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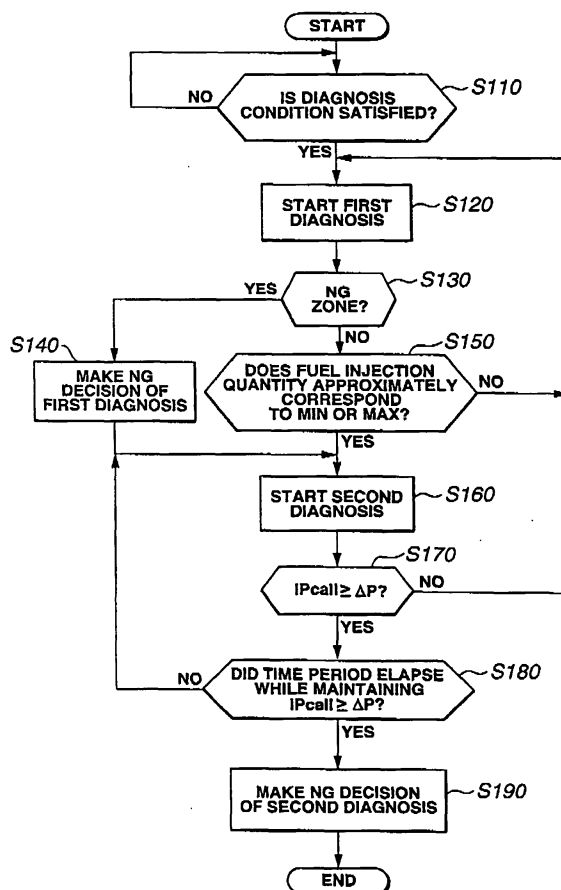
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(54) **Fuel supply control system for internal combustion engine**

(57) A fuel supply control system is arranged to execute a first diagnosis based on the a fuel injection quantity (Q_i) and a fuel pump discharge quantity (Q) after a feedback control of a fuel pressure (p) is started, to execute a second diagnosis when a result of the first diagnosis is NG or when the fuel pump discharge quantity (Q) approximately takes one of a maximum quantity (MAX) or minimum quantity (MIN) of the fuel pump discharge quantity, and to make a NG decision in the second diagnosis when a condition of a magnitude of a difference (P_{cal}) between a target fuel pressure (P_t) and an actual fuel pressure (P) is greater than a predetermined pressure is maintained for a predetermined time period (T).

FIG.6



Description

BACKGROUND OF THE INVENTION

[0001] The invention relates to a fuel supply control system of an internal combustion engine which system variably controls a fuel discharge quantity of a fuel pump according to a demand fuel injection quantity of fuel injectors and which diagnoses an abnormality of the fuel supply control system of executing a feedback control of a fuel discharge pressure.

[0002] Japanese Patent Provisional Publication No. 10-176589 discloses a fuel supply control system which comprises a high-pressure fuel pump of a variable displacement type. This high-pressure fuel pump is arranged to execute a feedback control of a fuel discharge pressure. A diagnosis method based on a correspondence between a fuel discharge quantity and the fuel discharge pressure (fuel pressure) is employed for diagnosing the abnormality of the fuel supply control system. Further, this diagnosis method is arranged to determine the abnormality of the fuel supply control system when the fuel pressure with respect to the fuel discharge quantity becomes out of a normal zone.

SUMMARY OF THE INVENTION

[0003] However, since the fuel pressure is determined from a flow rate balance (ratio) between a fuel discharge quantity of a fuel pump and a fuel injection quantity of fuel injectors, the fuel pressure range determined from the flow rate range in a normal use is very expanded. This largely decreases the abnormal decisive fuel pressure range and degrades the diagnosis accuracy.

[0004] It is therefore an object of the present invention to provide a diagnosis system which is capable of accurately diagnosing a fuel supply control system of feedback controlling a fuel pressure while variably controlling a fuel discharge quantity of a fuel pump.

[0005] An aspect of the present invention resides in a fuel supply control system for an internal combustion engine controlling a fuel discharge pressure according to an engine operating condition. The fuel supply control system comprises a fuel pump capable of varying a fuel discharge quantity of fuel; a fuel passage connected to the fuel pump; a fuel injector injecting the fuel supplied through the fuel passage from the fuel pump into the internal combustion engine; a pressure detector connected to the fuel passage, the pressure detector detecting a fuel pressure of the fuel in the fuel passage; and a control unit connected to the fuel pump, the fuel injector and the pressure detector. The controller is configured to determine a target fuel pressure according to the engine operating condition, to control the fuel pump to bring the fuel pressure closer to the target fuel pressure, and to diagnose an abnormality of the fuel supply control system on the basis of the fuel discharge quantity and a fuel injection quantity injected from the fuel

injector.

[0006] Another aspect of the present invention resides in a method of controlling a fuel discharge pressure of fuel supplied to an internal combustion engine according to an engine operating condition. The method comprises an operation of determining a target fuel pressure according to the engine operating condition, an operation of controlling a fuel pump to bring a fuel pressure of the fuel pump closer to the target fuel pressure, and an operation of diagnosing an abnormality of a fuel supply control system on the basis of a fuel discharge quantity of the fuel pump and a fuel injection quantity of a fuel injector.

