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(54) **Fuel injection system with an apparatus for removing air from fuel**

Kraftstoffeinspritzsystem mit einer Vorrichtung zum Entlüften von Kraftstoff

Système d'injection de carburant avec dispositif pour extraction d'air du carburant

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Description

[0001] The present invention relates to an accumulation type fuel injection system having a pressure reducing valve disposed in a common rail that accumulates high-pressure fuel and distributes the high-pressure fuel to fuel injection valves mounted in respective cylinders of an internal combustion engine, wherein the pressure reducing valve quickly reduces common rail pressure corresponding to fuel injection pressure.

[0002] A fuel injection system of a multi-cylinder diesel engine, an accumulation type fuel injection system having a common rail, a plurality of fuel injection valves, or injectors, and an intake-controlling type fuel supply pump is disclosed in Japanese Patent Laid-Open Publications No. 10-131820, No. 2000-282929, No. 2001-82230, and in US 6 058 912 A1 for instance. The common rail accumulates fuel at a high pressure corresponding to a fuel injection pressure. The fuel injection valve injects the high-pressure fuel accumulated in the common rail into each cylinder of an internal combustion engine. The fuel supply pump pressurizes the fuel drawn from a fuel tank into a pressurizing chamber and pressure-feeds the high-pressure fuel to the common rail.

[0003] In the accumulation type fuel injection system, generally, an intake control valve for increasing the common rail pressure is disposed in the fuel supply pump. The intake control valve regulates an opening degree of a fuel supply passage connecting the fuel tank with the pressurizing chamber. Thus, the intake control valve changes the quantity of the fuel discharged by the fuel supply pump so that the common rail pressure is quickly increased, for instance, during an accelerating operation. On the other hand, a pressure reducing valve for reducing the common rail pressure is disposed in the end of the common rail. The pressure reducing valve opens a fuel discharging passage connecting the common rail with the fuel tank to decrease the common rail pressure quickly, for instance, during a decelerating operation.

[0004] A high-pressure fuel passage leading from the pump chamber or the pressurizing chamber of the fuel supply pump to the fuel chambers of injectors through the common rail is filled with the high-pressure fuel during the normal operation of the engine by the fuel supply pump. However, after the engine is stopped, the fuel pressure in the high-pressure fuel passage, or the common rail pressure, gradually decreases. If the vehicle is left for a long time after the engine is stopped, air may enter the pump chamber or the pressurizing chamber of the fuel supply pump from the fuel tank and the like. Moreover, low-boiling elements in the fuel may be gasified and vaporized, and may be trapped in the high-pressure fuel passage as the fuel pressure decreases.

[0005] A part of the air and the vapor is drawn from the pump chamber to the pressurizing chamber of the fuel supply pump and is pressure-fed from the fuel supply pump to the fuel chamber of the injector through the common rail, during the engine starting operation or the idling

operation immediately following the engine starting operation. If the nozzle needle of the injector opens at predetermined injection timing, the fuel including the air and the like is injected into the cylinder of the engine. As a result, accuracy in the injection quantity control is lowered, causing problems such as abnormality in the engine start and fluctuation in an idling rotation speed (rough idling).

[0006] It is therefore an object of the present invention to provide an accumulation type fuel injection system capable of stabilizing fuel injection quantity control during an engine starting operation or an idling operation immediately following the engine starting operation by reducing quantity of air delivered from a pressurizing chamber of a fuel supply pump into a fuel injection valve through a common rail during the engine starting operation or the idling operation immediately following the engine starting operation.

[0007] According to an aspect of the present invention, a pressure reducing part is operated during an engine starting operation or an idling operation immediately following the engine starting operation, because high pressure is not required in fuel in a common rail. Thus, the high-pressure fuel in a high-pressure fuel passage leading from a pressurizing chamber of the fuel supply pump to fuel injection valves through the common rail is discharged into a fuel tank. Therefore, the air and the like, which enters the fuel supply pump while a vehicle is left for a long time after the engine is stopped, are discharged from the high-pressure fuel passage at that time. Accordingly, the quantity of the air delivered to the fuel chamber of the fuel injection valve is minimized. In addition, the high-pressure fuel passage is filled with the high-pressure fuel in the following engine starting operation or the idling operation immediately following the engine starting operation. Therefore, the fuel including the air and the like is not injected into cylinders of the engine even if the fuel injection valve is opened at predetermined injection timing. As a result, the injection quantity control during the engine starting operation and the idling operation immediately following the engine starting operation is stabilized.

[0008] Features and advantages of embodiments will be appreciated, as well as methods of operation and the function of the related parts, from a study of the following detailed description, the appended claims, and the drawings, all of which form a part of this application. In the drawings:

FIG. 1 is a schematic diagram showing an entire construction of a common rail type fuel injection system according to a first embodiment of the present invention;

FIG. 2 is a flowchart showing a driving method of a pressure reducing valve according to the first embodiment of the present invention;

FIG. 3 (a) is a graph showing a transition of driving duty ratio R_D to the pressure reducing valve with re-

spect to temperature difference between cooling water temperature THW and pump fuel temperature THF;

FIG. 3 (b) is a graph showing a transition of a driving period K of the pressure reducing valve with respect to temperature difference between the cooling water temperature THW and the pump fuel temperature THF, according to the first embodiment of the present invention; and

FIG. 4 is a flowchart showing a driving method of a pressure reducing valve according to a second embodiment of the present invention.

(First Embodiment)

[0009] The first embodiment of the present invention will be explained based on FIGS. 1 to 3.

[0010] An accumulation type fuel injection system shown in FIG. 1 is a common rail type fuel injection system known as a fuel injection system of an internal combustion engine such as a multi-cylinder diesel engine. The common rail type fuel injection system accumulates high-pressure fuel in a common rail 1 and injects the fuel into respective cylinders of the engine at predetermined timing from a plurality of (four, in the embodiment) injectors 2 branching from the common rail 1. The common rail 1 is required to continuously accumulate the fuel at a high pressure corresponding to a fuel injection pressure. Therefore, the high-pressure fuel is pressure-fed from a fuel supply pump 3 to the common rail 1 through a high-pressure fuel passage 11, a high-pressure pipe.

[0011] The quantity of the fuel pressure-fed by the fuel supply pump 3, or the pump discharging quantity, is controlled by an engine control unit (ECU) 10, so that the fuel pressure in a high-pressure fuel passage leading from a pressurizing chamber of the fuel supply pump 3 to fuel chambers of the injectors 2 through the common rail 1 becomes an optimum value in accordance with operating state or condition of the engine. More specifically, in order to continuously accumulate the fuel at the high pressure corresponding to the fuel injection pressure in the common rail 1, a valve opening degree of an electromagnetic intake control valve 7 for controlling the quantity of the fuel drawn into the fuel supply pump 3 is regulated. Thus, the intake control valve 7 is feedback-controlled so that the fuel pressure in the common rail 1, or the common rail pressure, generally equals a target fuel pressure, or a target common rail pressure.

[0012] A fuel pressure sensor 25 for detecting the common rail pressure is disposed in the end of the common rail 1 (in the right end in FIG. 1). In the other end of the common rail 1 (in the left end in FIG. 1), a normally-closed type pressure reducing valve 6 is disposed. The pressure reducing valve 6 opens and closes a fuel recirculating passage 13 leading from the common rail 1 to fuel a recirculating passage 15 and a fuel recirculating passage 16 connected with a fuel tank 5. The fuel recirculating passages 13, 15, 16 are low-pressure pipes. The fuel

tank 5 is included in a low-pressure part of the fuel system.

[0013] The pressure reducing valve 6 is an electromagnetic valve that is electronically controlled by a pressure reducing valve driving signal from the ECU 10 and quickly reduces the common rail pressure during a decelerating operation or when the engine is stopped, for instance. The pressure reducing valve 6 may be an electromagnetic flow control valve that changes its valve opening degree to control the quantity of the fuel recirculated to the low-pressure part of the fuel system, or may be an electromagnetic opening and closing valve that opens when it is energized and closes when the energization is stopped.

[0014] In a case in which the pressure reducing valve 6 is the electromagnetic flow control valve, the pressure reducing valve 6 is constructed with a valve member for regulating the opening degree of the fuel recirculating passage 13 for recirculating the fuel from the common rail 1 to the fuel tank 5, an electromagnetic actuator such as a linear solenoid for biasing the valve member in an opening direction, a valve biasing member such as a spring for biasing the valve member in a closing direction, and the like.

[0015] The injectors 2 are connected to downstream ends of a plurality of high-pressure passages 12 branching from the common rail 1. The injector 2 is an electromagnetic fuel injection valve having a nozzle for injecting fuel into each cylinder of the engine, a nozzle holder connected with the nozzle above the nozzle in FIG. 1, an electromagnetic actuator, or an injection controlling electromagnetic valve 4 for driving a nozzle needle disposed in the nozzle in an opening direction, and a biasing means such as a spring for biasing the nozzle needle in a closing direction.

