift actuator of the engine according to the first embodiment of the present invention, the first body 20 is mounted on a rotation shaft 21 that performs rotation motion, and a return spring 15 may be further provided to provide restoring force to return the first body 20 rotated by the cam 11 to the original position of the first body 20.

[0040] The return spring 15 may include a torsion spring having the center protruding forward.

[0041] For example, the central portion of the return spring 15 protrudes forward to be supported by a front wall 31 of a second body 30 to be described below, and both ends of the return spring 15 may be supported by support steps 26 formed at both sidewalls of the first body 20 to be described below.

[0042] As described above, as the return spring to return the first body according to the present invention to the original position thereof is mounted on the rotation shaft of the first body, a head machining process of the first body, which is required when the compressive spring is mounted under the first body in contact with the first body according to the related art, may be omitted.

[0043] Therefore, according to the present invention, as the conventional compressive spring is applied, the head machining work of the first body is omitted, so that the workability can be improved. In addition, the variable valve lift actuator of the engine has a simple configuration, so that the variable valve lift actuator can be easily applied to the engine of an actual vehicle.

[0044] The first body 20 may have both sidewalls and a rear wall so that the sectional surface of the first body 20 has a substantially U shape having an open front portion when viewed from the top.

[0045] In addition, a rotation roller 22 may be mounted in the first body 20 to rotate according to the rotation of the cam 11 in order to minimize friction when the rotation roller 22 makes contact with the cam 11.

[0046] According to the present embodiment, a latching spring, which provides restoring force to the latching pin 40, is not provided in the first body 20.

[0047] Coupling holes 23 coupled to the rotation shaft 21 may be formed in front ends of both sidewalls of the first body 20, and mounting holes 25, into which a roller shaft 24 of the rotation roller 22 is inserted, may be formed

at centers of the both sidewalls of the first body 20.

[0048] The rotation shaft 21 may be coupled to the both sidewalls of the first body 20 and both sidewalls of the second body 30 while passing through the both sidewalls of the first and second bodies 20 and 30, and the return spring 15 may be fitted around an outer circumference of the central portion of the rotation shaft 21.

[0049] Accordingly, the first body 20 may be rotated about the rotation shaft 21.

[0050] The roller shaft 24 is coupled to a pair of mounting holes 25 formed in both sidewalls of the first body 20 while passing through the mounting holes 25, and a bearing may be interposed between the roller shaft 24 and the rotation roller 22 so that the rotation roller 22 may be smoothly rotated.

[0051] Meanwhile, the support steps 26 may be formed on inner surfaces of the both sidewalls of the first body 20 to support both ends of the return spring 15, respectively.

[0052] In addition, the first body 20 may be provided at a rear wall thereof with a locking step 27, to which the latching pin 40 is locked, so that the first and second bodies 20 and 30 are integrally rotated according to the rotation of the cam 11 when the latching pin 40 is moved forward.

[0053] The second body 30 may include the front wall 31, both sidewalls, and a rear surface that is open, to have a U shape when viewed from the top and to be arranged corresponding to a front surface and both lateral sides of the first body 20, respectively.

[0054] Each sidewall of the second body 30 may include an inner sidewall 32 and an outer sidewall 33.

[0055] A pressing plate 34 may be mounted at each of both sides of the front wall 31 of the second body 30 and interposed between the inner sidewall 32 and the outer sidewall 33 to press an upper end of the valve 14.

[0056] The pressing plates 34 may be mounted in a horizontal direction, and press the upper end of the valve 14 when the second body 20 is rotated to move up or down the upper end of the valve 14, thereby opening or closing the valve 14.

[0057] A rear end portion of the second body 30 may be supported by pivot support members 16.

[0058] According to the present embodiment, the pivot support member 16 may include a hydraulic lash adjuster to automatically adjust an opening of the valve 14 using hydraulic pressure.

[0059] For example, the hydraulic lash adjuster extends or contracts depending on the variation in the pressure of oil in the state that the hydraulic lash adjuster is constantly supplied with oil therein, thereby finely adjusting the opening of the valve 14.

[0060] In other words, if the pressure of the oil is lower than preset pressure, the hydraulic lash adjuster is maintained in a contacting state as a check valve provided in the hydraulic lash adjuster is maintained in a closing state.

[0061] On the contrary, if the pressure of the oil is equal

to or more than the preset pressure, as the check valve is opened to open the moving path of the oil, the hydraulic lash adjuster extends to move up the rear end of the second body 30, so that the opening of the valve 14 can be adjusted.

[0062] To this end, support plates 35 may be formed outside a pair of inner sidewalls 32 of the second body 30 to be supported in contact with upper ends of the pivot support members.

[0063] Accordingly, the second body 30 may rotate about the pivot support member 16.

[0064] Meanwhile, the second body 30 is provided at a lower end portion thereof with a mounting part 36 allowing the latching pin 40 to slidably move forward, and a moving space 37 (see FIG. 4) may be formed at the central portion of the mounting part 36 in a forward-backward direction.

[0065] The mounting part 36 may be interposed between rear end portions of a pair of inner sidewalls 32 of the second body 30.

[0066] The latching pin 40 is integrally coupled to a solenoid pin 51 of the driving module 50, and may move forward or backward as the solenoid pin 51 moves forward or backward.

[0067] To this end, the latching pin 40 may be formed in the shape of a cylinder having a substantially circular or oval-shaped sectional surface, and formed therein with a mounting space 41 corresponding to a front end of the solenoid pin 51 formed in a substantially T shape.

[0068] The driving module 50 may be provided in the form of a solenoid to move forward and backward the solenoid pin 51 according to a control signal of an electronic control unit (not shown) to control the operation of the engine.

[0069] For example, if power is applied to the solenoid by the control signal in the state that a front end portion of the solenoid pin 51 is mounted in the latching pin 40, the solenoid generates a magnetic field from an internal winding coil to move forward the solenoid pin 51 and to press the latching pin 40 so that the latching pin 40 is moved.

[0070] On the contrary, if power is cut off by the control signal, as the magnetic field generated from the inner part of the solenoid is disappeared, the solenoid moves backward the solenoid pin 51 to return the latching pin 40 the original position thereof.

[0071] FIG. 3 is a partially enlarged sectional surface showing a carrier in which the variable valve lift actuator of the engine shown in FIG. 1 is mounted.

[0072] As shown in FIG. 3, variable valve lift actuators of the engine may be provided in number corresponding to that of cylinders of the engine, and mounted to be inclined at a preset angle with respect to the upper portion of a carrier 60.

[0073] Hereinafter, the operating method of the variable valve lift actuator of the engine according to the first embodiment of the present invention will be described in detail with reference to FIGS. 4 and 5.

[0074] FIGS. 4 and 5 are views showing the operating state of the variable valve lift actuator of the engine according to the first embodiment of the present invention.

[0075] FIG. 4 is a view showing the operation state of opening or closing the valve through the rotation motion of the cam in the variable valve lift actuator of the engine. FIG. 5 shows the operating state of controlling the deactivation of the valve.

[0076] The variable valve lift actuator of the engine according to the first embodiment of the present invention operates the driving module 50 to move forward the latching pin 40 as shown in FIG. 4 when opening or closing the valve 14 through the rotation motion of the cam 11.