[0007] The other objects and features of this invention will become understood from the following description with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] Fig. 1 is a schematic view showing a construction of a fuel supply control system according to an embodiment of the present invention.

[0009] Fig. 2 is a flowchart showing a pump discharge quantity calculation processing executed by a control unit shown in Fig. 1.

[0010] Fig. 3 is a graph showing a map for retrieving a target fuel pressure from an engine speed and a target torque.

[0011] Fig. 4 is a graph showing a map for retrieving a fuel injection quantity from the engine speed and the target torque.

[0012] Fig. 5 is a graph showing a map for retrieving a basic discharge quantity of a fuel pump from the engine speed and the fuel injection quantity corresponding to the load.

[0013] Fig. 6 is a flowchart showing a diagnosis processing executed by the control unit shown in Fig. 1.

[0014] Fig. 7 is a graph showing a map employed in the first diagnosis of the processing shown in Fig. 6.

DETAILED DESCRIPTION OF THE INVENTION

[0015] Referring to the drawings, there will be discussed an embodiment of a fuel supply control system according to the present invention.

[0016] Fig. 1 shows the fuel supply control system which is for an in-cylinder direct-injection internal combustion engine and which is provided with a high-pressure fuel pump, in accordance with the present invention.

[0017] As shown in Fig. 1, an electric low-pressure fuel pump (feed pump) 2 is disposed in a fuel tank 1 and feeds fuel to a low-pressure regulator 4 through a fuel filter 3. Low-pressure regulator 4 regulates a pressure of the fuel at a predetermined low-pressure such as a pressure ranging from 0.3 to 0.5 MPa. The pressure-regulated fuel is fed to a high-pressure fuel pump 6 through a low-pressure fuel passage 5, and is then fed

to fuel injectors 8 through a high-pressure passage 7. A fuel pressure sensor 9 is attached to high-pressure passage 7. Fuel pressure sensor 9 detects the pressure P of the pressurized fuel and outputs a fuel pressure signal indicative of the pressure P in high-pressure passage 7 to a control unit 10. Control unit 10 further receives a signal indicative of an engine speed N detected by a crank angle sensor 11, and a cylinder decision signal outputted from a cylinder decision sensor 12.

[0018] Control unit 10 outputs a control signal to an electromagnetic valve 6a of high-pressure fuel pump 6 so that a fuel discharge quantity Q discharged from a pump main body 6b of high pressure fuel pump 6 is variably controlled. Therefore, the pressure P in high-pressure passage 7 is capable of being controlled at a desired high pressure ranging from 3 to 15 MPa according to the control signal outputted from control unit 10.

[0019] The fuel supply control system is arranged such that fuel pressure P is feedback controlled according to a flow rate balance (ratio) between fuel discharge quantity Q of high-pressure fuel pump 6 and a fuel injection quantity Qi injected from fuel injectors 8. Therefore, a controlled factor of the fuel pressure feedback control is fuel discharge quantity Q of high-pressure fuel pump 6. When actual fuel pressure P detected by fuel pressure sensor 9 is lower than a target fuel pressure Pt, control unit 10 controls the fuel pressure so as to bring actual fuel pressure P closer to target fuel pressure Pt by increasing fuel discharge quantity Q of high-pressure fuel pump 6. When actual fuel pressure P is higher than target fuel pressure Pt, control unit 10 controls the fuel pressure so as to bring actual fuel pressure P closer to target fuel pressure Pt by decreasing fuel discharge quantity Q of high-pressure fuel pump 6.

[0020] Practically, fuel pressure P in the high-pressure line is determined based on fuel discharge quantity Q of high-pressure fuel pump 6, fuel injection quantity Qi of fuel injectors 8, a bulk modulus of fuel, a rigidity of high pressure passage (conduit) 7, a volume of the high pressure portion.

[0021] Suction/discharge of high-pressure fuel pump 6 is executed by a pump drive cam interconnected with a camshaft of the engine, and high-pressure fuel pump 6 operates at times corresponding to the number of cylinders or half of the number of the cylinders of the engine per one rotation of pump drive cam.

[0022] After the low-pressure fuel of a pumping stroke volume is sucked from fuel tank 1 into high-pressure fuel pump 6 during the suction process of high-pressure fuel pump 6, a pump chamber of high-pressure fuel pump 6 is shut off from an upstream side corresponding to the low pressure side by closing electromagnetic valve 6a at a proper timing during the discharge process. By these series operations, the pressure of the fuel is increased and sent to high-pressure fuel passage 7.

[0023] A necessary discharge quantity of high-pressure fuel pump 6 is calculated from target fuel pressure Pt and fuel injection quantity Qi, and the closing opera-

tion timing of electromagnetic valve 6a which is controlled on the basis of engine speed N detected by crank angle sensor 11, and a pump cam phase detected from the cylinder decision signal outputted from cylinder decision sensor 12.

