

(19)



(11)

EP 2 546 501 A1

(12)

EUROPEAN PATENT APPLICATION

(43) Date of publication:

16.01.2013 Bulletin 2013/03

(51) Int Cl.:

F02D 41/22 (2006.01)

F02D 41/38 (2006.01)

(21) Application number: **12175666.2**

(22) Date of filing: **10.07.2012**

(84) Designated Contracting States:

**AL AT BE BG CH CY CZ DE DK EE ES FI FR GB
GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO
PL PT RO RS SE SI SK SM TR**

Designated Extension States:

BA ME

(30) Priority: **11.07.2011 JP 2011153088**

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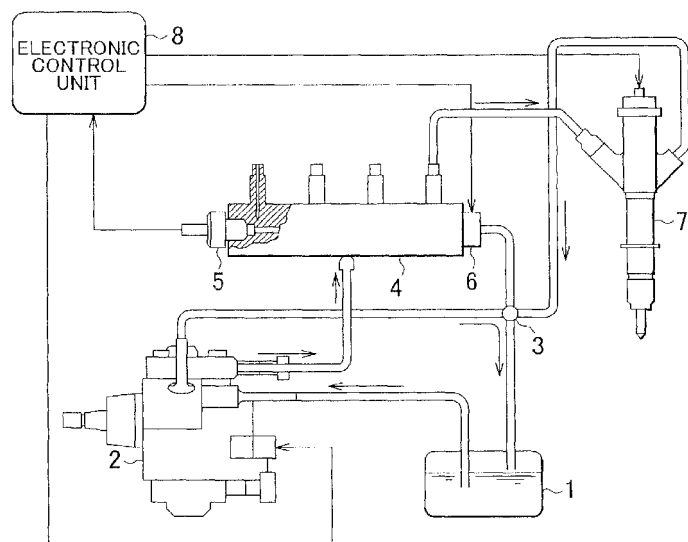
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(54) **Malfunction detection device for engine and malfunction detection method for engine**

(57) A malfunction detection device for an engine detects whether a pressure reducing valve (6) that discharges fuel from a fuel system of an engine to reduce fuel pressure in the fuel system is stuck closed. The malfunction detection device is configured to provide a valve opening command to open the pressure reducing valve (6) after the engine is stopped, detect an amount of reduction in the fuel pressure per unit time before the valve

opening command is provided and an amount of reduction in the fuel pressure per unit time after the valve opening command is provided, and determine whether the pressure reducing valve (6) is stuck closed based on the detected amount of reduction in the fuel pressure per unit time before the valve opening command is provided and the detected amount of reduction in the fuel pressure per unit time after the valve opening command is provided.

FIG. 1



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Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The invention relates to a malfunction detection device for an engine and a malfunction detection method for an engine, which detect a state where a pressure reducing valve that discharges fuel from a fuel system of an engine to reduce fuel pressure in the fuel system is stuck closed, as a malfunction.

2. Description of Related Art

[0002] A common rail diesel engine that is provided with a common rail in which high-pressure fuel is accumulated has been placed into practical use, as is well known. The fuel supplied through the common rail is injected into combustion chambers of the engine. In recent years, raising of fuel pressure has been promoted to improve injection response and promote atomization of sprayed fuel in the above-described common rail diesel engine. The raising of fuel pressure has caused a demand for improvement in the accuracy of control on the pressure of fuel accumulated in the common rail (rail pressure). The rail pressure is controlled through control on an amount of fuel that is pressurized and supplied to the common rail by a high-pressure fuel pump, and control on a pressure reducing valve that discharges the fuel from the common rail.

[0003] As a pressure reducing valve, there is employed a normally-closed valve that provides communication between the inside of a common rail and a relief passage with the use of an electromagnetic attraction force that is generated by the passage of electric current through a solenoid, for example. In the pressure reducing valve, a valve closing operation failure occurs, that is, the pressure reducing valve is not fully closed even when the passage of electric current through the solenoid is interrupted, in some cases. As a malfunction detection device for an engine, which detects a valve closing operation failure of a pressure reducing valve as described above, a device described in Japanese Patent Application Publication No. 2006-257883 (JP 2006-257883 A) is known. In the malfunction detection device described in JP 2006-257883 A, a reference pressure reduction amount is set to the sum of a pressure reduction amount that is estimated from an upper limit of a fuel release amount, which is defined in a performance standard of the pressure reducing valve, and a pressure reduction amount that is estimated from an upper limit of a fuel leakage amount, which is defined in a performance standard of the injectors. If an amount of reduction in rail pressure after the pressure reducing valve is opened after the engine is stopped is equal to or larger than the reference pressure reduction amount, it is determined that a valve closing operation failure has occurred in the pressure

reducing valve.