[0077] Then, as the front end portion of the first latching pin 40 protrudes forward through the mounting part 36 of the second body 30 while being locked to the locking step 27 formed on the rear wall of the first body 20, so that the first body 20 is coupled to the second body 30.

[0078] Accordingly, the variable valve lift actuator of the engine according to the first embodiment of the present invention may open or close the valve 14 by moving up or down the valve 14 as the first and second bodies 20 and 30 are rotated at an angle within a preset angle range through the rotation motion of the cam 11.

[0079] In this case, the central portion of the return spring 15 fitted around the rotation shaft 21 is supported to the lower end of the front wall 31 of the second body 31, and both ends of the return spring 15 are supported to the support steps 26 formed at both sidewalls of the first body 20.

[0080] Accordingly, the return spring 15 provides the restoring force to the first body 20 so that the first and second bodies 20 and 30 rotated by the cam 11 may be returned to the original positions thereof.

[0081] On the contrary, in the variable valve lift actuator according to the first embodiment of the present invention, the power applied to the driving module 50 is cut off by the control signal of the electronic control unit in the case that the deactivation control operation of the valve 14 is realized to deactivate a portion of the cylinders.

[0082] Accordingly, the latching pin 40 is returned to the original position thereof as the solenoid pin 51 of the driving module 50 is moved backward as shown in FIG. 5.

[0083] In this case, as the latching pin 40 is moved backward to be received in the mounting part 36 of the second body 30, the first body 20 is decoupled from the second body 30.

[0084] Then, the front and rear end portions of the second body 30 are fixed in contact with the upper ends of the valve 14 and the pivot support member 16, respectively.

[0085] Therefore, in the variable valve lift actuator of the engine according to the first embodiment of the present invention, even if the cam 11 is rotated, since the second body 30 is fixed in contact with the upper end of the valve 14, the deactivation control operation of the valve 14 can be realized.

[0086] As described above, according to the present

invention, the opening or closing operation of the valve and the deactivation control operation can be realized by selectively coupling or decoupling the first body to or from the second body using the latching pin, so that a portion of the cylinders can be deactivated in the low-speed and low-load state of the engine.

[0087] Therefore, according to the present invention, the fuel consumption can be minimized at the low-speed and low-load state to improve the efficiency of the engine and maximize the fuel efficiency of the vehicle.

[0088] Through the above procedure, according to the present invention, the deactivation control operation of the valve may be performed to deactivate some cylinders according to the operating conditions of the engine.

[Embodiment 2]

[0089] Hereinafter, the structure of a variable valve lift actuator of an engine according to the second embodiment of the present invention will be described in detail with reference to FIGS. 6 and 7.

[0090] FIG. 6 is a perspective view showing the variable valve lift actuator of the engine according to the second embodiment of the present invention. FIG. 7 is an exploded perspective view showing the variable valve lift actuator of the engine shown in FIG. 6.

[0091] The variable valve lift actuator of the engine according to the second embodiment of the present invention has the configuration similar to that of the first embodiment as shown in FIGS. 6 and 7 except that additional components may be further provided to perform the variable two-stage control operation for the lift amount of the valve according to the operating conditions of the engine at a high-speed or low-speed mode.

[0092] In other words, a high speed cam 12, which is used to control the lift amount of the valve 14 to a maximum value at a high-speed and high-load state of the engine, and a low-speed cam 13, which is used to control the lift amount of the valve 14 to a minimum value at the low-speed and low-load state of the engine, may be mounted on the camshaft 10.

[0093] The high speed cam 12 may be manufactured in a shape corresponding to that of the cam 11 according to the first embodiment.

[0094] A pair of low-speed cams 13 may be provided so that the low-speed cams 13 make contact with both sides of the second body 30, and may be mounted at both sides of the second body 30.

[0095] Each low-speed cam 13 has a diameter less than the maximum diameter of the high speed cam 12.

[0096] First and second rollers 38 and 39 may be mounted at both sides of the second body 30 to perform rotation motion in contact with the low-speed cams 13 at the low-speed and low-load state of the engine.

[0097] To this end, the outer sidewalls 33 of the second body 30 may extend with lengths corresponding to the lengths of the inner sidewalls 32, and the pressing plate 34 and the support plate 35 may be formed between the

outer sidewall 33 and the inner sidewall 32.

[0098] In addition, the roller shaft 24 may extend with a length corresponding to the distance between a pair of outer sidewalls 33 of the second body 30.

[0099] The first and second rollers 38 and 39 may be rotatably mounted on a roller shaft 24 through-coupled to the inner sidewalls 32 and the outer sidewalls 33 at both sides of the second body 30, respectively.

[0100] Hereinafter, the operating method of the variable valve lift actuator of the engine according to the second embodiment of the present invention will be described in detail with reference to FIGS. 8 and 9.

[0101] FIGS. 8 and 9 show the operating state of the variable valve lift actuator of the engine according to the second embodiment of the present invention.

[0102] FIG. 8 shows the operating state of the variable valve lift actuator of the engine, which operates at the high-speed mode when the engine is at the high-speed and high-load state. FIG. 9 shows the operating state of the variable valve lift actuator of the engine, which operates at the low-speed mode when the engine is at the low-speed and low-load state.

[0103] Meanwhile, the variable valve lift actuator of the engine according to the second embodiment of the present invention operates the driving module 50 to move forward the latching pin 40 as shown in FIG. 8 when the engine is at the high-speed and high-load state of the engine.

[0104] Then, the front end portion of the latching pin 40 protrudes forward through the mounting part 36 of the second body 30 while be locked to the locking step 27 formed on the rear wall of the first body 20 to couple the first body 20 to the second body 30.

[0105] In this case, the first body 20 makes contact with the high speed cam 12 mounted on the camshaft 10 to perform rotation motion together with the second body 30.

[0106] Therefore, the variable valve lift actuator of the engine according to the second embodiment of the present invention rotates the first and second bodies 20 and 30 at an angle within a present angle range through the rotation motion of the high speed cam 12 while moving up or down the valve 14 to open or close the valve 14.

[0107] In this case, as the lift amount (H) of the valve 14 by the high speed cam 12 becomes greater than a lift amount (h) of the valve 14 by the low-speed cam 13, the flux of air supplied to the cylinder of the engine is increased (see FIG. 9).

[0108] Meanwhile, the variable valve lift actuator of the engine according to the second embodiment of the present invention operates in the state that the mounting part 36 of the body 30 is received therein and the first and second bodies 20 and 30 are decoupled from each other as shown in FIG. 9 at the low-speed and low-load state of the engine.

[0109] In this case, the first and second rollers 38 and 39 mounted in the second body 30 perform rotation motion in contact with a pair of low speed cams 13 mounted

on the camshaft 10.

[0110] Then, the second body 30 rotates about the pivot support member 16 to open or close the valve 14 as the low speed cam 13 rotates.

[0111] In this case, as the lift amount (h) of the valve 14 by the low speed cam 13 becomes smaller than the lift amount H (see FIG. 3) of the valve 14 by the high speed cam 12, a flow amount of air to be supplied to the cylinder of the engine is reduced.

[0112] As described above, according to the present invention, the first and second bodies are coupled to or decoupled from each other using the latching pin so that the lift amount of the valve can be controlled in two stages of high and low speed modes through the rotation motion of the high speed cam and the low speed cam.

[0113] Meanwhile, although the deactivation control operation of the valve and an operation of controlling the lift amount of the valve in two stages of the high and low speed modes have been described using components of each of the first and second embodiment, the present invention is not limited thereto.