[0016] A fuel supply passage is formed in the nozzle holder for supplying the high-pressure fuel from the connecting part connected with the downstream end of each high-pressure passage 12 to the fuel chamber formed around a seat part of the nozzle needle in the nozzle. Another fuel supply passage is also formed in the nozzle holder for supplying the high-pressure fuel through an orifice and the like from the connecting part to a back pressure controlling chamber for controlling the back pressure of a command piston connected with the nozzle needle.

[0017] The fuel injection from the injector 2 into the combustion chamber of each cylinder of the engine is electronically controlled by turning on and off of the energization to the injection controlling electromagnetic valve 4 that controls the fuel pressure in the back pressure controlling chamber. More specifically, during the injection controlling electromagnetic valve 4 is open, the high-pressure fuel accumulated in the common rail 1 is injected to the combustion chamber of each cylinder of the engine. Leak fuel overflowing from each injector 2 to the low-pressure part of the fuel system and return fuel discharged from the back pressure controlling chamber

is returned to the fuel tank 5 through the fuel recirculating passages 15, 16.

[0018] The fuel supply pump 3 has a commonly known low-pressure feed pump, cams, a plurality of plungers, a plurality of pressurizing chambers, or plunger chambers, a plurality of fuel intake passages, the high-pressure pipes 11 connected with the pressurizing chambers, and a plurality of fuel pressure-feed passages. The feed pump draws low-pressure fuel from the fuel tank 5 through a fuel filter 9 by rotation of a pump driving shaft rotating with a crankshaft of the engine. The cams are rotated by the pump driving shaft. The plunger is driven to reciprocate between a top dead center and a bottom dead center by the cam. The pressure chamber pressurizes the low-pressure fuel drawn by the reciprocating movement of the plunger in each cylinder. The low-pressure fuel is drawn into the pressurizing chambers from the feed pump through the fuel intake passages. The fuel supply pump 3 pressurizes the low-pressure fuel drawn into the pressurizing chambers. The fuel pressure-feed passage is used for pressure-feeding the high-pressure fuel from the pressurizing chamber into the common rail 1 through a discharging outlet and the high-pressure pipe 11.

[0019] The fuel intake passages respectively have intake check valves for preventing the back flow. The fuel pressure-feed passages respectively have high-pressure check valves. The high-pressure check valve opens when the fuel pressure in the pressurizing chamber increases above a predetermined pressure. The fuel supply pump 3 has a leak port to prevent the increase of the fuel temperature in the fuel supply pump 3. The leak fuel, or the return fuel from the fuel supply pump 3 is returned to the fuel tank 5 through the fuel recirculating passages 14, 16.

[0020] The intake control valve 7 is disposed in a fuel passage connecting the outlet part of the feed pump with the fuel intake passages of the fuel supply pump 3, or is disposed in the fuel intake passages for delivering the fuel from the feed pump to the pressurizing chambers of the fuel supply pump 3. The intake control valve 7 changes the pump discharging quantity by regulating the valve opening degree of the fuel passage connecting the outlet part of the feed pump with the fuel intake passages of the fuel supply pump 3 or by regulating the opening degree of the fuel intake passages.

[0021] The intake control valve 7 is an electromagnetic flow control valve for controlling the quantity of the fuel drawn from the feed pump into the pressurizing chamber of the fuel supply pump 3. The intake control valve 7 has a valve member for regulating the opening degree of the fuel passage or the fuel intake passage, an electromagnetic actuator such as a solenoid coil for driving the valve in an opening direction, a valve biasing means such as a spring for biasing the valve in a closing direction, and the like.

[0022] The intake control valve 7 is electronically controlled by a pump driving signal from the ECU 10. The

intake control valve 7 regulates the quantity of the fuel drawn into the pressurizing chamber of the fuel supply pump 3 in proportion to the intensity of pump driving current applied to the solenoid coil through a pump driving circuit, for instance. Thus, the intake control valve 7 changes the pump discharging quantity and controls the common rail pressure. The intake control valve 7 is driven in a direction to increase the pump discharging quantity, or in a direction to increase the valve opening degree, as the pump driving signal from the ECU 10, or the pump driving current provided from the ECU 10 through the pump driving circuit, increases.

[0023] The ECU 10 has a commonly constructed microcomputer. The microcomputer has functions of a CPU for performing control processing and calculation processing, a storage unit such as a ROM or an EEPROM, a RAM or a back-up RAM for storing various programs and data, an input circuit, an output circuit, a power source circuit, the pump driving circuit and the like. The ECU 10 is connected with a starter energization circuit for energizing a starter for starting the engine. If an engine key is inserted into a key cylinder and is rotated to a position "ST", a starter switch is switched on and the ECU 10 switches on a starter relay of the starter energization circuit (STA-ON). Thus, the engine is cranked and is started.

[0024] When the engine key is inserted into the key cylinder and is rotated to a position "IG", an ignition switch is turned on (IG-ON). Then, the ECU 10 electronically controls actuators of various controlling parts such as the intake control valve 7, the injection controlling electromagnetic valve 4, the pressure reducing valve 6 and the starter relay, based on a control program stored in the storage unit. If the ignition switch is turned off (IG-OFF), the above processing by the ECU 10 based on the control program stored in the storage unit is forced to end.

[0025] Sensor signals outputted from the various sensors are inputted to the microcomputer housed in the ECU 10 after the signals are converted from analog signals to digital signals by an A/D converter. The microcomputer is connected with operating condition detecting means for detecting the operating condition or operating state of the engine, such as a rotation speed sensor 21 for detecting engine rotation speed NE, an accelerator position sensor 22 for detecting an accelerator position, a cooling water temperature sensor 23 for detecting cooling water temperature THW of cooling water of the engine, a fuel temperature sensor 24 for detecting the pump fuel temperature THF of the fuel drawn into the fuel supply pump 3, an ambient air detecting sensor for detecting temperature of air outside the vehicle compartment or ambient air temperature, and a fuel pressure sensor 25 for detecting the common rail pressure.

[0026] The ECU 10 has an injection quantity and timing controlling means for controlling the quantity and timing of the fuel injection by the injectors 2 of each cylinder. The injection quantity and timing controlling means has an injection quantity and timing calculating means, an

injection pulse width calculating means and an injector driving means. The injection quantity and timing calculating means calculates optimum command injection timing and command injection quantity, or command injection period, in accordance with the operating condition or state of the engine. The injection pulse width calculating means calculates an injector injection pulse having an injector injection pulse period, or the injection pulse width. The injector injection pulse period is an energizing period to the injection controlling electromagnetic valve 4 of the injector 2. The energizing period is determined in accordance with the operating condition of the engine and the command injection quantity. The injector driving means applies the injector injection pulse to the injection controlling electromagnetic valve 4 through an injector driving circuit 19.

[0027] The ECU 10 calculates the command injection quantity, the target injection quantity, based on information on the operating condition of the engine, such as the engine rotation speed NE and the accelerator position. The ECU 10 calculates the command injection timing based on the engine rotation speed NE and the command injection quantity. The ECU 10 calculates the injection pulse width based on the common rail pressure and the command injection quantity. The ECU 10 applies the injection controlling electromagnetic valve 4 with the injector injection pulse corresponding to the injection pulse width at the command injection timing. Thus, the engine is operated.

[0028] The ECU 10 has a pump discharging quantity controlling means that calculates the optimum common rail pressure in accordance with the operating condition of the engine and drives the intake control valve 7. The ECU 10 calculates the target common rail pressure based on information on the operating condition or state of the engine such as the engine rotation speed NE and the command injection quantity. The ECU 10 regulates the pump driving signal to the intake control valve 7 in order to attain the target common rail pressure. Thus, the ECU 10 controls the pump discharging quantity and the common rail pressure.

[0029] More preferably, aiming to improve the fuel injection accuracy, the pump driving signal to the intake control valve 7 should be feedback-controlled so that the actual common rail pressure generally equals the target common rail pressure. Thus, actual injection quantity is prevented from decreasing below the target injection quantity. Preferably, the driving signal to the intake control valve 7 should be controlled in a duty cycle control. A precise digital control is achieved by employing the duty cycle control in which the valve opening degree of the intake control valve 7 is changed by regulating the on-off ratio of the pump driving signal per unit time, the energization period ratio, the duty ratio, in accordance with the pressure difference between the common rail pressure and the target common rail pressure. As a result, the optimum injection quantity control corresponding to the operating condition of the engine is achieved.

[0030] The ECU 10 outputs the pressure reducing valve driving signal to open the pressure reducing valve 6 when the engine is decelerated or is stopped. The quantity of the air entering the pump chamber of the fuel supply pump 3 increases as the engine stopping period since the engine is stopped until the engine is started is extended. The cooling water temperature THW and the pump fuel temperature THF respectively decrease as the engine stopping period is extended.

[0031] The ECU 10 includes a pressure reducing valve controlling means for controlling the valve opening degree, the valve opening period ratio or the valve opening period of the pressure reducing valve 6 in accordance with at least one of the cooling water temperature THW or the pump fuel temperature THF detected when the engine is started.