[0004] Malfunctions of the pressure reducing valve include not only the valve closing operation failure described above but also a malfunction that the pressure reducing valve is stuck closed and does not open, due to a stuck valve element, even when electric current is passed through the solenoid. It is possible to detect a state where the pressure reducing valve is stuck closed by detecting a fact that the rail pressure is not reduced even when a command to open the pressure reducing valve is provided after the engine is stopped. However, the factors causing increases in the amount of reduction in rail pressure include not only opening of the pressure reducing valve but also fuel leakage from the fuel system due to foreign matter caught in a valve portion of an injector and foreign matter caught in a spill valve of a high-pressure fuel pump. Therefore, if foreign matter is caught in the valve portion of the injector or the spill valve of the high-pressure fuel pump, the rail pressure is reduced even though the pressure reducing valve is not opened. Therefore, it is not possible to appropriately detect whether the pressure reducing valve is stuck closed, when the pressure reducing valve is stuck closed and, in addition, a failure that increases an amount of reduction in rail pressure has occurred.

SUMMARY OF THE INVENTION

[0005] The invention provides a malfunction detection device for an engine and a malfunction detection method for an engine, which are able to more appropriately detect whether a pressure reducing valve is stuck closed.

[0006] A first aspect of the invention relates to a malfunction detection device for an engine, which detects whether a pressure reducing valve that discharges fuel from a fuel system of an engine to reduce fuel pressure in the fuel system is stuck closed. The malfunction detection device is configured to provide a valve opening command to open the pressure reducing valve after the engine is stopped, detect an amount of reduction in the fuel pressure per unit time before the valve opening command is provided and an amount of reduction in the fuel pressure per unit time after the valve opening command is provided, and determine whether the pressure reducing valve is stuck closed based on the detected amount of reduction in the fuel pressure per unit time before the valve opening command is provided and the detected amount of reduction in the fuel pressure per unit time after the valve opening command is provided.

[0007] If fuel leakage from the fuel system has occurred due to foreign matter caught in a valve portion of an injector or foreign matter caught in a spill valve of a high-pressure fuel pump, the fuel pressure in the fuel system is reduced regardless of whether the pressure reducing valve is opened or closed. In this case, reduction in the fuel pressure due to the fuel leakage occurs before the pressure reducing valve is opened, and both reduction in the fuel pressure due to the fuel leakage and re-

duction in the fuel pressure due to opening of the pressure reducing valve occur after the pressure reducing valve is opened. Therefore, even when the fuel pressure is reduced due to a factor other than opening of the pressure reducing valve, it is possible to determine whether the amount of reduction in the fuel pressure is increased due to opening of the pressure reducing valve, that is, whether the pressure reducing valve is actually opened in response to the valve opening command, by comparing the amount of reduction in the fuel pressure per unit time before the valve opening command for the pressure reducing valve is provided with the amount of reduction in the fuel pressure per unit time after the valve opening command is provided. Therefore, with the above configuration, it is possible to more appropriately detect whether the pressure reducing valve is stuck closed.

[0008] In the above aspect, the malfunction detection device may be configured to determine that the pressure reducing valve is stuck closed when there is no change between the detected amount of reduction in the fuel pressure per unit time before the valve opening command for the pressure reducing valve is provided and the detected amount of reduction in the fuel pressure per unit time after the valve opening command for the pressure reducing valve is provided.

[0009] If fuel leakage from the fuel system has occurred due to, for example, foreign matter caught in the valve portion of the injector or foreign matter caught in the spill valve of the high-pressure fuel pump, the fuel pressure in the fuel system is reduced regardless of whether the pressure reducing valve is opened or closed. In this case as well, if the pressure reducing valve is actually opened in response to the command, the rate of reduction in the fuel pressure, that is, the amount of reduction in the fuel pressure per unit time should increase. Accordingly, if the amount of reduction in the fuel pressure per unit time is not changed even though the command to open the pressure reducing valve is provided, it is determined that the pressure reducing valve is not opened despite provision of the valve opening command, that is, the pressure reducing valve is stuck closed. Therefore, with the above configuration, it is possible to more appropriately detect whether the pressure reducing valve is stuck closed.

[0010] In the above aspect, the malfunction detection device may be configured to determine whether the pressure reducing valve is stuck closed based on a difference between the detected amount of reduction in the fuel pressure per unit time before the valve opening command is provided and the detected amount of reduction in the fuel pressure per unit time after the valve opening command is provided.