[0114] For example, when the components of the second embodiment of the present invention are applied to the camshaft having only the high speed cam, the deactivation control operation of the valve may be realized.

[0115] In other words, the two-stage control operation and the deactivation control operation of the valve may be realized according to the configuration of the cam by changing only the components of the cam and using the configuration of the second embodiment.

[Embodiment 3]

[0116] FIG. 10 is a perspective view showing a variable valve lift actuator of an engine according to the third embodiment of the present invention.

[0117] The variable valve lift actuator according to the third embodiment of the present invention has a configuration similar to that of the second embodiment as shown in FIG. 10 except that the front wall is provided at the central portion thereof with a mounting hole to fix upper and lower ends of the central portion of the return spring to improve latching performance.

[0118] In other words, the front wall may include a first fixing bar, which fixes the upper end of the central portion of the return spring, a second fixing bar, which fixes the lower end of the central portion of the return spring, while interposing the mounting hole between the first and second fixing bars.

[0119] Accordingly, the central portion of the return spring may be fixedly mounted in the mounting hole between the first and second fixing bars constituting the front wall of the second body, and both ends of the return spring may be supported to the support steps formed on both sidewalls of the first body.

[0120] Accordingly, the return spring may provide the restoring force to return the first body rotated by the cam to the original position thereof, and may facilitate a latch-

ing function of the latching pin based on the retractable motion of the latching pin.

[0121] According to the present invention, through the above procedure, the deactivation control operation of the valve to deactivate a portion of the cylinders and the variable two-stage control operation at the high-speed mode and low-speed mode can be performed according to the operating conditions of the engine.

[0122] The present invention is applied to a variable valve lift actuator technology of an engine to perform the deactivation control operation of the valve to deactivate a portion of the cylinders and the variable two-stage control operation at the high-speed mode and low-speed mode.

[0123] Although a preferred embodiment of the present invention has 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 invention as disclosed in the accompanying claims.

Claims

1. A variable valve lift actuator comprising:

a first body to rotate at an angle within a preset angle range through rotation motion of a high speed cam coupled to a camshaft;
 a second body coupled to the first body or decoupled from the first body to rotate at an angle within a preset angle range such that a valve is open or closed through the rotation motion of the high speed cam when the second body is coupled to the first body;
 a latching pin provided retractably forward the first body through the second body such that the first body is coupled to the second body or decoupled from the second body;
 a driving module to retractably actuate the latching pin;
 a rotation shaft provided on the valve while traversing both sidewalls of the first and second bodies such that the first body is rotatable; and
 a return spring fitted around the rotation shaft to provide restoring force for the first body such that the first body rotated by the high speed cam returns to an original position thereof,

wherein a deactivation control operation of the valve is performed to deactivate a cylinder by operating the latching pin to decouple the first body from the second body at a low-speed and low-load state of an engine.

2. The variable valve lift actuator of claim 1, wherein the second body comprises a front wall, inner sidewalls, and outer sidewalls provided at a front surface

and both sides of the second body, respectively, to be arranged corresponding to a front surface and both sides of the first body;

a pressing plate mounted at each of both sides of the front wall of the second body to press an upper end of the valve through rotation motion of the second body; and

a support plate provided at a rear end portion of the inner sidewall to be supported in contact with an upper end of a pivot support member, and wherein the return spring has a central portion protruding to be supported to the front surface of the second body, and both ends supported to support steps formed at the both sidewalls of the first body.

3. A variable valve lift actuator comprising:

a first body to rotate at an angle within a preset angle range through rotation motion of a high speed cam coupled to a camshaft;
 a second body coupled to the first body or decoupled from the first body to rotate through the rotation motion of a high speed cam when being coupled to the first body, and to rotate through rotation motion of low speed cams provided at both sides of the high speed cam when being decoupled from the first body such that a lift amount of a valve is controlled;
 a latching pin provided retractably forward the first body through the second body such that the first body is coupled to the second body or decoupled from the second body;
 a driving module to retractably actuate the latching pin;
 a rotation shaft provided on the valve while traversing both sidewalls of the first and second bodies such that the first body is rotatable; and
 a return spring fitted around the rotation shaft to provide restoring force for the first body such that the first body rotated by the cam returns to an original position thereof,

wherein the lift amount of the valve is variably controlled in two stages of high and low speed modes of the valve based on operating conditions of the engine.

4. The variable valve lift actuator of claim 3, wherein the second body comprises a front wall, inner sidewalls, and outer sidewalls provided at a front surface and both sides of the second body, respectively, to be arranged corresponding to a front surface and both sides of the first body; a pressing plate mounted at each of both sides of the front wall of the second body to press an upper end of the valve through rotation motion of the second body; and a support plate interposed between a rear end por-

tion of the inner sidewall and a rear end portion of the outer sidewall to be supported in contact with an upper end of a pivot support member, and wherein the return spring has a central portion protruding to be supported to the front surface of the second body, and both ends supported to support steps formed at both sidewalls of the first body. 5

5. The variable valve lift actuator of claim 4, wherein the front wall of the second body is provided therein with a mounting hole allowing the central portion of the return spring to protrude, and wherein the front wall comprises a first fixing bar mounted in a horizontal direction over the mounting hole to fix an upper end of the return spring and a second fixing bar mounted in the horizontal direction under the mounting hole to fix a lower end of the return spring, such that upper and lower ends of the central portion of the return spring are fixed. 10 15 20
6. The variable valve lift actuator of claim 4, further comprising first and second rollers interposed between the inner sidewall and the outer sidewall and rotating by the low-speed cam to reduce friction when making contact with the low speed cam. 25
7. The variable valve lift actuator of one of claims 1 to 5, further comprising a rotation roller mounted in the first body and rotating by the high speed cam to reduce friction when making contact with the high speed cam, wherein the first body is provided at a rear end portion thereof with a locking step, to which the latching pin is locked, such that the first and second bodies integrally rotate as the high cam rotates when the latching pin is moved forward. 30 35
8. The variable valve lift actuator of claim 7, wherein the second body has a mounting part through which the latching pin slidably passes, and the mounting part has a moving space along which the latching pin moves. 40
9. The variable valve lift actuator of claim 7, wherein the latching pin is integrally coupled to a solenoid pin of the driving module, and a front end portion of the solenoid pin is formed in a T shape. 45
10. The variable valve lift actuator of claim 3, wherein, when only the high speed cam is mounted on the camshaft, a deactivation control operation of the valve is performed to deactivate a cylinder by operating the latching pin to decouple the first body from the second body at a low-speed and low-load state of an engine. 50 55