[0032] An air quantity estimating means included in the pressure reducing valve controlling means estimates the quantity of the air entering the fuel supply pump 3 during the engine stopping period, in accordance with at least one of the cooling water temperature THW or the pump fuel temperature THF detected when the engine is started. The pressure reducing valve controlling means calculates the optimum valve opening degree, the valve opening period ratio or the valve opening period in accordance with the estimated air quantity. Then, the pressure reducing valve controlling means outputs the pressure reducing valve driving signal corresponding to the calculated opening degree, the opening period ratio or the opening period to the pressure reducing valve 6.

[0033] Preferably, the driving signal to the pressure reducing valve 6 should be controlled in a duty cycle control. A precise digital control is achieved by employing the duty cycle control in which the valve opening degree of the pressure reducing valve 6 is changed by regulating the on-off ratio of the pump driving signal per unit time, or the driving duty ratio R_D , in accordance with the cooling water temperature THW or the fuel temperature THF detected when the engine is started.

[0034] Next, an operating method of the pressure reducing valve 6 according to the first embodiment will be explained based on FIGS. 1 to 3.

[0035] The flowchart shown in FIG. 2 is carried out when a driver of a vehicle shows intention to start the engine. The flowchart in FIG. 2 is started if the vehicle driver inserts the engine key into the key cylinder and rotates it to the "IG" position. Other than that, the flowchart in FIG. 2 may be started when the vehicle driver unlocks a door lock of the vehicle, when the vehicle driver opens the driver seat side door to get in the vehicle, when the vehicle driver closes the driver seat side door after the driver gets in the vehicle, or when the vehicle driver inserts the engine key into the key cylinder.

[0036] When the flowchart in FIG. 2 starts, it is determined whether the ignition switch is turned on (IG-ON) or not in step S1. If the result of the determination in step S1 is "NO", the operation proceeds to processing in step S11, and after that, the flowchart in FIG. 2 is ended. If

the result of the determination in step S1 is "YES", a timer counter C responsible for valve opening period of the pressure reducing valve 6 is reset to 0 in step S2. Next, sensor signals are inputted from various sensors such as the rotation speed sensor 21, the accelerator position sensor 22, the cooling water temperature sensor 23, the fuel temperature sensor 24, the ambient air temperature sensor and the fuel pressure sensor 25. Next, it is determined whether the cooling water temperature THW is lower than a predetermined temperature T_1 and the pump fuel temperature THF is lower than a predetermined temperature T_2 in step S3. The cooling water temperature THW is detected by the cooling water temperature sensor 23 and the pump fuel temperature THF is detected by the fuel temperature sensor 24 respectively during the engine starting operation. If the result of the determination in step S3 is "NO", the operation proceeds to the processing in step S11, and after that, the flowchart in FIG. 2 is ended.

[0037] If the result of the determination in step S3 is "YES", the air quantity Q_A of the air, which enters the fuel supply pump 3 during the engine stopping period, is estimated, and the driving duty ratio R_D to the pressure reducing valve 6 and a driving period K, which corresponds to the opening period, of the pressure reducing valve 6 are calculated in accordance with the estimated air quantity Q_A in step S4. The ECU 10, or the air quantity estimating means, estimates the air quantity Q_A in accordance with the temperature difference between the cooling water temperature THW and the pump fuel temperature THF detected during the engine starting operation or the idling operation immediately following the engine starting operation. More specifically, the air quantity Q_A is estimated to be larger as the temperature difference $|THW-THF|$ becomes smaller as shown in FIG. 3 (a). It is because the temperature difference $|THW-THF|$ becomes smaller as the engine stopping period is extended. Then, the ECU 10, the pressure reducing valve controlling means, calculates the driving duty ratio R_D corresponding to the valve opening degree in accordance with the temperature difference $|THW-THF|$, or the air quantity Q_A . As shown in FIG. 3 (a), the driving duty ratio R_D is set larger as the temperature difference $|THW-THF|$ becomes smaller. Meanwhile, the ECU 10 calculates the valve driving period K in accordance with the temperature difference $|THW-THF|$, or the air quantity Q_A . As shown in FIG. 3 (b), the driving period K is set larger as the temperature difference $|THW-THF|$ becomes smaller, like the driving duty ratio R_D .

[0038] Next, it is determined whether the engine is in a starting operation or not. More specifically, it is determined whether the vehicle driver has turned the engine key from the "IG" position to the "ST" position and the starter switch has been turned on, and the starter relay of the starter energization circuit has been turned on (STA-ON) in step S5. If the result of the determination is "NO", the operation proceeds to the processing in step S11, and after that, the flowchart in FIG. 2 is ended.

[0039] If the result of the determination in step S5 is "YES", it is determined whether the engine rotation speed NE is lower than the idling rotation speed M or not in step S6. If the result of the determination is "NO", the operation proceeds to the processing in step S11, and after that, the flowchart in FIG. 2 is ended.

[0040] If the result of the determination in step S6 is "YES", it is determined whether the timer counter C is lower than the driving period K of the pressure reducing valve 6 or not. More specifically, it is determined whether the elapsed time since the operation of the pressure reducing valve 6 is started is shorter than the driving period K or not in step S7. If the result of the determination is "NO", the driving duty ratio R_D to the pressure reducing valve 6 is nullified, that is, the driving current supply to the pressure reducing valve 6 is stopped, and the pressure reducing valve 6 is closed in step S11. After that, the flowchart in FIG. 2 is ended.

[0041] If the result of the determination in step S7 is "YES", the driving duty ratio R_D calculated in step S4 is commanded in step S8. Next, the driving duty ratio R_D commanded in step S8 is outputted to the pressure reducing valve 6 in step S9. Next, the timer counter C is counted up ($C=C+1$). After that, the operation returns to the processing in step S5.

[0042] Next, function of the common rail type fuel injection system according to the embodiment will be explained based on FIGS. 1 to 3.

[0043] During the engine starting operation or the idling operation immediately following the engine starting operation, the pressure reducing valve 6 is opened by an optimum opening degree corresponding to the difference between the cooling water temperature THW and the fuel temperature THF. Until the driving period K passes after the pressure reducing valve 6 is opened, the fuel possibly including the air in early phase of pressure-feed is discharged from the pressure reducing valve 6 and is returned to the fuel tank 5 through the fuel recirculating passages 13, 15, 16.

[0044] As explained above, in the common rail type fuel injection system according to the embodiment, the target common rail pressure is low during the engine starting operation. Therefore, the fuel injection accuracy is not lowered even if the common rail pressure is lowered then. Therefore, the pressure reducing valve 6 is opened until the driving period K set in step S4 in the flowchart in FIG. 2 passes when the engine is started, or when the starter relay is switched on and the engine rotation speed NE is under the idling rotation speed M, that is, during the cranking operation of the engine. Thus, the fuel in the common rail 1 is discharged from the pressure reducing valve 6 into the fuel tank 5 through the fuel recirculating passages 13, 15, 16.

[0045] Thus, the air and the like entering the fuel supply pump 3 are discharged from the high-pressure fuel passage when the engine is started. As a result, the quantity of the air delivered to the fuel chamber of the injector 2 from the pressurizing chamber of the fuel supply pump

3 through the common rail 1 is minimized.

[0046] In the following engine starting operation, the high-pressure fuel passage is filled with the high-pressure fuel. Therefore, even if the nozzle needle of the injector 2 is opened at the predetermined timing, the fuel including the air is not injected into the combustion chamber of each cylinder of the engine. Accordingly, the control of the fuel injection quantity during the engine starting operation and the idling operation immediately following the engine starting operation is stabilized. As a result, the starting performance of the engine is improved and the idling rotation speed is stabilized.

(Second Embodiment)

[0047] A driving method of the pressure reducing valve according to the second embodiment of the present invention is explained based on FIG. 4.

[0048] If the routine in FIG. 4 is started, it is determined whether the ignition switch is switched on (IG-ON) or not in step S21. If the result of the determination in step S21 is "NO", the operation proceeds to processing in step S31, and after that, the flowchart in FIG. 4 is ended. If the result of the determination in step S21 is "YES", a timer counter C responsible for the valve opening period of the pressure reducing valve 6 is reset to zero in step S22. Next, like the first embodiment, sensor signals are inputted from the various sensors, and it is determined whether the cooling water temperature THW is lower than the predetermined temperature T_1 and the pump fuel temperature THF is lower than the predetermined temperature T_2 in step S23. If the result of the determination is "NO", the operation proceeds to the processing of step S31, and after that, the flowchart in FIG. 4 is ended.

[0049] If the result of the determination in step S23 is "YES", the air quantity Q_A is estimated in accordance with the temperature difference $|THW-THF|$ and the driving duty ratio R_D to the pressure reducing valve 6 and the driving period K of the pressure reducing valve 6 are calculated in accordance with the air quantity Q_A in step S24, like the first embodiment. Next, it is determined whether the engine has been just started or not. More specifically, it is determined whether the starter switch is switched from ON to OFF and the starter relay of the starter energization circuit for controlling the energization to the starter is switched from ON (STA-ON) to OFF (STA-OFF) in step S25. If the result of the determination is "NO", the operation proceeds to the processing of step S31, and after that, the flowchart in FIG. 4 is ended.