[0024] There is discussed the procedure of determining a fuel discharge quantity of high-pressure fuel pump 6 with reference to Fig. 2. This program shown in Fig. 2 is a routine executed by control unit 10 at predetermined time intervals.

[0025] At step S10 of Fig. 2, control unit 10 reads engine operation indicative data including engine speed N, an output of an airflow meter, actual fuel pressure P detected by fuel pressure sensor 9, a detection value of an accelerator manipulation quantity, and other data relating to the engine operation.

[0026] At step S20 control unit 10 calculates a load To (a target torque) of the engine on the basis of the engine operation data read in step S10.

[0027] At step S30 control unit 10 calculates a target fuel pressure Pt by retrieving data indicative of target fuel pressure Pt from a map shown in Fig. 3 with reference to engine speed N and load To (target torque) of the engine. The map of Fig. 3 shows a relationship among target fuel pressure Pt, engine speed N and load (target torque) To and has been previously stored in a memory of control unit 10. As is apparent from Fig. 3, target fuel pressure Pt is selected from predetermined several pressures A, B and C (MPa) according to engine speed N and load To, and the predetermined several pressures A, B and C (MPa) has been set to produce the optimal combustion state.

[0028] At step S40 control unit 10 calculates a fuel injection quantity Qi by retrieving fuel injection quantity Qi from a map shown in Fig. 4 with reference to engine speed N and load To (target torque). This map shown in Fig. 4 has been previously stored in the memory of control unit 10. As is apparent from Fig. 4, fuel injection quantity Qi tends to increase as engine speed N and/or load To increases.

[0029] At step S50 control unit 10 calculates a difference Pcal by subtracting actual fuel pressure P from target fuel pressure Pt ($P_{cal} = P_t - P$).

[0030] At step S60 control unit 10 calculates a correction quantity Qh for pump discharge quantity Q by multiply difference Pcal calculated at step S50 and a fuel pressure feedback gain K of a constant value which has been previously stored in the memory of control unit 10 ($Q_h = P_{cal} \times K$).

[0031] At step S70 control unit 10 calculates pump discharge quantity Q by retrieving a basic pump discharge quantity Qbas from a map shown in Fig. 6 with reference to engine speed N and load To corresponding to fuel injection quantity Qi and by adding the obtained basic pump discharge quantity Qbas and correction quantity Qh obtained at step S60 ($Q = Q_{bas} + Q_h$). The map shown in Fig. 5 shows a relationship among basic pump discharge quantity Qbas, engine speed N and

load T_o (target torque) and has been previously stored in a memory of control unit 10. As is apparent from Fig. 5, basic pump discharge quantity Q_{bas} tends to increase as engine speed N and/or load T_o increases.

[0032] Further, control unit 10 executes a diagnosis for accurately diagnose an abnormal state (trouble-shoot) of the fuel supply system. Fig. 6 shows such a diagnosis procedure executed by control unit 10.

[0033] At step S110 of Fig. 6, control unit 10 determines whether or not a diagnosis start condition is satisfied. When the determination at step S110 is affirmative, the routine proceeds to step S120. When the determination at step S110 is negative, the routine repeats step S110 until the affirmative determination is made at step S110.

[0034] The diagnosis start condition will be discussed hereinafter. Control unit 10 executes the fuel feedback control so as to variably adjust the fuel discharge quantity Q of high-pressure fuel pump 6, with respect to a necessary fuel supply quantity calculated from the target fuel pressure P_t and the necessary fuel injection quantity. More specifically, when a ratio between the fuel injection quantity Q_i and the fuel discharge quantity Q is 1:1, the flow rate balance therebetween is balanced, and therefore the fuel pressure is kept constant. When the fuel pressure should be increased, the fuel discharge quantity Q of high-pressure fuel pump 6 is temporally increased and is then controlled so that the flow rate balance is adjusted to 1:1 after a moment when the actual fuel pressure P reaches the target fuel pressure P_t . When the fuel pressure should be decreased, the fuel discharge quantity Q of high-pressure fuel pump 6 is temporally decreased, and is then controlled so that the flow rate balance is adjusted to 1:1 at a moment when the actual fuel pressure P reaches the target fuel pressure P_t .

[0035] Herein, when the signal lines employed to calculate the fuel discharge quantity Q , such as lines to fuel pressure sensor 9, crank angle sensor 11, and cylinder decision sensor 12 are put in an abnormal state or in an unstable state just after the engine startup, it is difficult to correctly execute the fuel pressure control. Therefore, the fuel pressure feedback control is suspended under the abnormal state or during the unstable state.

[0036] Accordingly, the diagnosis start condition according to the present invention is determined on the assumption that the fuel pressure feedback control is being executed. When the diagnosis start condition is satisfied, the diagnosis program proceeds from step S110 to step S120.

[0037] At step S120, control unit 10 starts a first diagnosis on the basis of the flow rate balance between fuel discharge quantity Q of high-pressure fuel pump 6 and fuel injection quantity Q_i of fuel injectors 8. More specifically, control unit 10 determines whether the flow rate balance is in NG zone or OK zone with reference to a diagnosis map shown in Fig. 7 on the basis of fuel discharge quantity Q of high-pressure fuel pump 6 and fuel

injection quantity Q_i of fuel injectors 8.