[0011] If fuel leakage from the fuel system has occurred due to, for example, foreign matter caught in the valve portion of the injector or foreign matter caught in the spill valve of the high-pressure fuel pump, the fuel pressure in the fuel system is reduced regardless of whether the pressure reducing valve is opened or closed.

In this case as well, if the pressure reducing valve is actually opened in response to the command, the rate of reduction in the fuel pressure, that is, the amount of reduction in the fuel pressure per unit time should be larger than that before the command is provided. Accordingly, if the difference between the amount of reduction in the fuel pressure per unit time before the valve opening command is provided and the amount of reduction in the fuel pressure per unit time after the valve opening command is provided is approximately zero, it is determined that the pressure reducing valve is not opened despite provision of the valve opening command, that is, the pressure reducing valve is stuck closed. Therefore, with the above configuration, it is possible to more appropriately detect whether the pressure reducing valve is stuck closed.

[0012] In the above aspect, the malfunction detection device may be configured to determine whether the pressure reducing valve is stuck closed based on a ratio of the detected amount of reduction in the fuel pressure per unit time after the valve opening command is provided to the detected amount of reduction in the fuel pressure per unit time before the valve opening command is provided.

[0013] If fuel leakage from the fuel system has occurred due to, for example, foreign matter caught in the valve portion of the injector or foreign matter caught in the spill valve of the high-pressure fuel pump, the fuel pressure in the fuel system is reduced regardless of whether the pressure reducing valve is opened or closed. In this case as well, if the pressure reducing valve is actually opened in response to the command, the amount of reduction in the fuel pressure per unit time should be larger than that before the command is provided. Accordingly, if the ratio of the amount of reduction in the fuel pressure per unit time after the valve opening command is provided to the amount of reduction in the fuel pressure per unit time before the valve opening command is provided is approximately one, it is determined that the pressure reducing valve is not opened despite provision of the valve opening command, that is, the pressure reducing valve is stuck closed. Therefore, with the above configuration, it is possible to more appropriately detect whether the pressure reducing valve is stuck closed.

[0014] The malfunction detection device for an engine according to the above aspect may be applied to a common rail diesel engine in which a pressure reducing valve is configured as a valve that discharges fuel from a common rail.

[0015] A second aspect of the invention relates to a malfunction detection method for an engine, for detecting whether a pressure reducing valve that discharges fuel from a fuel system of an engine to reduce fuel pressure in the fuel system is stuck closed. The malfunction detection method includes: detecting an amount of reduction in the fuel pressure per unit time after the engine is stopped; providing a valve opening command to open the pressure reducing valve; detecting an amount of re-

duction in the fuel pressure per unit time after the valve opening command is provided; and determining whether the pressure reducing valve is stuck closed based on the detected amount of reduction in the fuel pressure per unit time before the valve opening command is provided and the detected amount of reduction in the fuel pressure per unit time after the valve opening command is provided.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] Features, advantages, and technical and industrial significance of exemplary embodiments of the invention will be described below with reference to the accompanying drawings, in which like numerals denote like elements, and wherein:

FIG. 1 is a schematic view showing the structure of a fuel system of a common rail diesel engine to which a malfunction detection device for an engine according to an embodiment of the invention is applied;

FIG. 2 is a flowchart showing the process of a routine for determining whether a valve is stuck closed according to the embodiment;

FIG. 3 is a time chart showing an example of a control mode for determining whether the valve is stuck closed according to the embodiment when there is no fuel leakage; and

FIG. 4 is a time chart showing an example of a control mode for determining whether the valve is stuck closed according to the embodiment when there is fuel

leakage.

DETAILED DESCRIPTION OF EMBODIMENTS

[0017] Hereafter, a malfunction detection device for an engine according to an embodiment of the invention will be described in detail with reference to FIG. 1 to FIG. 4. The malfunction detection device according to the embodiment is applied to a common rail diesel engine.

[0018] First, the structure of a common rail diesel engine to which the malfunction detection device according to the embodiment is applied will be described with reference to FIG. 1. The fuel stored in a fuel tank 1 is drawn up by a high-pressure fuel pump 2. The high-pressure fuel pump 2 that is driven by a crankshaft pressurizes the fuel drawn up from the fuel tank 1 and then discharges the pressurized fuel. The high-pressure fuel discharged from the high-pressure fuel pump 2 is delivered to a common rail 4. The high-pressure fuel pump 2 is provided with a spill valve by which excess fuel is returned to the fuel tank 1 through a check valve 3.