[0050] If the result of the determination of step S25 is "YES", a flag "STA-ON→OFF" is raised. Next, it is determined whether the engine is in the idling operation immediately following the engine starting operation or not. More specifically, it is determined whether the engine rotation speed NE detected by the rotation speed sensor 21 is lower than the idling rotation speed M or not in step S26. If the result of the determination is "NO", the operation proceeds to the processing in step S31, and after

that, the flowchart in FIG. 4 is ended. If the result of the determination in step S26 is "YES", the following steps S27 to S31 are the same as steps S7 to S11 of the flowchart in FIG. 2 according to the first embodiment.

[0051] As explained above, in the common rail type fuel injection system according to the second embodiment, the pressure reducing valve 6 is opened until the driving period K passes during the idling operation immediately following the engine starting operation. Therefore, the fuel in the common rail 1 is discharged from the pressure reducing valve 6 to the fuel tank 5 through the fuel recirculating passages 13, 15, 16. Thus, the air and the like entering the fuel supply pump 3 are fully discharged during the idling operation immediately following the engine starting operation. As a result, similar effect as in the first embodiment is achieved.

(Modified Example)

[0052] In the embodiments, the normally-closed type pressure reducing valve 6, which fully closes when the energization to its electromagnetic valve is stopped, is opened during the engine starting operation and the idling operation immediately following the engine starting operation. Alternatively, the fuel injection system may be constructed so that a normally-opened type pressure reducing valve, which fully opens when the energization to its electromagnetic valve is stopped, is opened during the engine starting operation and the idling operation immediately following the engine starting operation. The pressure reducing valve 6 may be disposed in the high-pressure fuel passage 11 and the like leading from the plunger chamber, the pressurizing chamber, of the fuel supply pump 3 to the fuel passage in the injector 2 through the common rail 1, other than the common rail 1.

[0053] In the embodiments, the pressure reducing valve 6 is opened during the engine starting operation and the idling operation immediately following the engine starting operation. Alternatively, an injector driving means may be employed for applying an injection-disabling signal, an injector disabling pulse, to the injection controlling electromagnetic valve 4 of the injector 2 during the engine starting operation and the idling operation immediately following the engine starting operation. The injection-disabling signal is weaker than a signal to drive the injection controlling electromagnetic valve 4 to inject the fuel into the cylinder of the engine. Thus, the quantity of the leak fuel flowing into the fuel tank 5 from the control chamber of the injector 2 through the fuel recirculating passages 15, 16 is increased. As a result, similar effect as in the first embodiment is achieved.

[0054] In the embodiments, the intake control valve 7 is disposed for regulating the intake quantity of the fuel drawn into the plunger chamber of the fuel supply pump 3. Alternatively, a discharging quantity controlling type pump electromagnetic valve for regulating the quantity of the fuel discharged from the plunger chamber of the fuel supply pump 3 to the common rail 1 may be applied.

In the embodiments, the normally-closed type intake control valve 7, which fully closes when the energization to its electromagnetic valve is stopped, is used. Alternatively, a normally-opened type pump electromagnetic valve, which fully opens when energization to its electromagnetic valve is stopped, may be applied.

[0055] In the embodiments, the command injection quantity, the command injection timing and the target common rail pressure are calculated based on the engine operating information such as the engine rotation speed NE and the accelerator position. The command injection quantity, the command injection timing and the target common rail pressure may be corrected by adding injection quantity correction, injection timing correction and fuel pressure correction thereto. The injection quantity correction, the injection timing correction and the fuel pressure correction are provided with taking account of the cooling water temperature THW, the fuel temperature THF, or the detection signals from sensors such as a suction air temperature sensor, a suction air pressure sensor, a cylinder determination sensor and an injection timing sensor.

[0056] The actuators of the respective controlling parts such as the intake control valve 7, the injection controlling electromagnetic valve 4, the pressure reducing valve 6, and the starter relay of the starter energization circuit may be electronically controlled based on the control program stored in the storage unit when the engine key is returned to the "IG" position to turn on the ignition switch (IG-ON) after the engine key is inserted into the key cylinder and is rotated to the "ST" position to turn on the starter switch and to crank the engine.

[0057] If a flag for allowing the engine start is raised after step S4 in the flowchart in FIG. 2 and the flag is interlocked with a warning lamp disposed in the front surface of the vehicle compartment, the engine start is facilitated as explained below. If the warning lamp lights when the vehicle driver inserts the engine key into the key cylinder and rotates the key to the "IG" position, the driver determines that the flag for allowing the engine start is OFF and the calculation in step S4 of the flowchart in FIG. 2 is being performed. After that, if the warning lamp is turned out, the vehicle driver determines that the calculation in step S4 of the flowchart in FIG. 2 is finished and the flag for allowing the engine start is ON, and the driver rotates the key from the "IG" position to the "ST" position to operate the starter to crank the engine. Thus, the engine is started surely after the calculation of the driving duty ratio R_D to the pressure reducing valve 6 or the driving period K of the pressure reducing valve 6.

[0058] In the embodiments, the ECU 10 estimates the air quantity Q_A in accordance with the difference between the cooling water temperature THW and the pump fuel temperature THF detected when the engine is started. In the embodiments, the driving duty ratio R_D and the driving period are set larger as the temperature difference $|THW-THF|$ becomes smaller. Alternatively, the ECU 10 may estimate the air quantity Q_A based on the cooling

water temperature THW or the pump fuel temperature THF detected when the engine is started, wherein the driving duty ratio R_D and the driving period are set larger as the cooling water temperature THW or the pump fuel temperature is decreased. It is because the cooling water temperature THW and the pump fuel temperature THF are decreased as the stopping period of the engine is extended.

[0059] The ECU 10, or the air quantity estimating means, estimates the quantity of the air entering the fuel supply pump 3 from the fuel tank 5 and the like during the engine stopping period since the engine is stopped until the engine is started, in accordance with the cooling water temperature THW or the pump intake side fuel temperature THF at the time when the engine is started. The ECU 10 calculates the optimum valve opening degree or the valve opening period ratio in accordance with the quantity of the air entering the fuel supply pump 3, and outputs the pressure reducing valve driving signal corresponding to the calculated opening degree or opening period ratio to the pressure reducing valve 6.

[0060] Alternatively, the ECU 10 may be constructed so that the cooling water temperature THW or the pump fuel temperature THF at the time when the engine is stopped is stored in a temperature storing means, a storage unit such as an EEPROM or a backup RAM, and the air quantity estimating means estimates the air quantity Q_A in accordance with the decrease in the temperature from the cooling water temperature THW or the pump fuel temperature THF, which are detected and stored when the engine is stopped, to the cooling water temperature THW or the pump fuel temperature THF detected when the engine is started. In this case, instead of using the stand-by RAM or the EEPROM, a nonvolatile storage such as an EPROM or a flash storage unit, or other kinds of storage media such as a DVD-ROM, a CD-ROM, or a flexible disc may be applied for storing the cooling water temperature THW and the pump fuel temperature THF detected when the engine is stopped, while the ignition switch is turned off (IG-OFF). In this case, stored contents are also preserved even if the power supply to the ECU from the battery is stopped during IG-OFF. In order to store the cooling water temperature THW and the pump fuel temperature THF at the time when the engine is stopped, the stoppage of the ECU power supply to the ECU 10 has to be delayed until a predetermined period passes.

[0061] The estimation of the air quantity Q_A is affected by the ambient air temperature, including the case in which the air quantity Q_A is estimated in accordance with the temperature decrease from the cooling water temperature THW or the pump fuel temperature THF at the time when the engine is stopped to the cooling water temperature THW or the pump fuel temperature THF at the time when the engine is started. Therefore, the accuracy in estimating the air quantity Q_A may be corrected in accordance with the ambient air temperature.

[0062] In the embodiments, the driving duty ratio R_D

to the pressure reducing valve 6 and the driving period K of the pressure reducing valve 6 are calculated in accordance with the estimated air quantity Q_A . Alternatively, the driving duty ratio R_D to the pressure reducing valve 6 and the driving period K of the pressure reducing valve 6 may be calculated in accordance with air quantity detected by an air quantity sensor disposed for detecting the air quantity of the air entering the high-pressure fuel passage.

[0063] The temperature of injector leak fuel overflowing into the fuel tank 5 from the injector 2 or the temperature of pump overflow fuel overflowing into the fuel tank 5 from the fuel supply pump 3 may be detected by the fuel temperature sensor 24 disposed in one of the fuel recirculating passages 14, 15, 16, instead of detecting the pump fuel temperature THF. Instead of detecting the cooling water temperature THW, the engine temperature such as engine lubricant temperature or engine surface temperature may be detected.

[0064] The present invention should not be limited to the disclosed embodiments, but may be implemented in many other ways without departing from the claims.