[0038] Herein, the NG zone and the OK zone of Fig. 7 have been defined such that when it is possible to ensure the demand fuel injection quantity by converging the actual fuel pressure P into the target fuel pressure P_t within the normal increasing and decreasing range of the fuel discharge quantity Q , it is determined that the flow rate balance is in the OK zone. On the other hand, when it is not possible to ensure the required fuel injection quantity by converging the actual fuel pressure P into the target fuel pressure P_t within the normal increasing and decreasing range, it is determined that the flow rate balance is in the NG zone. This OK or NG determination in the first diagnosis is executed taking account of the variations of parts, the degradation of the performance, the change of the circumstantial condition such as the property of the fuel and the fuel temperature. Further, an undecided zone adjacent to MAX side represents a zone where control unit 10 cannot make a NG decision although control unit 10 controls fuel discharge quantity Q toward an up-side when the fuel pressure P is decreased due to any trouble. Similarly, an undecided zone adjacent to MIN side represents a zone where control unit 10 cannot make a NG decision although control unit 10 controls fuel discharge quantity Q toward a down-side when the fuel pressure P is increased due to any trouble.

[0039] At step S130 control unit 10 determines whether or not the result of the first diagnosis indicates that the flow rate balance is in the NG zone. When the determination at step S130 is affirmative, that is, when it is determined that flow rate balance is in the NG zone, the program proceeds to step S140. When the determination at step S130 is negative, the program proceeds to step S150.

[0040] At step S140, the control unit 10 makes the NG decision of the first diagnosis and thereafter the program proceeds to step S160.

[0041] At step S150 subsequent to the negative determination (OK zone) of step S130, control unit 10 determines whether or not the fuel discharge quantity Q of high-pressure fuel pump 6 approximately corresponds to a minimum value MIN or a maximum value MAX thereof. When the determination at step S150 is negative, that is, when the fuel discharge quantity Q is not a quantity adjacent to minimum value MIN or maximum value MAX, control unit 10 determines that the diagnosis result of the first diagnosis is normal. Therefore, the program returns to step S120 as a result of the negative determination at step S150, so as to continue the first diagnosis for the next change of the engine operating condition.

[0042] On the other hand, when the determination at step S150 is affirmative, that is, when the fuel discharge quantity Q of high-pressure fuel pump 6 is close to the minimum value MIN or the maximum value MAX, the program proceeds to step S160.

[0043] At step S160 control unit 10 starts a second

diagnosis on the basis of the fuel pressure. More specifically, control unit 10 diagnoses the normality of the fuel supply control system on the basis of an absolute value of the difference Pcal between target fuel pressure Pt and actual fuel pressure P.

[0044] At step S170 control unit 10 determines whether or not the absolute value |Pcal| of the difference Pcal is greater than or equal to a predetermined value ΔP , which has been set at a value greater than a width of a dead zone in the variable control of the fuel discharge pressure and is particularly set at a value within a range from $|\pm 0.3|$ through $|\pm 0.5|$ MPa.

[0045] When the determination at step S170 is negative, that is, when the absolute value |Pcal| of the difference Pcal is smaller than the predetermined value ΔP , the program returns to step S120. When the determination at step S170 is affirmative, that is, when the absolute value |Pcal| of the difference Pcal is greater than or equal to the predetermined value ΔP , the program proceeds to step S180.

[0046] At step S180 control unit 10 determines whether or not a condition of $|Pcal| \geq \Delta P$ is maintained for a predetermined time period T. When the determination at step S180 is affirmative, the program proceeds to step S190. When the determination at step S180 is negative, the program returns to step S160.

[0047] At step S190 subsequent to the affirmative determination at step S180, control unit 10 makes the NG decision (a decision of the abnormality) in the second diagnosis.

[0048] When the program proceeds to step S190 after the program proceeds through step S130 and step S140, that is, when both of the first diagnosis and the second diagnosis were the NG decision indicative that the fuel supply control system is in the abnormal state, the flow rate control of high-pressure fuel pump 6 is put in a state that it is impossible to converge the actual fuel pressure P to the target fuel pressure Pt. Therefore, control unit 10 can diagnose that the fuel supply control system is put in a high-level abnormal state in this both NG state. In contrast, when the first diagnosis was the NG decision and when the second diagnosis was not the NG decision, it is possible to converge the actual fuel pressure P to the target fuel pressure Pt in the flow rate control range outside of a normal range although it is impossible to converge the actual fuel pressure P to the target fuel pressure Pt in the flow rate control within a normal range. Accordingly control unit 10 diagnoses that the fuel supply control system is put in a low-level abnormal state.