FIG. 1

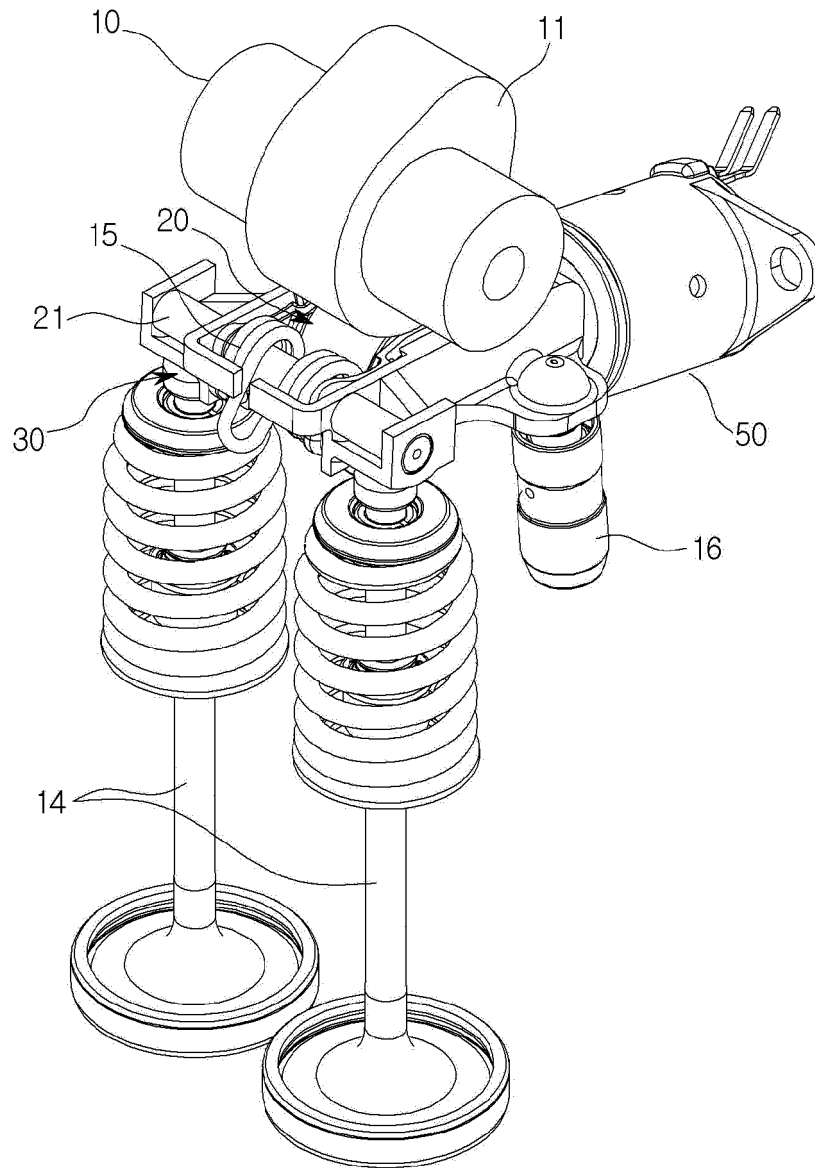


FIG. 2

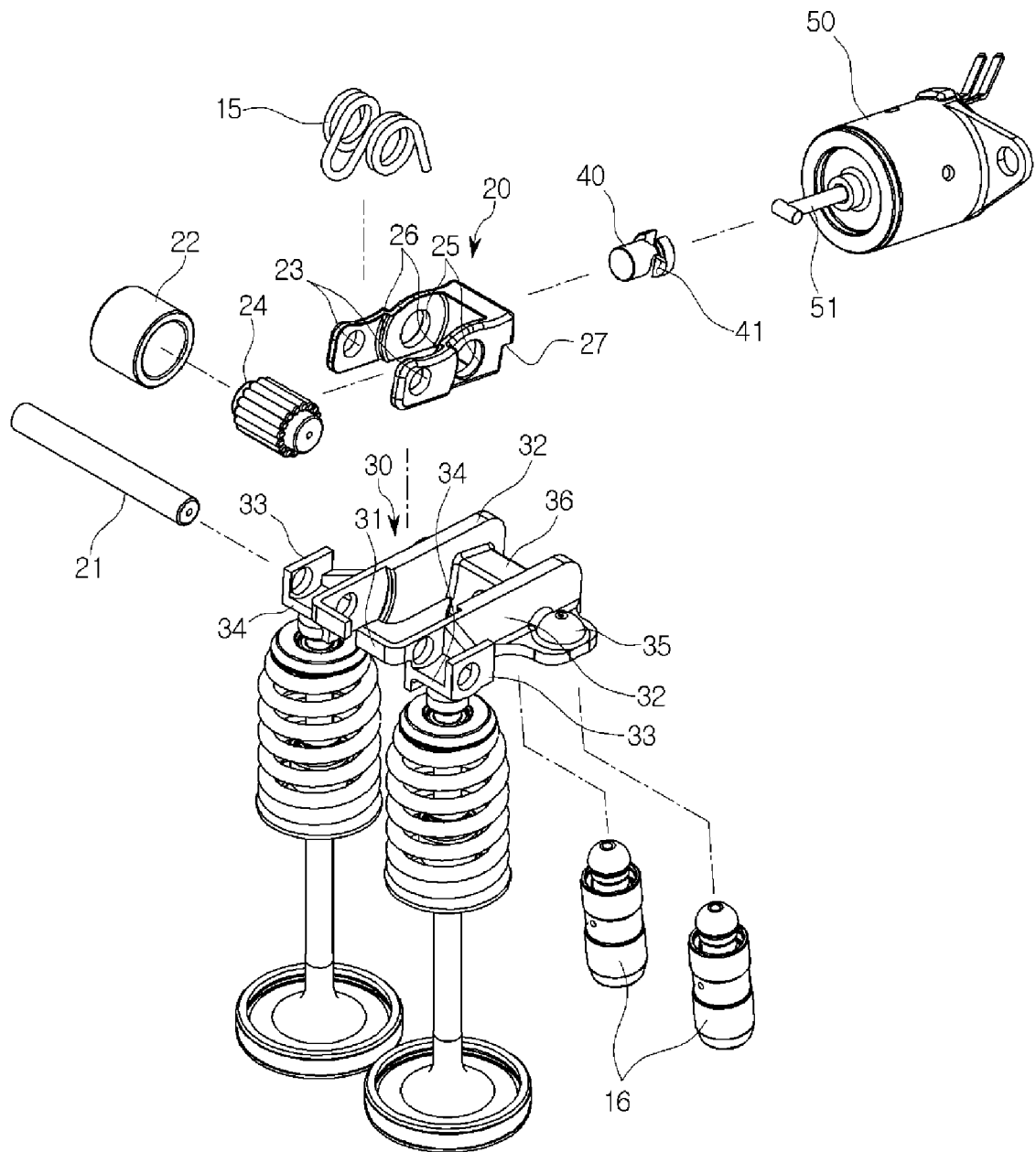


FIG. 3

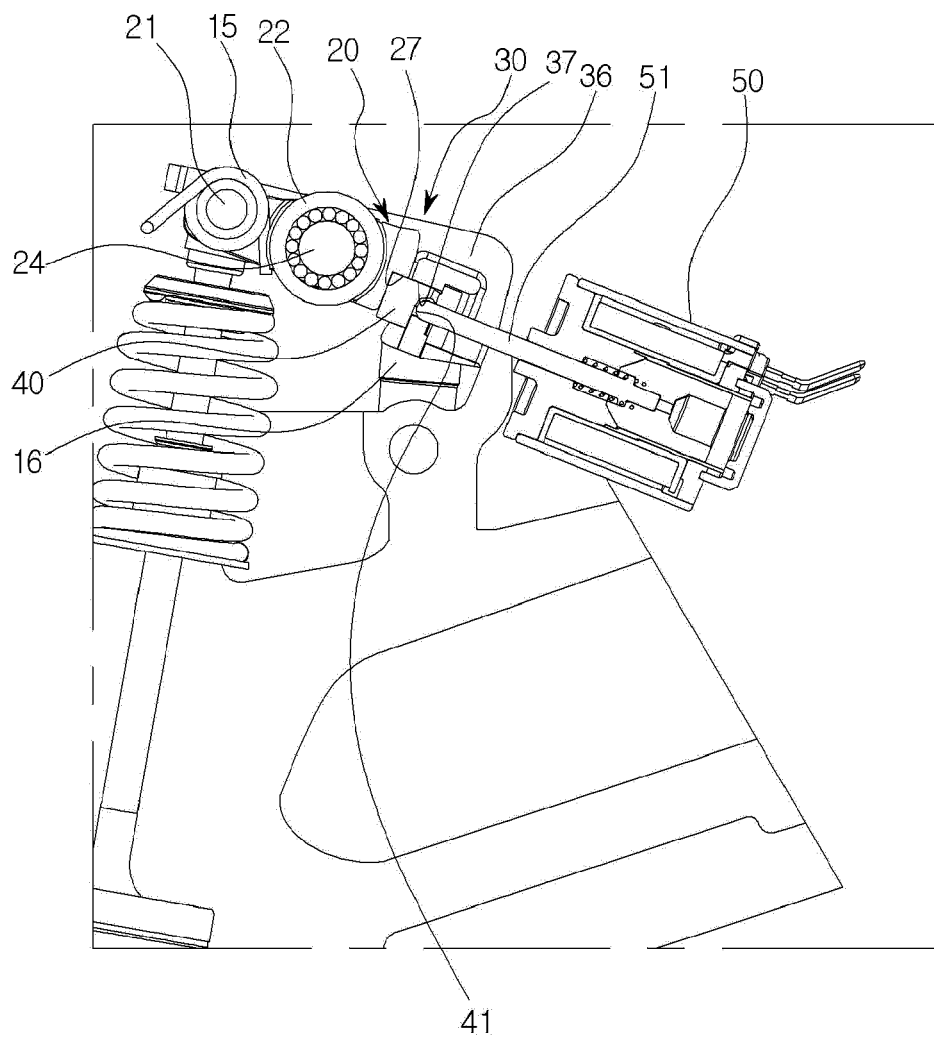


FIG. 4

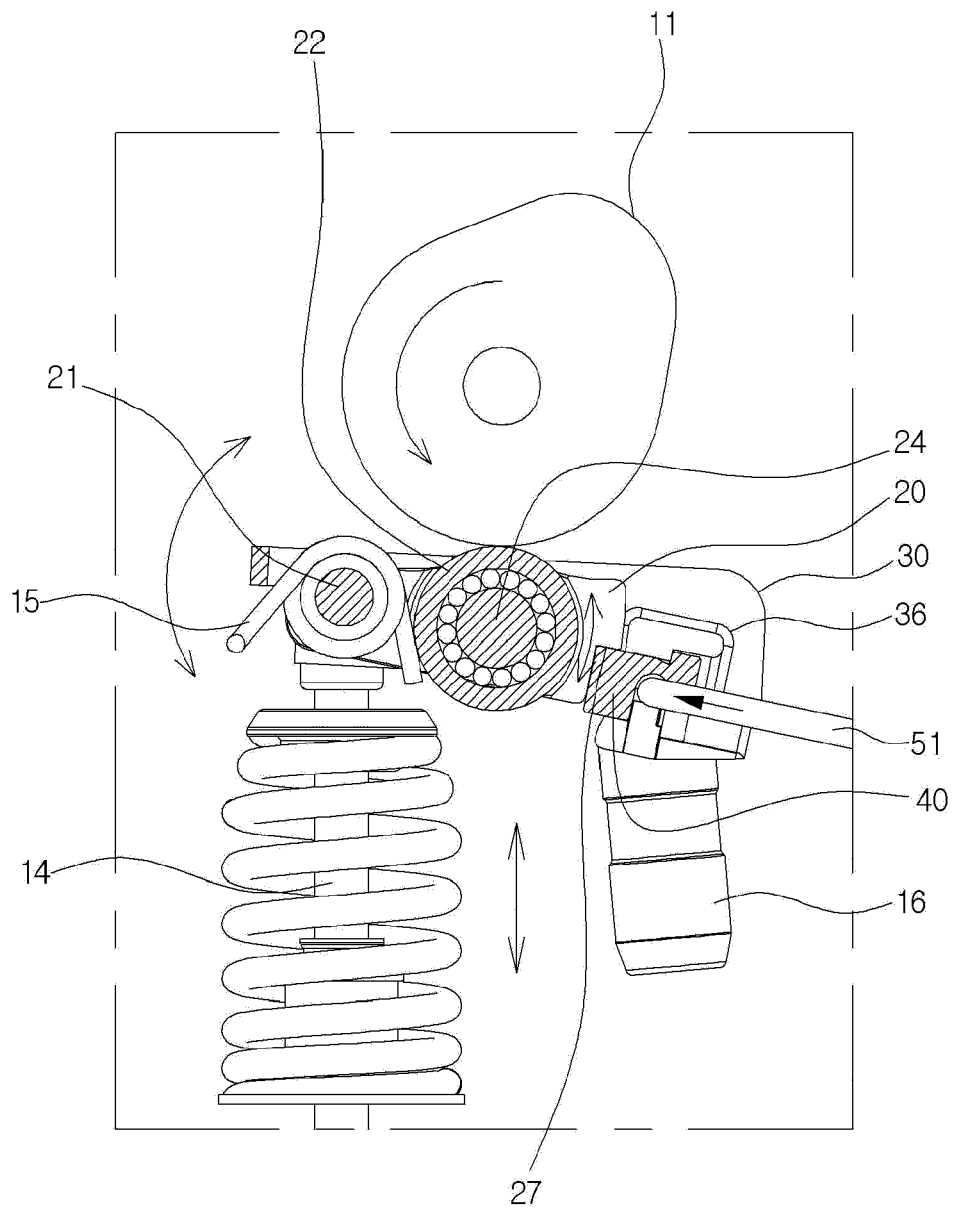


FIG. 5

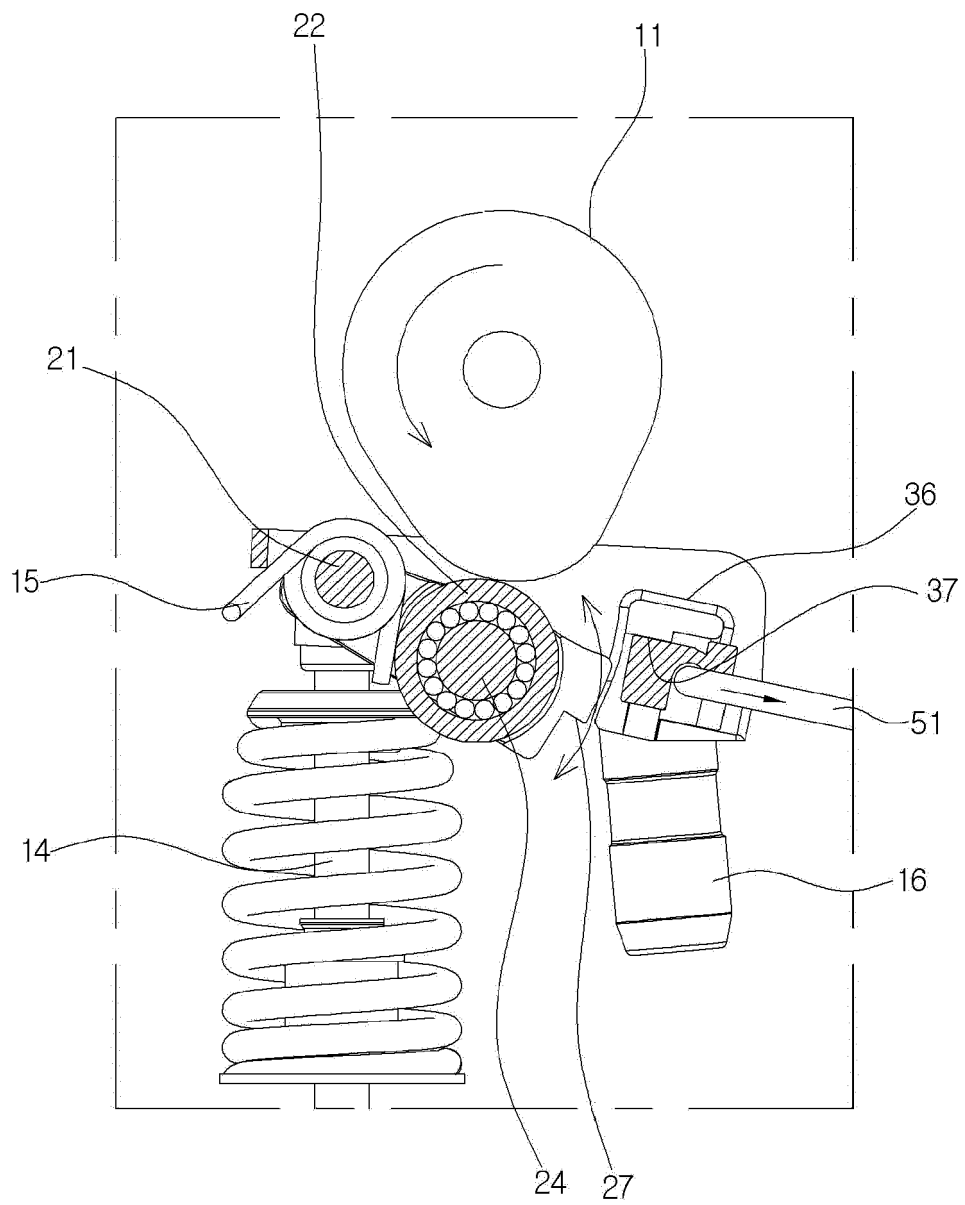


FIG. 6

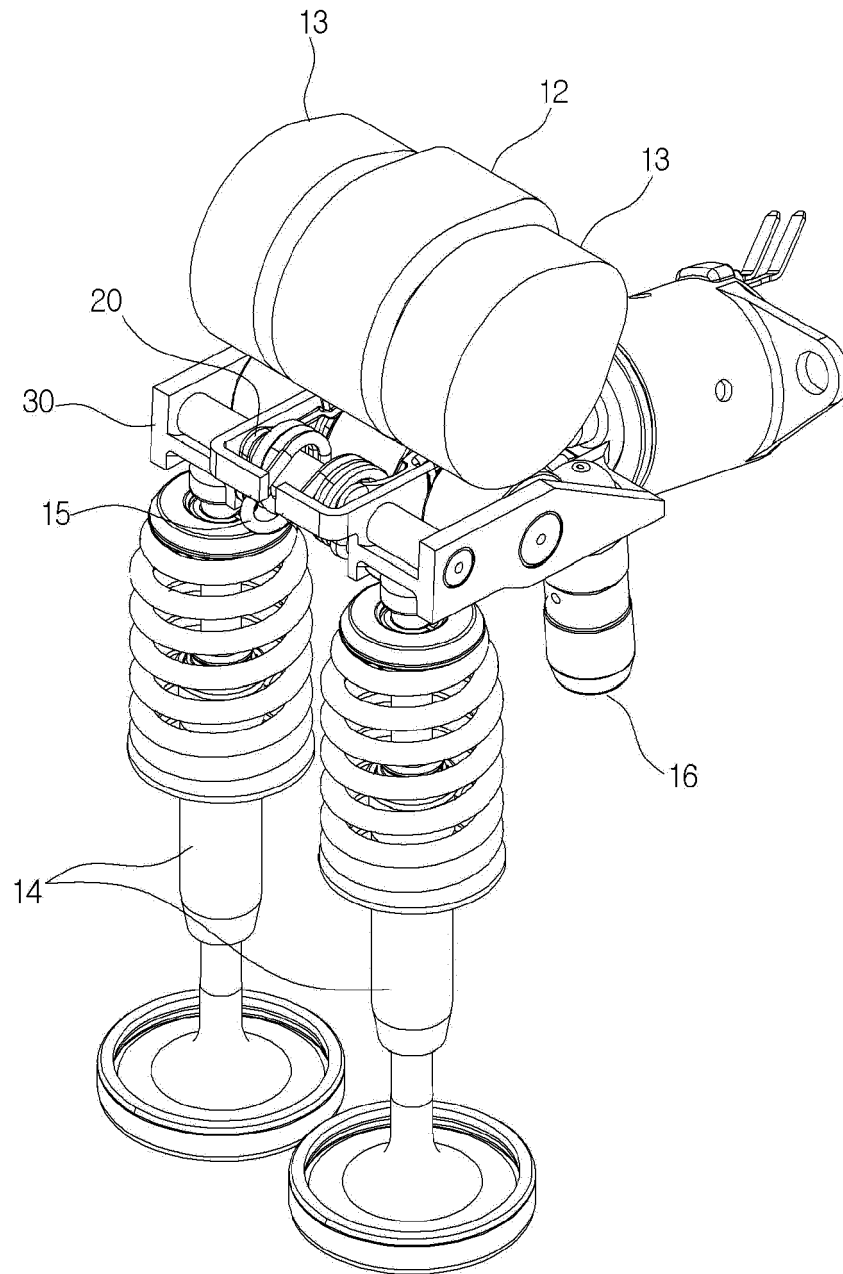


FIG. 7

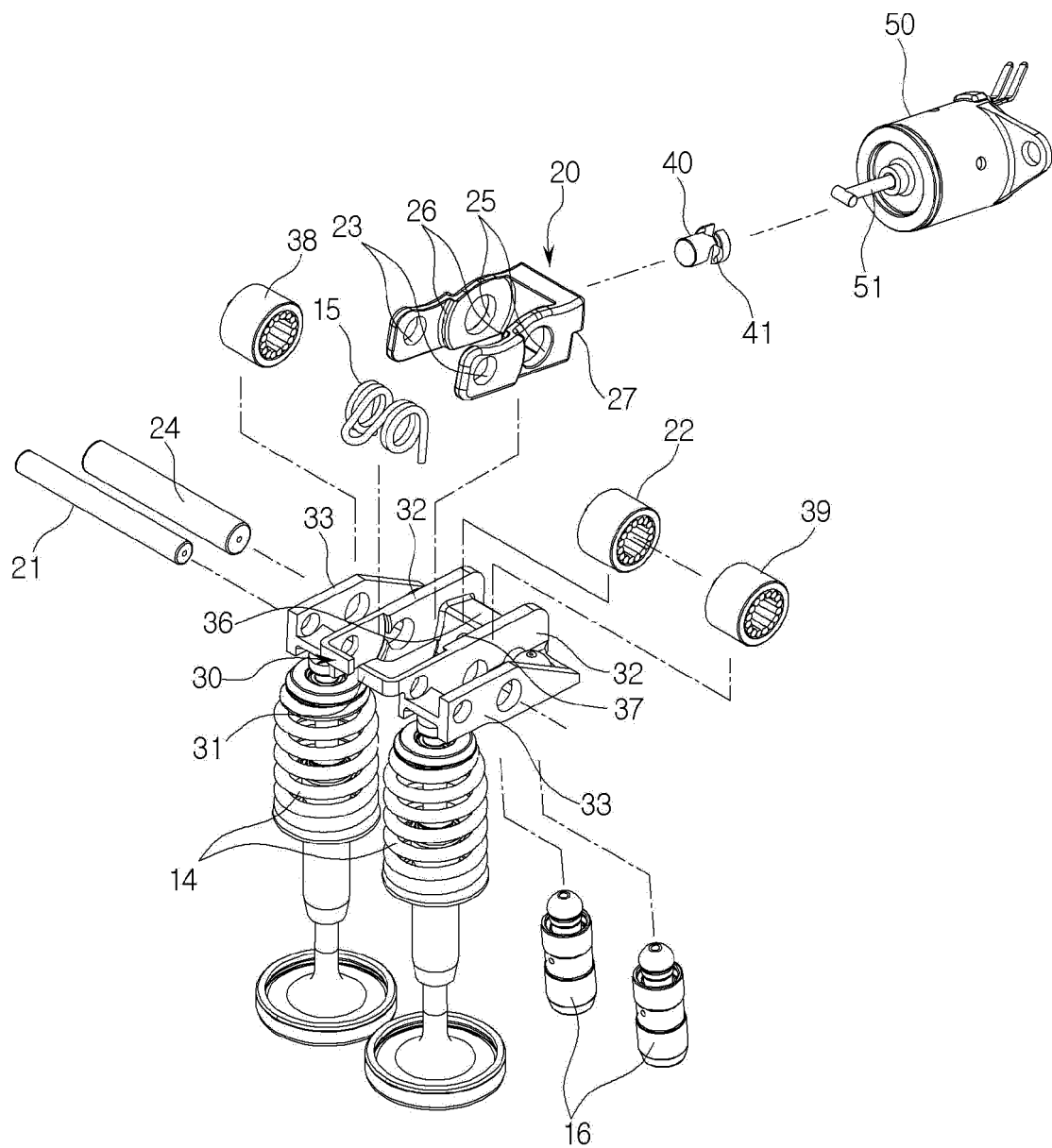


FIG. 8

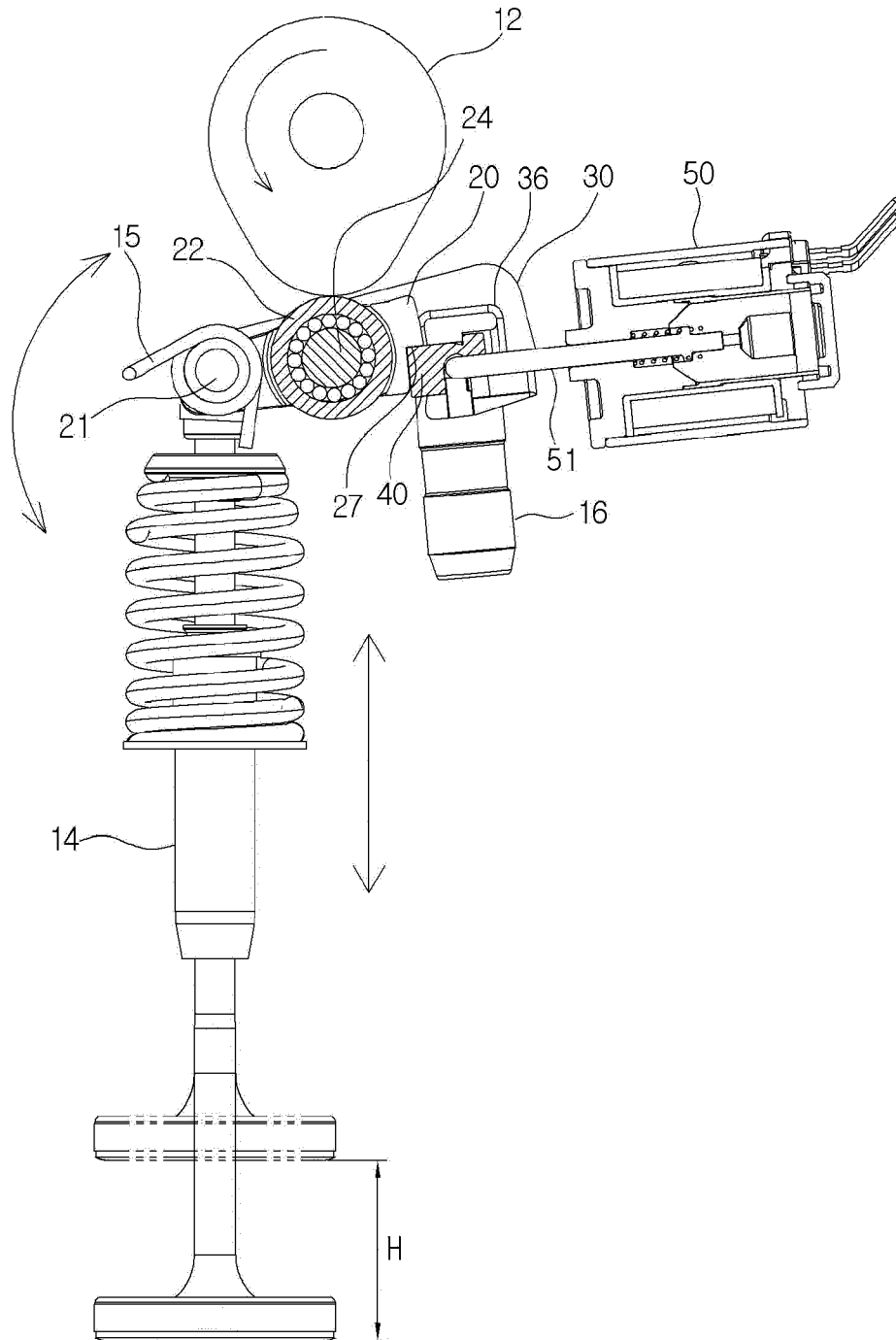


FIG. 9