Claims

1. An accumulation type fuel injection system, comprising:

a common rail (1) for accumulating fuel at a pressure corresponding to a fuel injection pressure;
a fuel injection valve (2) for injecting the fuel accumulated in the common rail (1) into a cylinder of an engine;

a fuel supply pump (3) that pressurizes the fuel drawn from a fuel tank (5) into a pressurizing chamber thereof and pressure-feeds the fuel to the common rail (1); and

a pressure reducing part (4, 6, 10, 13, 14, 15, 16) for reducing pressure of the fuel in the common rail (1) by discharging into the fuel tank (5) the fuel in a high-pressure fuel passage leading from the pressurizing chamber of the fuel supply pump (3) to the fuel injection valve (2) through the common rail (1) during an engine starting operation or an idling operation immediately following the engine starting operation, wherein the pressure reducing part (4, 6, 10, 13, 14, 15, 16) has a pressure reducing valve (6) for reducing the pressure of the fuel in the common rail (1) and fuel recirculating passages (13, 15, 16) for recirculating the fuel in the common rail (1) to the fuel tank (5), and

wherein the pressure reducing valve (6) opens during the engine starting operation or the idling operation immediately following the engine starting operation to discharge the fuel in the common rail (1) into the fuel recirculating pas-

sage (13, 15, 16), **characterised by**

an air quantity estimating means (10, 23, 24) for estimating quantity of air entering the high-pressure fuel passage in accordance with an engine stopping period since the engine is stopped until the engine is started; and

pressure reducing valve controlling means (10) that increases valve opening degree or valve opening period ratio of the pressure reducing valve (6) or extends the valve opening period of the pressure reducing valve (6) as the quantity of the air entering the high-pressure fuel passage increases.

2. The accumulation type fuel injection system set forth in claim 1,

wherein the air quantity estimating means (10, 23, 24) has a cooling water temperature detecting means (23) for detecting temperature of cooling water of the engine and a fuel temperature detecting means (24) for detecting temperature of the fuel drawn into the fuel supply pump (3) or temperature of the fuel overflowing from the high-pressure fuel passage into the fuel recirculating passages (13, 14, 15, 16), and

wherein the air quantity estimating means (10) estimates the quantity of the air entering the high-pressure fuel passage in accordance with at least one of the cooling water temperature, which is detected by the cooling water temperature detecting means (23) during the engine starting operation or the idling operation immediately following the engine starting operation, or the fuel temperature, which is detected by the fuel temperature detecting means (24) during the engine starting operation or the idling operation immediately following the engine starting operation, when the engine is started.

3. The accumulation type fuel injection system set forth in claim 1,

wherein the air quantity estimating means (10, 23, 24) has cooling water temperature detecting means (23) for detecting temperature of cooling water of the engine, fuel temperature detecting means for detecting temperature of the fuel drawn into the fuel supply pump (3) or temperature of the fuel overflowing from the high-pressure fuel passage to the fuel recirculating passages (13, 14, 15, 16), temperature storing means for storing the cooling water temperature detected by the cooling water temperature detecting means (23) when the engine is stopped or the fuel temperature detected by the fuel temperature detecting means (24) when the engine is stopped, and temperature decrease measuring means (23, 24) for measuring decrease in temperature from the cooling water temperature or the fuel temperature, which is stored in the temperature storing means (10), at the time when the engine is stopped, to the engine cool-

ing water temperature detected by the cooling water temperature detecting means (23) when the engine is started or the fuel temperature detected by the fuel temperature detecting means (24) when the engine is started, and

wherein the air quantity estimating means (10, 23, 24) estimates the quantity of the air entering the high-pressure fuel passage in accordance with the decrease in the temperature from the cooling water temperature or the fuel temperature at the time when the engine is stopped to the cooling water temperature or the fuel temperature at the time when the engine is started.

4. The accumulation type fuel injection system set forth in claim 2 or 3, wherein the air quantity estimating means (10, 23, 24) has ambient air temperature detecting means for detecting temperature of air outside a vehicle compartment, and wherein the air quantity estimating means corrects temperature difference between the cooling water temperature and the fuel temperature at the time when the engine is started or the temperature decrease from the cooling water temperature or the fuel temperature at the time when the engine is stopped to the cooling water temperature or the fuel temperature at the time when the engine is started, in accordance with the air temperature detected by the ambient air temperature detecting means.
5. The accumulation type fuel injection system set forth in claim 1, wherein the pressure reducing part (4, 6, 10, 13, 14, 15, 16) has an injection controlling electromagnetic valve (4) and a fuel recirculating passage (15) for recirculating leak fuel, which overflows from the fuel injection valve (2), to the fuel tank (5), and wherein the injection controlling electromagnetic valve (4) discharges the fuel in the fuel injection valve (2) into the fuel recirculating passage (15) during the engine starting operation or the idling operation immediately following the engine starting operation.
6. The accumulation type fuel injection system set forth in claim 5, wherein the pressure reducing part (4, 6, 10, 13, 14, 15, 16) has an injection valve driving means (10) for applying an injection-disabling signal to the fuel injection valve (2) during the engine starting operation or the idling operation immediately following the engine starting operation, the injection-disabling signal being weaker than a signal to drive the fuel injection valve (2) to inject the fuel into the cylinder of the engine.
7. The accumulation type fuel injection system set forth in claim 2, wherein the air quantity estimating means (10, 23, 24) estimates the quantity of the air entering

the high-pressure fuel passage in accordance with difference between the cooling water temperature detected by the cooling water temperature detecting means (23) when the engine is started and the fuel temperature detected by the fuel temperature detecting means (24) when the engine is started.

Patentansprüche

1. Speicherkraftstoffeinspritzsystem mit:

einer Sammelleitung (1) zum Speichern von Kraftstoff bei einem Druck, der einem Kraftstoffeinspritzdruck entspricht;
einem Kraftstoffeinspritzventil (2) zum Einspritzen des Kraftstoffs, der in der Sammelleitung (1) gespeichert ist, in einen Zylinder einer Maschine;

einer Kraftstoffzulehrpumpe (3), die den von einem Kraftstofftank (5) angezogenen Kraftstoff in einer Druckbeaufschlagungskammer von sich mit Druck beaufschlagung und den Kraftstoff unter Druck zu der Sammelleitung (1) zuführt; und

einem Druckverringerteil (4, 6, 10, 13, 14, 15, 16) zum Verringern eines Drucks des Kraftstoffs in der Sammelleitung (1) durch ein Abgeben des Kraftstoffs in einem Hochdruckkraftstoffdurchgang, der von der Druckbeaufschlagungskammer der Kraftstoffzulehrpumpe (3) durch die Sammelleitung (1) zu dem Kraftstoffeinspritzventil (2) führt, in den Kraftstofftank (5), während eines Maschinenstartbetriebs oder eines Leerlaufbetriebs, der dem Maschinenstartbetrieb unmittelbar folgt,

wobei der Druckverringerteil (4, 6, 10, 13, 14, 15, 16) ein Druckverringereventil (6) zum Verringern des Drucks des Kraftstoffs in der Sammelleitung (1) und Kraftstoffrezirkulationsdurchgänge (13, 15, 16) zum Rezirkulieren des Kraftstoffs in der Sammelleitung (1) zu dem Kraftstofftank (5) aufweist, und

wobei das Druckverringereventil (6) während des Maschinenstartbetriebs oder des Leerlaufbetriebs, der dem Maschinenstartbetrieb unmittelbar folgt, öffnet, um den Kraftstoff in der Sammelleitung (1) in den Kraftstoffrezirkulationsdurchgang (13, 15, 16) abzugeben,

gekennzeichnet durch

eine Luftmengenschätzeinrichtung (10, 23, 24) zum Schätzen einer Menge von Luft, die in den Hochdruckkraftstoffdurchgang eintritt, in Übereinstimmung mit einer Maschinenanhaltdauer, seit einem Stoppen der Maschine bis zu einem Starten der Maschine; und

eine Druckverringereventil-Steuerungseinrichtung (10), die einen Ventilöffnungsgrad oder