[0019] The common rail 4, which is an accumulator pipe, is provided with a rail pressure sensor 5 that detects a fuel pressure inside the common rail 4, that is, a rail pressure. Further, the common rail 4 is provided with a pressure reducing valve 6. The fuel discharged from the

common rail 4 upon opening of the pressure reducing valve 6 is returned to the fuel tank 1 through the check valve 3.

[0020] Injectors 7 for respective cylinders are connected to the common rail 4. The high-pressure fuel accumulated inside the common rail 4 is distributed to the injectors 7 for the respective cylinders. Then, the fuel is injected from the injectors 7 to combustion chambers of the diesel engine. The excess fuel, that is, the fuel that is supplied to the injectors 7 but is not injected from the injectors 7, is returned to the fuel tank 1 through the check valve 3.

[0021] The common rail diesel engine that has the above-described fuel system is controlled by an electronic control unit 8 for engine control. The electronic control unit 8 includes a central processing unit (CPU) that executes various calculations related to engine control, a read-only memory (ROM) that stores programs and data for the engine control, and a random access memory (RAM) that temporarily stores, for example, calculation results obtained by the CPU and detection results obtained by sensors provided at various portions of the engine. The electronic control unit 8 adjusts an amount of fuel that is pumped from the high-pressure fuel pump 2 and an amount of fuel that is discharged from the common rail 4 through the pressure reducing valve 6, based on the detection results obtained by the rail pressure sensor 5. In this way, the electronic control unit 8 controls the rail pressure so that a target value of the rail pressure is achieved. In addition, the electronic control unit 8 transmits command signals to solenoid valves of the injectors 7 to control fuel injection timing and a fuel injection amount.

[0022] In the common rail diesel engine configured as described above, the electronic control unit 8 determines whether the pressure reducing valve 6 is stuck closed when the engine is stopped. The determination is made through the process of a routine for determining whether the valve is stuck closed as shown in FIG. 2. The process of the routine is started by the electronic control unit 8 when an ignition switch is turned off. When the ignition switch is turned off, the pressure reducing valve 6 is closed.

[0023] When the process of the routine is started, first, an amount of reduction in fuel pressure (rail pressure) per unit time, that is, a rate of reduction in fuel pressure is detected in step S101. When the detection is completed, a valve opening command is output to the pressure reducing valve 6 (i.e., a valve opening command for the pressure reducing valve 6 is provided) in step S102. Then, after the output of the valve opening command, an amount of reduction in fuel pressure (rail pressure) per unit time, that is, a rate of reduction in fuel pressure is detected again in step S103.

[0024] After detection of the rate of reduction in fuel pressure before the output of the valve opening command and detection of the rate of reduction in fuel pressure after the output of the valve opening command are

completed, it is determined in step S104 whether there is a change in rate of reduction in fuel pressure between before and after the output of the valve opening command. Whether there is a change in rate of reduction in fuel pressure between before and after the output of the valve opening command is determined, for example, by determining whether a difference in rate of reduction in fuel pressure between before and after the output of the valve opening command is equal to or larger than a predetermined reference value, or by determining whether a ratio of the rate of reduction in fuel pressure after the output of the valve opening command to the rate of reduction in fuel pressure before the output of the valve opening command is equal to or higher than a predetermined reference value.

[0025] If a condition that there is no change in rate of reduction in fuel pressure between before and after the output of the valve opening command is satisfied (YES in S104), it is determined in step S105 that the pressure reducing valve 106 is stuck closed, and then the process of the routine ends. On the other hand, if there is a significant change in rate of reduction in fuel pressure between before and after the output of the valve opening command, in other words, if the condition that there is no change in rate of reduction in fuel pressure between before and after the output of the valve opening command is not satisfied (NO in S104), it is determined in step S106 that the pressure reducing valve 6 is not stuck closed and then the process of the routine ends.

[0026] Next, operations of the thus configured malfunction detection device for an engine according to the embodiment will be described. First, with reference to FIG. 3, description will be provided regarding a control mode when there has not occurred fuel leakage from the fuel system due to foreign matter caught in a valve portion of the solenoid valve of the injector 7 or foreign matter caught in the spill valve of the high-pressure fuel pump 2.

[0027] At time t_0 in FIG. 3, the ignition switch (IG switch) is turned off. Then, based on a reduction amount ΔP_{Pref} of the fuel pressure (rail pressure), that is, an amount by which the fuel pressure (rail pressure) is reduced until a lapse of a predetermined period T_A after the ignition switch is turned off at time t_0 , an amount of reduction in fuel pressure per unit time, that is, a reduction rate $\Delta P_{\text{Pref}}/T_A$ is calculated. When the ignition switch is turned off, the pressure reducing valve 6 is closed. If there is no fuel leakage, the fuel pressure inside the common rail 4 is maintained. Therefore, in this case, the fuel pressure reduction amount ΔP_{Pref} and the fuel pressure reduction rate $\Delta P_{\text{Pref}}/T_A$ are both zero.