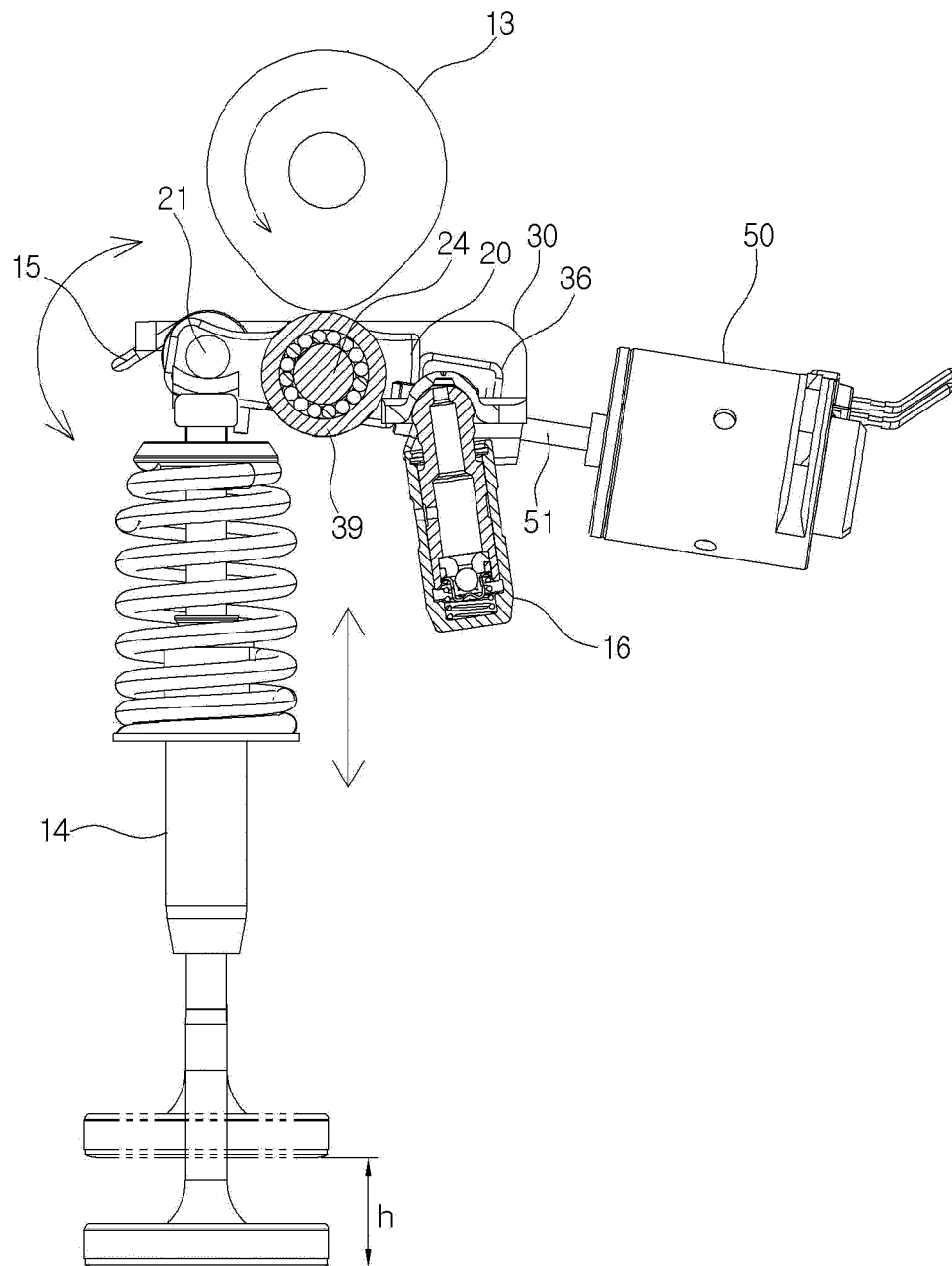
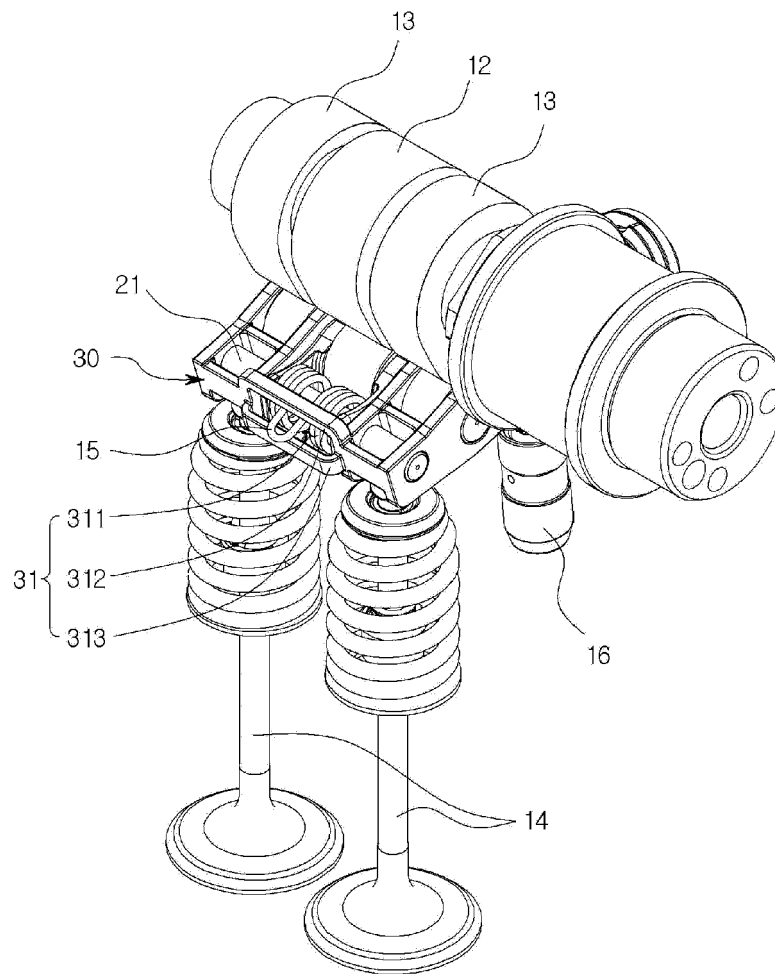


FIG. 10





EUROPEAN SEARCH REPORT

Application Number
EP 16 16 3100

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DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 5 544 626 A (DIGGS MATTHEW B [US] ET AL) 13 August 1996 (1996-08-13)	1,2,7-10	INV. F01L13/00 F01L1/26
Y	* the whole document *	1-10	