[0049] On the other hand, when the program proceeds through step S150 to step S190, that is, when the fuel discharge quantity Q of high-pressure fuel pump 6 is approximately the minimum value MIN or the maximum value MAX and when the second diagnosis is the NG decision, control unit 10 determines that it is impossible to diagnose the state of the fuel supply system from the first diagnosis using the flow rate balance and ex-

cutes the second diagnosis. As a result of the second diagnosis, control unit 10 diagnoses that the fuel supply system is put in the abnormal state. Under this state, it is impossible to converge actual fuel pressure P to target fuel pressure Pt during when fuel discharge quantity Q is approximately the minimum value MIN or the maximum value MAX. However, it is not clear whether it is possible to converge actual fuel pressure P to target fuel pressure Pt when the engine operating condition is changed to a condition where the demand fuel injection quantity takes an intermediate value. That is, although control unit 10 cannot determine the degree of the abnormality of the fuel supply control system, control unit 10 can diagnose that the fuel supply control system has an abnormality that it is impossible to converge the actual fuel pressure P to the target fuel pressure Pt in the flow rate control within the normal range.

[0050] Consequently, although the fuel supply control system of the embodiment according to the present invention can determine the level of the abnormality as possible, the degree of the abnormality may not be determined. Further, this fuel supply control system according to the present invention may be arranged to execute the second diagnosis only when fuel discharge quantity Q is approximately the minimum value MIN or the maximum value MAX, without executing the second diagnosis when the first diagnosis is the NG decision.

[0051] With the thus arranged diagnosis of the fuel supply control system according to the present invention, the first diagnosis for diagnosing the abnormality from fuel discharge quantity Q of high-pressure fuel pump 6 and fuel injection quantity Qi of fuel injectors 8 is executed as to the fuel supply control system of the internal combustion engine for executing the feedback control of actual fuel pressure P while variably controlling fuel discharge quantity Q of high-pressure fuel pump 6 according to the demand fuel injection quantity of fuel injector 8. Accordingly, it becomes possible to set the decision value (NG zone) for the diagnosis according to the operating condition corresponding to the demand fuel injection quantity. This arrangement improves the accuracy of the diagnosis of the fuel supply control system.

[0052] More specifically, since the first diagnosis is arranged to set the NG zone and the OK zone as shown in Fig. 7 and to determine that the fuel supply control system is put in the abnormal state when a difference between the fuel discharge quantity Q of high-pressure fuel pump 6 and the fuel injection quantity Qi of fuel injector 8 is greater than or equal to the predetermined value, it becomes possible to easily execute the first diagnosis.

[0053] Further, since the first diagnosis is arranged to vary a ratio (a width of the OK zone) between the NG zone and the OK zone shown in Fig. 7 according to the operating condition corresponding to the demand fuel injection quantity, and to vary the predetermined value of the first diagnosis according to the operating condition

corresponding to the demand fuel injection quantity, it becomes possible to easily and accurately execute the diagnosis.

[0054] Furthermore, the diagnosis executed by the fuel supply control system according to the present invention is arranged to execute the second diagnosis different from the first diagnosis when the controlled variable of high-pressure fuel pump 6 is maintained at an adjacent value of the upper limit value or lower limit value, that is, when the fuel discharge quantity Q of high-pressure fuel pump 6 is approximately minimum value MIN or maximum value MAX. That is, it becomes possible to change the diagnosis from the first diagnosis to the second diagnosis when it is impossible that the first diagnosis cannot determine the state of the fuel supply control system. This extends the diagnosis executable area.

[0055] Since the second diagnosis executed by the fuel supply control system according to the present invention is arranged to diagnose that the fuel supply control system is put in the abnormal state when a magnitude of the difference Pcal between the actual fuel pressure P and the target fuel pressure Pt is greater than or equal to the predetermined pressure ΔP , it becomes possible to accurately diagnose the abnormality of the fuel supply control system by executing the second diagnosis even if the first diagnosis based on the flow rate balance diagnoses that the fuel supply control system is put in the normal state when the controlled variable (fuel discharge quantity Q) of high-pressure fuel pump 6 is maintained at an adjacent value of the upper limit or the lower limit.

[0056] Further, since the predetermined pressure ΔP of the second diagnosis is set at a value greater than a dead-zone width in the variable control of the fuel discharge pressure, the determination as to the abnormality of the fuel supply control system is certainly executed. Furthermore, since the predetermined pressure ΔP may be set at a magnitude (absolute value) ranging from 0.3 through 0.5 MPa ($|\pm 0.3|$ through $|\pm 0.5|$), which is greater than the dead zone width, the decision value becomes sufficiently smaller than the decision value (about ± 5 MPa) of the fuel discharge pressure employed in an earlier technology using the fuel discharge quantity and the fuel discharge pressure of the fuel pump. This enables the high-accuracy diagnosis in the extended diagnosis range.

[0057] Furthermore, since the second diagnosis according to the present invention is arranged to diagnose that the fuel supply control system is put in the abnormal state when the abnormal state is maintained for the predetermined time period T, an erroneous diagnosis caused by the transient deviation of the fuel pressure is prevented. Therefore, the reliability of the diagnosis is further improved.

[0058] This application is based on a prior Japanese Patent Application No. 2002-169008. The entire contents of the Japanese Patent Application No. 2002-169008 with a filing date of June 10, 2002 are

hereby incorporated by reference.