- ein Ventilöffnungsauverhältnis des Druckverringerrungsvertils (6) erhöht oder die Ventilöffnungsduer des Druckverringerrungsvertils (6) verlängert, wenn sich die Menge der Luft erhöht, die in den Hochdruckkraftstoffdurchgang eindringt.
2. Speicherkraftstoffeinspritzsystem nach Anspruch 1, wobei die Luftmengenschätzereinrichtung (10, 23, 24) eine Kühlwassertemperaturerfassungseinrichtung (23) zum Erfassen einer Temperatur eines Kühlwassers der Maschine und eine Kraftstofftemperaturerfassungseinrichtung (24) zum Erfassen einer Temperatur des Kraftstoffs, der in die Kraftstoffzufuhrpumpe (3) gezogen wird, oder einer Temperatur des Kraftstoffs, der von dem Hochdruckkraftstoffdurchgang in die Kraftstoffrezirkulationsdurchgänge (13, 14, 15, 16) überläuft, aufweist, und wobei die Luftmengenschätzereinrichtung (10) die Menge der Luft, die in den Hochdruckkraftstoffdurchgang eintritt, in Übereinstimmung mit wenigstens einer von der Kühlwassertemperatur, die durch die Kühlwassertemperaturerfassungseinrichtung (23) während des Maschinenstartbetriebs oder des Leerlaufbetriebs, der dem Maschinenstartbetrieb unmittelbar folgt, erfasst wird oder der Kraftstofftemperatur schätzt, die durch die Kraftstofftemperaturerfassungseinrichtung (24) während des Maschinenstartbetriebs oder des Leerlaufbetriebs erfasst wird, der dem Maschinenstartbetrieb unmittelbar folgt, wenn die Maschine gestartet ist.
3. Speicherkraftstoffeinspritzsystem nach Anspruch 1, wobei die Luftmengenschätzereinrichtung (10, 23, 24) eine Kühlwassertemperaturerfassungseinrichtung (23) zum Erfassen einer Temperatur von Kühlwasser der Maschine, eine Kraftstofftemperaturerfassungseinrichtung zum Erfassen einer Temperatur des Kraftstoffs, der in die Kraftstoffzufuhrpumpe (3) gezogen wird, oder einer Temperatur des Kraftstoffs, der von dem Hochdruckkraftstoffdurchgang zu den Kraftstoffrezirkulationsdurchgängen (13, 14, 15, 16) überläuft, eine Temperaturspeichereinrichtung zum Speichern der Kühlwassertemperatur, die durch die Kühlwassertemperaturerfassungseinrichtung (23) erfasst wird, wenn die Maschine gestoppt wird, oder der Kraftstofftemperatur, die durch die Kraftstofftemperaturerfassungseinrichtung (24) erfasst wird, wenn die Maschine gestoppt wird, und eine Temperaturverringerrungsmesseinrichtung (23, 24) hat zum Messen einer Temperaturverringerrung von der Kühlwassertemperatur oder der Kraftstofftemperatur, die in der Temperaturspeichereinrichtung (10) gespeichert ist, zu der Zeit, wenn die Maschine gestoppt wird, auf die Maschinenkühlwassertemperatur, die durch die Kühlwassertemperaturerfassungseinrichtung (23) erfasst wird, wenn die Maschine gestartet wird, oder auf die Kraftstofftemperatur, die durch die Kraftstofftemperaturerfassungseinrichtung (24) erfasst wird, wenn die Maschine gestartet wird, und
4. Speicherkraftstoffeinspritzsystem nach Anspruch 2 oder 3, wobei die Luftmengenschätzereinrichtung (10, 23, 24) eine Umgebungslufttemperaturerfassungseinrichtung zum Erfassen einer Temperatur von Luft außerhalb eines Fahrzeugraums aufweist, und wobei die Luftmengenschätzereinrichtung eine Temperaturdifferenz zwischen der Kühlwassertemperatur und der Kraftstofftemperatur zu der Zeit, wenn die Maschine gestartet wird, oder die Temperaturverringerrung von der Kühlwassertemperatur oder der Kraftstofftemperatur zu der Zeit, wenn die Maschine gestoppt wird, auf die Kühlwassertemperatur oder die Kraftstofftemperatur zu der Zeit, wenn die Maschine gestartet wird, in Übereinstimmung mit der Lufttemperatur korrigiert, die durch die Umgebungslufttemperaturerfassungseinrichtung erfasst wird.
5. Speicherkraftstoffeinspritzsystem nach Anspruch 1, wobei der Druckverringerrungsteil (4, 6, 10, 13, 14, 15, 16) ein eine Einspritzung steuerndes, elektromagnetisches Ventil (4) und einen Kraftstoffrezirkulationsdurchgang (15) zum Rezirkulieren von entweichendem Kraftstoff, der von dem Kraftstoffeinspritzventil (2) überläuft, zu dem Kraftstofftank (5) aufweist, und wobei das Einspritzung steuernde, elektromagnetische Ventil (4) den Kraftstoff in dem Kraftstoffeinspritzventil (2) in den Kraftstoffrezirkulationsdurchgang (15) während des Maschinenstartbetriebs oder des Leerlaufbetriebs abgibt, der dem Maschinenstartbetrieb unmittelbar folgt.
6. Speicherkraftstoffeinspritzsystem nach Anspruch 5, wobei der Druckverringerrungsteil (4, 6, 10, 13, 14, 15, 16) eine Einspritzventilantriebseinrichtung (10) zum Aufbringen eines Einspritzungsunterbrechungssignals auf das Kraftstoffeinspritzventil (2) während des Maschinenstartbetriebs oder des Leerlaufbetriebs aufweist, der dem Maschinenstartbetrieb unmittelbar folgt, wobei das Einspritzungsunterbrechungssignal schwächer als ein Signal ist, um das Kraftstoffeinspritzventil (2) anzutreiben, um den Kraftstoff in den Zylinder der Maschine einzuspritzen.

7. Speicherkraftstoffeinspritzsystem nach Anspruch 2, wobei die Luftmengenschätzeinrichtung (10, 23, 24) die Menge der Luft, die in den Hochdruckkraftstoffdurchgang eintritt, in Übereinstimmung mit einer Differenz zwischen der Kühlwassertemperatur, die durch die Kühlwassertemperaturerfassungseinrichtung (23) erfasst wird, wenn die Maschine gestartet wird, und der Kraftstofftemperatur schätzt, die durch die Kraftstofftemperaturerfassungseinrichtung (24) erfasst wird, wenn die Maschine gestartet wird.

Revendications

1. Système d'injection de carburant du type à accumulation, comprenant :
- une rampe commune (1) pour accumuler du carburant à une pression correspondant à une pression d'injection de carburant ;
 - une soupape d'injection (2) de carburant pour injecter, dans un cylindre d'un moteur, le carburant accumulé dans la rampe commune (1) ;
 - une pompe d'alimentation en carburant (3) qui met sous pression le carburant extrait d'un réservoir (5) de carburant et introduit dans une chambre de compression de celle-ci, et envoie le carburant sous pression dans la rampe commune (1) ; et
 - un organe de réduction de pression (4, 6, 10, 13, 14, 15, 16) servant à réduire la pression du carburant dans la rampe commune (1) en refoulant dans le réservoir (5) de carburant le carburant présent dans un passage de carburant à haute pression menant de la chambre de compression de la pompe (3) d'alimentation en carburant à la soupape d'injection (2) de carburant via la rampe commune (1) pendant une opération de démarrage de moteur ou pendant un fonctionnement au ralenti succédant immédiatement à l'opération du démarrage du moteur, dans lequel l'organe de réduction de pression (4, 6, 10, 13, 14, 15, 16) comporte un réducteur de pression (6) servant à réduire la pression du carburant dans la rampe commune (1) et des passages de recirculation (13, 15, 16) de carburant pour faire recirculer le carburant dans la rampe commune (1) jusqu'au réservoir (5) de carburant, et dans lequel le réducteur de pression (6) s'ouvre pendant l'opération de démarrage du moteur ou le fonctionnement au ralenti succédant immédiatement à l'opération de démarrage du moteur pour refouler dans le passage de recirculation (13, 15, 16) de carburant le carburant présent dans la rampe commune (1), **caractérisé par**
 - un moyen d'estimation (10, 23, 24) de quantité d'air servant à estimer la quantité d'air entrant

dans le passage de carburant à haute pression en fonction d'une période d'arrêt du moteur depuis l'arrêt du moteur jusqu'au démarrage du moteur ; et

un moyen de commande (10) de réducteur de pression qui accroit le degré d'ouverture ou le pourcentage de période d'ouverture du réducteur (6) de pression ou qui prolonge la période d'ouverture du réducteur (6) de pression lorsque la quantité de l'air entrant dans le passage de carburant à haute pression augmente.