X	US 2015/128890 A1 (CECUR MAJO [IT]) 14 May 2015 (2015-05-14)	3-6	
	* the whole document *		

X	US 2010/043737 A1 (ELNICK RODNEY K [US] ET AL) 25 February 2010 (2010-02-25)	3	
	* the whole document *		

Y,D	KR 101 465 636 B1 (MOTONIC CORP [KR]; UNIV ULSAN FOUND FOR IND COOP [KR]) 27 November 2014 (2014-11-27)	1-10	
	* the whole document *		

The present search report has been drawn up for all claims			TECHNICAL FIELDS SEARCHED (IPC)
			F01L
Place of search		Date of completion of the search	Examiner
The Hague		26 January 2017	Klinger, Thierry
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 16 16 3100

5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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26-01-2017

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5544626 A	13-08-1996	NONE	
US 2015128890 A1	14-05-2015	CN 104395564 A EP 2653673 A1 EP 2839123 A1 US 2015128890 A1 US 2017002698 A1 WO 2013156610 A1	04-03-2015 23-10-2013 25-02-2015 14-05-2015 05-01-2017 24-10-2013
US 2010043737 A1	25-02-2010	CN 101660434 A DE 102009038249 A1 US 2010043737 A1	03-03-2010 08-04-2010 25-02-2010
KR 101465636 B1	27-11-2014	NONE	

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- KR 101084739 [0007]
- KR 101084741 [0007]
- KR 1020120088363 [0007] [0011]
- KR 101465635 [0011]