[0059] Although the invention has been described above by reference to certain embodiments of the invention, the invention is not limited to the embodiments described above. Modifications and variations of the embodiments described above will occur to those skilled in the art in light of the above teachings. The scope of the invention is defined with reference to the following claims.

Claims

1. A fuel supply control system for an internal combustion engine controlling a fuel discharge pressure according to an engine operating condition, the fuel supply control system comprising:

a fuel pump (6) capable of varying a fuel discharge quantity of fuel;
 a fuel passage (7) connected to the fuel pump;
 a fuel injector (8) injecting the fuel supplied through the fuel passage (7) from the fuel pump (6) into the internal combustion engine;
 a pressure detector (9) connected to the fuel passage (7), the pressure detector (9) detecting a fuel pressure of the fuel in the fuel passage (7); and
 a control unit (10) connected to the fuel pump (6), the fuel injector (8) and the pressure detector (9), the controller being configured, to determine a target fuel pressure (Pt) according to the engine operating condition, to control the fuel pump (6) to bring the fuel pressure (P) closer to the target fuel pressure (Pt), and to diagnose an abnormality of the fuel supply control system on the basis of the fuel discharge quantity (Q) and a fuel injection quantity (Qi) injected from the fuel injector.

2. The fuel supply control system as claimed in claim 1, wherein the control unit (10) is configured to diagnose that the fuel supply control system is abnormal when a difference between the fuel discharge quantity (Q) of the fuel pump and the fuel injection quantity (Qi) of the fuel injector is greater than or equal to a predetermined value.
3. The fuel supply control system as claimed in claim 2, wherein the predetermined value is varied according to the operating condition of the engine.
4. The fuel supply control system as claimed in one of claims 1 through 3, wherein when a controlled variable of the fuel pump is maintained at a value adjacent to one of an upper limit (MAX) and a lower limit (MIN) of the controlled variable, the control unit

executes a second diagnosis for diagnosing the abnormality of the fuel supply control system.

5. The fuel supply control system as claimed in claim 4, wherein the second diagnosis executed by the control unit diagnoses that the fuel supply control system is abnormal when an absolute value of a difference (P_{cal}) between an actual fuel pressure (P) and a target fuel pressure (P_t) is greater than a predetermined value (ΔP). 5
10
6. The fuel supply control system as claimed in claim 5, wherein the predetermined value is set at a value greater than a width of a dead-zone in a variable control of an actual fuel pressure (P). 15
7. The fuel supply control system as claimed in one of claims 4 through 6, wherein the second diagnosis executed by the control unit diagnoses that the fuel supply control system is abnormal when the abnormal state is maintained for a predetermined time period (T). 20
8. The fuel supply control system as claimed in claim 1, wherein the control unit (10) is configured to diagnose that the fuel supply control system is abnormal when a ratio between the fuel discharge quantity (Q) of the fuel pump and the fuel injection quantity (Q_i) of the fuel injector is in a predetermined zone including the ratio of 1. 25
30
9. The fuel supply control system as claimed in claim 8, wherein a width of the predetermined zone is varied according to the operating condition of the engine. 35
10. A method of controlling a fuel discharge pressure of fuel supplied to an internal combustion engine according to an engine operating condition, the method comprising: 40
 - determining a target fuel pressure (P_t) according to the engine operating condition;
 - controlling a fuel pump to bring a fuel pressure (P) of the fuel pump closer to the target fuel pressure (P_t); and 45
 - diagnosing an abnormality of a fuel supply control system on the basis of a fuel discharge quantity (Q) of the fuel pump and a fuel injection quantity (Q_i) of a fuel injector. 50