2. Système d'injection de carburant du type à accumulation selon la revendication 1, dans lequel le moyen d'estimation (10, 23, 24) de quantité d'air comporte un moyen de détection (23) de température d'eau de refroidissement servant à détecter la température de l'eau de refroidissement du moteur, et un moyen de détection (24) de température de carburant servant à détecter la température du carburant entraîné jusqu'à la pompe (3) d'alimentation en carburant ou la température du carburant débordant depuis le passage de carburant à haute pression jusque dans les passages de recirculation (13, 14, 15, 16) de carburant, et dans lequel le moyen d'estimation (10) de quantité d'air estime la quantité d'air entrant dans le passage de carburant à haute pression en fonction de la température de l'eau de refroidissement, qui est détectée par le moyen de détection (23) de température d'eau de refroidissement pendant l'opération de démarrage du moteur ou le fonctionnement au ralenti succédant immédiatement à l'opération de démarrage du moteur, ou en fonction de la température du carburant, qui est détectée par le moyen de détection (24) de température de carburant pendant l'opération de démarrage du moteur ou le fonctionnement au ralenti qui succède immédiatement à l'opération de démarrage du moteur, lorsque le moteur a démarré.
3. Système d'injection de carburant du type à accumulation selon la revendication 1, dans lequel le moyen d'estimation (10, 23, 24) de quantité d'air comporte un moyen de détection (23) de température d'eau de refroidissement servant à détecter la température de l'eau de refroidissement du moteur, un moyen de détection de température de carburant servant à détecter la température du carburant entraîné jusqu'à la pompe (3) d'alimentation en carburant ou la température du carburant débordant depuis le passage de carburant à haute pression vers les passages de recirculation (13, 14, 15, 16) de carburant, un moyen de mémorisation de température pour mémoriser la température de l'eau de refroidissement détectée par le moyen de détection (23) de température d'eau de refroidissement lorsque le moteur est à l'arrêt ou la température du

- carburant détectée par le moyen de détection (24) de température de carburant lorsque le moteur est à l'arrêt, et un moyen de mesure (23, 24) de baisse de température pour mesurer la baisse de température à partir de la température d'eau de refroidissement ou de la température du carburant, qui est mémorisée dans le moyen de mémorisation (10) de température, au moment où le moteur est à l'arrêt, jusqu'à la température d'eau de refroidissement du moteur détectée par le moyen de détection (23) de température d'eau du moteur lorsque le moteur démarre ou la température du carburant détectée par le moyen de détection (24) de température de carburant lorsque le moteur démarre, et dans lequel le moyen d'estimation (10, 23, 24) de quantité d'air estime la quantité d'air entrant dans le passage de carburant à haute pression d'après la baisse de la température à partir de la température d'eau de refroidissement ou de la température du carburant au moment où le moteur s'arrête jusqu'à la température d'eau de refroidissement ou la température du carburant au moment où le moteur démarre.
4. Système d'injection de carburant du type à accumulation selon la revendication 2 ou 3, dans lequel le moyen d'estimation (10, 23, 24) de quantité d'air comporte un moyen de détection de température d'air ambiant pour détecter la température de l'air à l'extérieur d'un compartiment du véhicule, et dans lequel le moyen d'estimation de quantité d'air corrige la différence de température entre la température d'eau de refroidissement et la température du carburant au moment où le moteur démarre ou la baisse de température à partir de la température d'eau de refroidissement ou de la température du carburant au moment où le moteur s'arrête jusqu'à la température d'eau de refroidissement ou la température du carburant au moment où le moteur démarre, en fonction de la température d'air détectée par le moyen de détection de température d'air ambiant.
5. Système d'injection de carburant du type à accumulation selon la revendication 1, dans lequel l'organe de réduction de pression (4, 6, 10, 13, 14, 15, 16) comporte une électrovalve de commande d'injection (4) et un passage de recirculation (15) de carburant pour faire recirculer les fuites de carburant, résultant du débordement depuis la soupape d'injection (2) de carburant, vers le réservoir (5) de carburant, et dans lequel l'électrovalve (4) de commande d'injection refoule le carburant présent dans la soupape d'injection (2) de carburant jusque dans le passage de recirculation (15) de carburant pendant l'opération de démarrage du moteur ou le fonctionnement
- au ralenti succédant immédiatement à l'opération de démarrage du moteur.
6. Système d'injection de carburant du type à accumulation selon la revendication 5, dans lequel l'organe de réduction de pression (4, 6, 10, 13, 14, 15, 16) comporte un moyen d'entraînement (10) de soupape d'injection pour appliquer un signal de neutralisation d'injection à la soupape d'injection (2) de carburant pendant l'opération de démarrage du moteur ou le fonctionnement au ralenti qui succède immédiatement à l'opération de démarrage du moteur, le signal de neutralisation d'injection étant plus faible qu'un signal servant à entraîner la soupape d'injection (2) de carburant pour injecter le carburant dans le cylindre du moteur.
7. Système d'injection de carburant du type à accumulation selon la revendication 2, dans lequel le moyen d'estimation (10, 23, 24) de quantité d'air estime la quantité d'air entrant dans le passage de carburant à haute pression en fonction d'une différence entre la température de l'eau de refroidissement détectée par le moyen de détection (23) de température d'eau de refroidissement lorsque le moteur démarre et la température du carburant détectée par le moyen de détection (24) de température du carburant lorsque le moteur démarre.