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FIG.1

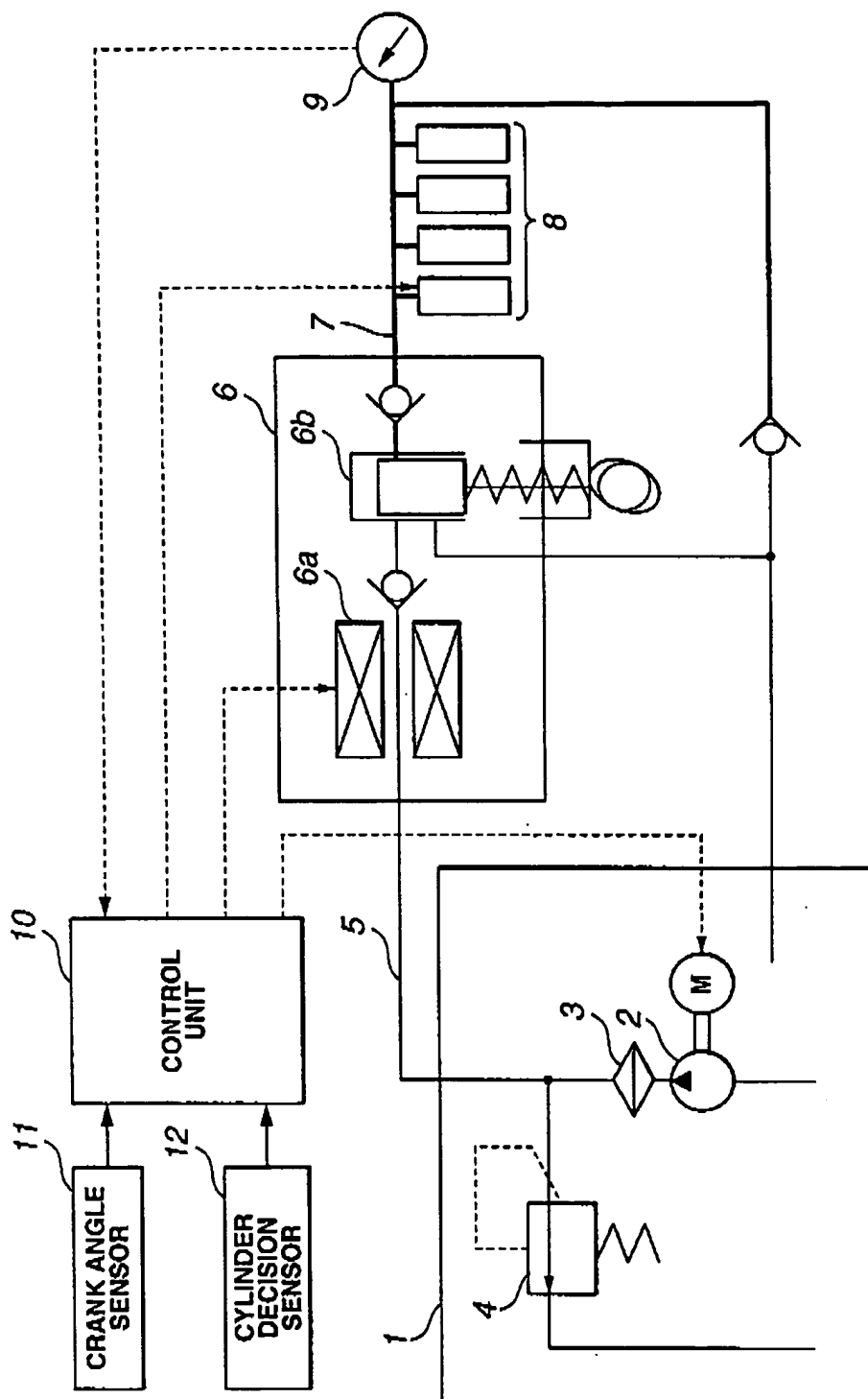


FIG.2

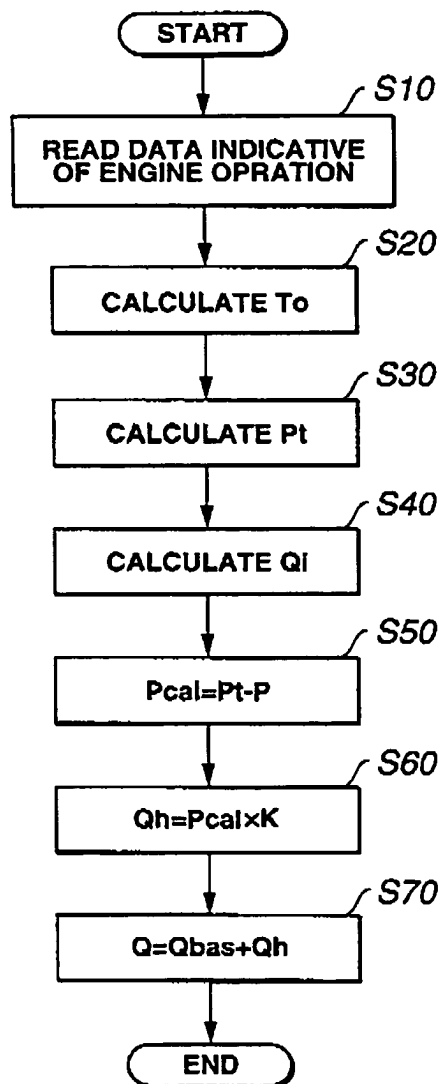


FIG.3