FIG. 1

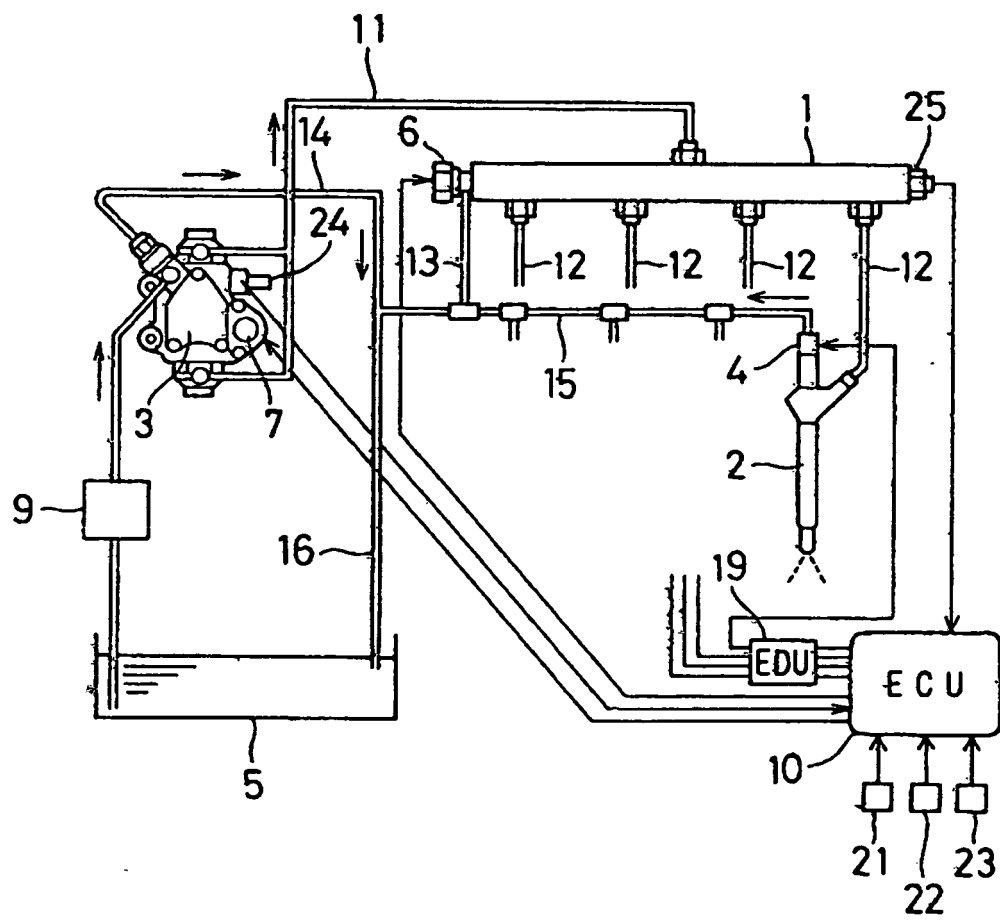


FIG. 2

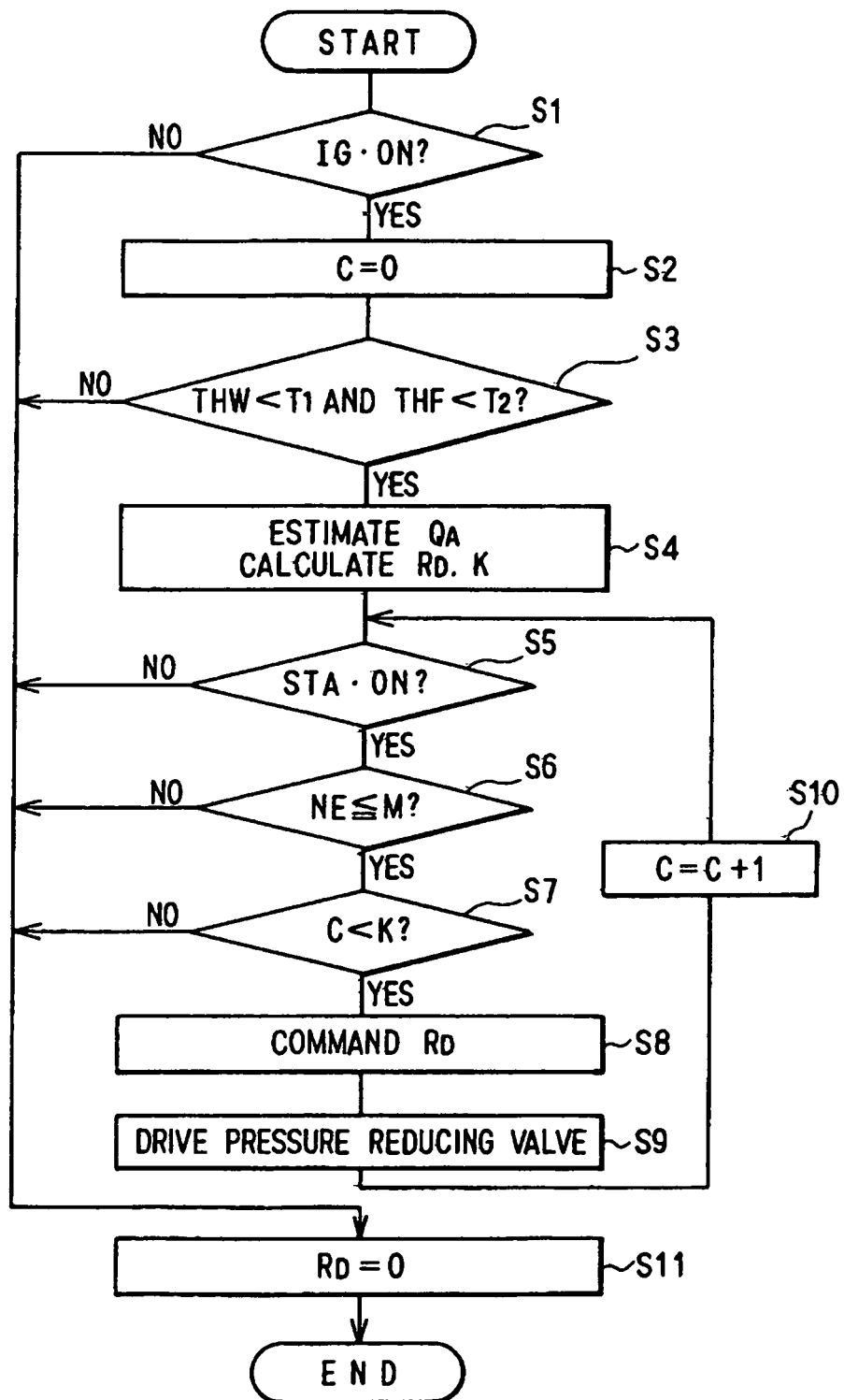


FIG. 3A

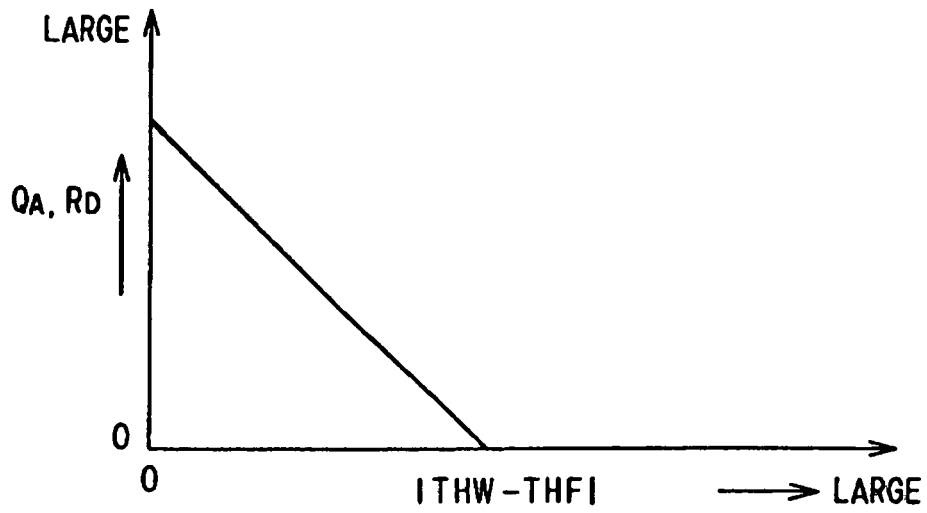


FIG. 3B

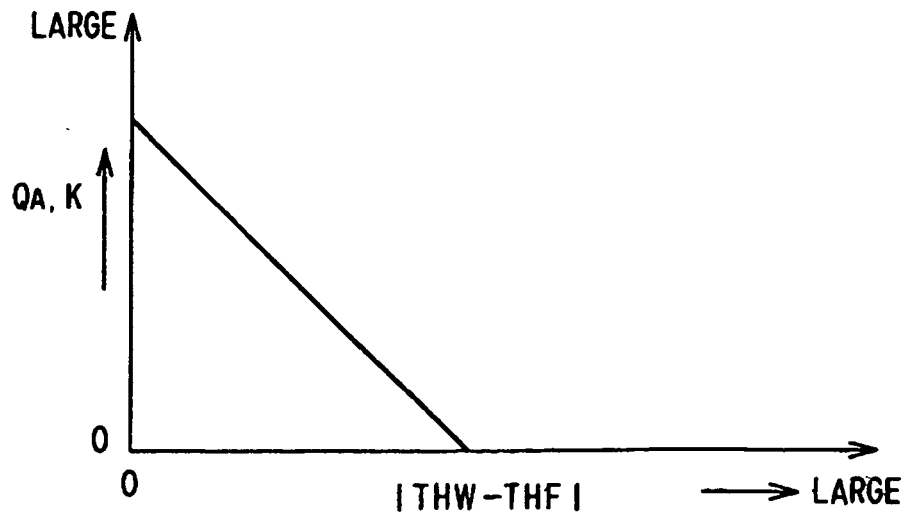
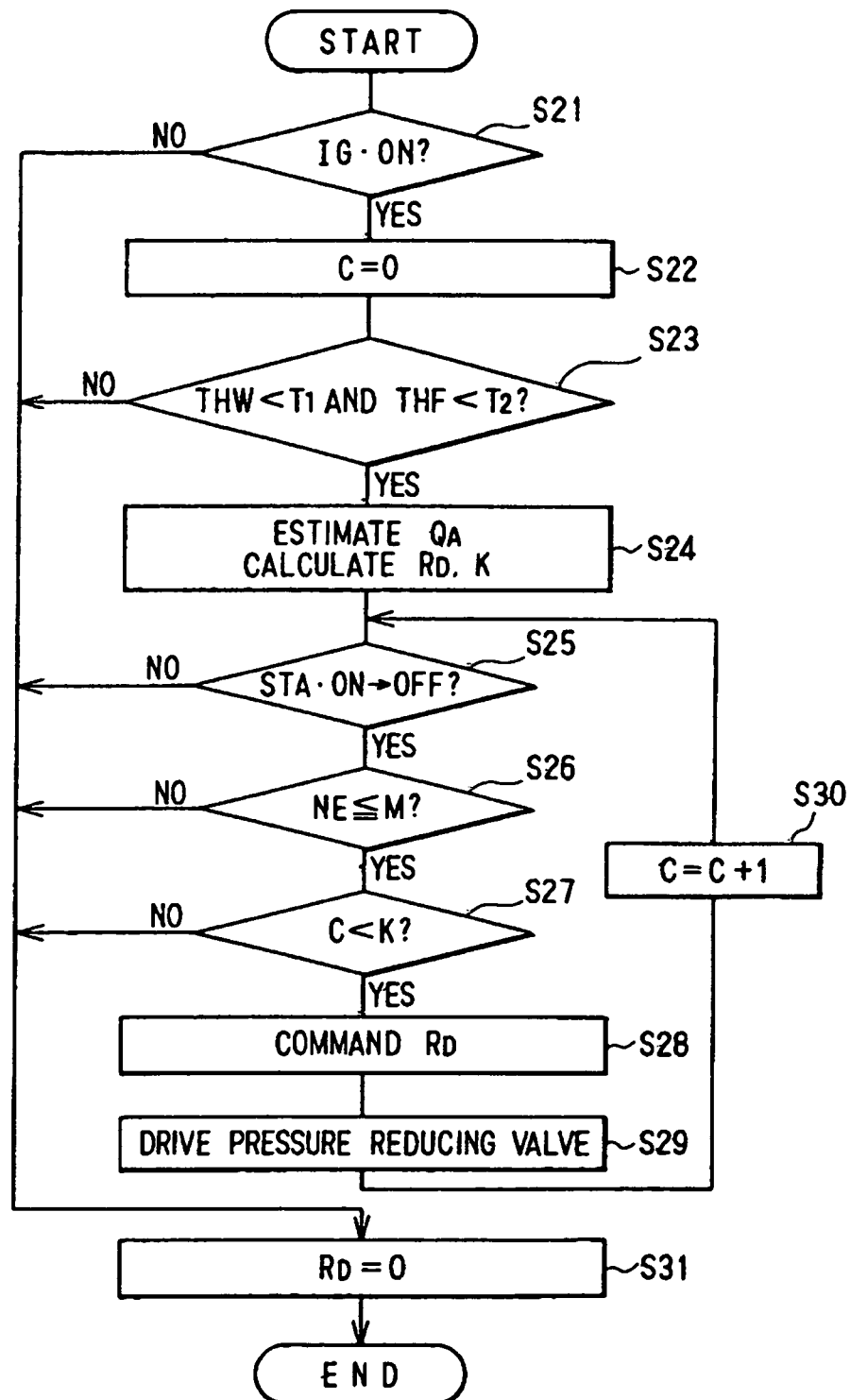


FIG. 4



REFERENCES CITED IN THE DESCRIPTION

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