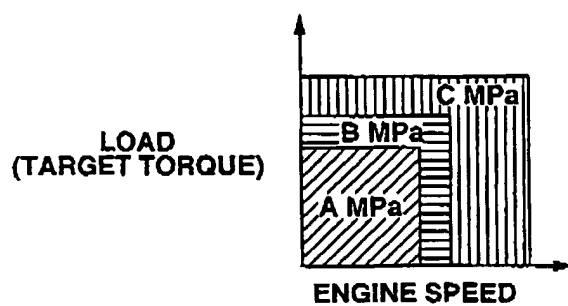


FIG.4

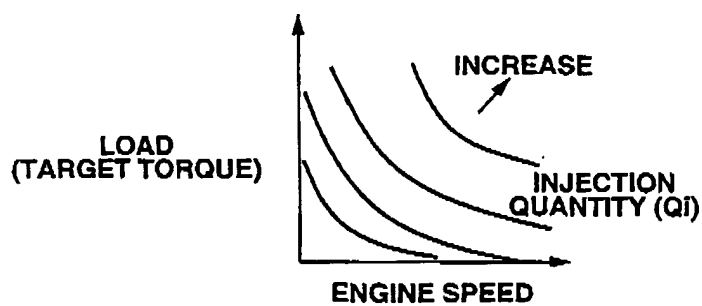


FIG.5

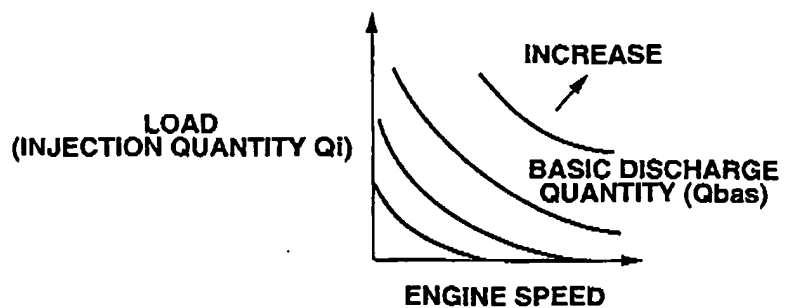


FIG.6

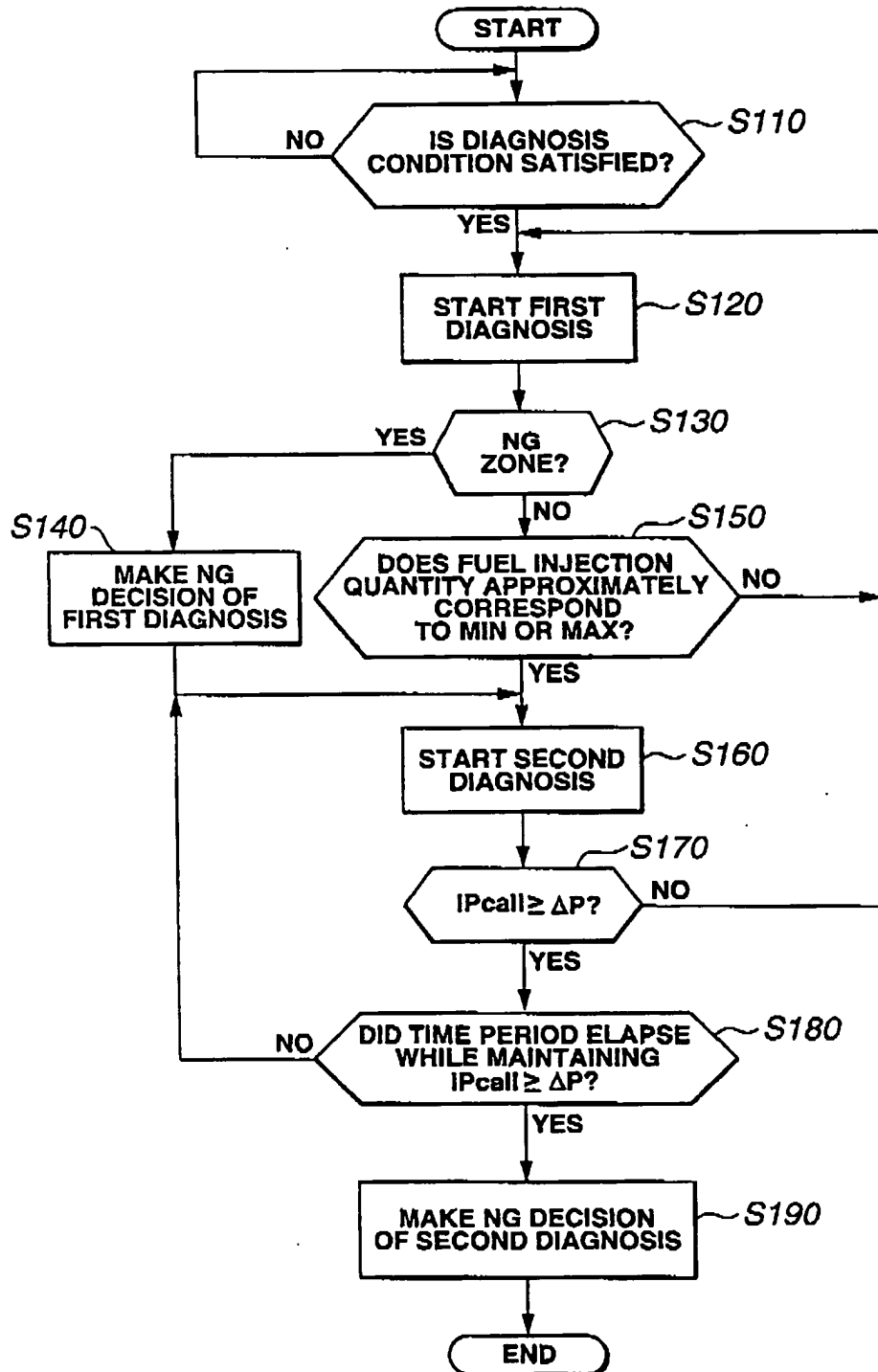


FIG.7