[0028] At time t_1 at which the calculation is completed, a valve opening command is output to the pressure reducing valve 6. Then, based on a reduction amount ΔP , that is, an amount by which the fuel pressure (rail pressure) is reduced until a lapse of a predetermined period T_B after the valve opening command is output at time t_1 , an amount of reduction in fuel pressure per unit time, that is, a reduction rate $\Delta P/T_B$ is calculated.

[0029] If there is no malfunction in the pressure reducing valve 6 and the pressure reducing valve 6 is opened in response to the above-described valve opening command, the fuel is discharged from the common rail 4 and the fuel pressure (rail pressure) inside the common rail 4 is reduced. In this case, there is a significant difference in rate of reduction in fuel pressure between before and after the output of the valve opening command. As a result, the electronic control unit 8 determines that the pressure reducing valve 6 is not stuck closed.

[0030] If the pressure reducing valve 6 is stuck closed, the pressure reducing valve 6 remains closed even if the valve opening command is output. The fuel is not discharged from the common rail 4, and the fuel pressure inside the common rail 4 (rail pressure) remains unchanged. Therefore, in this case, the rate of reduction in fuel pressure remains at zero even after the valve opening command is output, and there is no significant difference in rate of reduction in fuel pressure between before and after the output of the valve opening command. As a result, the electronic control unit 8 determines that the pressure reducing valve 6 is stuck closed.

[0031] Next, with reference to FIG. 4, description will be provided regarding a control mode when there has occurred fuel leakage from the fuel system due to foreign matter caught in the valve portion of the solenoid valve of the injector 7 or foreign matter caught in the spill valve of the high-pressure fuel pump 2.

[0032] At time t_0 in FIG. 4, the ignition switch (IG switch) is turned off. In this case as well, based on a reduction amount ΔP_{Pref} of the fuel pressure (rail pressure), that is, an amount by which the fuel pressure (rail pressure) is reduced until a lapse of a predetermined period T_A after the ignition switch is turned off at time t_0 , an amount of reduction in fuel pressure per unit time, that is, a reduction rate $\Delta P_{\text{Pref}}/T_A$ is calculated. In this case, the fuel pressure (rail pressure) inside the common rail 4 is reduced over time due to the fuel leakage at the injector 7 or at the high-pressure fuel pump 2. Therefore, the fuel pressure reduction rate $\Delta P_{\text{Pref}}/T_A$ in this case is a positive value.

[0033] At time t_1 at which the calculation is completed, a valve opening command is output to the pressure reducing valve 6. Then, based on a reduction amount ΔP , that is, an amount by which the fuel pressure (rail pressure) is reduced until a lapse of a predetermined period T_B after the valve opening command is output at time t_1 , an amount of reduction in fuel pressure per unit time, that is, a reduction rate $\Delta P/T_B$ is calculated.

[0034] If there is no malfunction in the pressure reducing valve 6 and the pressure reducing valve 6 is opened in response to the above valve opening command, the fuel is discharged from the common rail 4. In this case, because the fuel is discharged from the pressure reducing valve 6 when fuel leakage has occurred at the injector 7 or at the high-pressure fuel pump 2, the rate of reduction in fuel pressure is higher than that before the output of the valve opening command to the pressure reducing

valve 6. Accordingly, in this case, there is a significant difference in rate of reduction in fuel pressure between before and after the output of the valve opening command. As a result, the electronic control unit 8 determines that the pressure reducing valve 6 is not stuck closed.

[0035] On the other hand, if the pressure reducing valve 6 is stuck closed, the pressure reducing valve 6 remains closed even if the valve opening command is output, and the fuel is not discharged from the common rail 4. Therefore, in this case, the fuel pressure is reduced due to only the fuel leakage at the injector 7 or at the high-pressure fuel pump 2, and the rate of reduction in fuel pressure after the output of the valve opening command is unchanged from that before the output of the valve opening command. Therefore, in this case, there is no significant difference in rate of reduction in fuel pressure between before and after the output of the valve opening command. As a result, the electronic control unit 8 determines that the pressure reducing valve 6 is stuck closed.

[0036] With the malfunction detection device for an engine according to the embodiment described above, it is possible to produce the following advantageous effect. In the embodiment, the command (the valve opening command) to open the pressure reducing valve 6 is output after the engine is stopped. Then, the amount of reduction in fuel pressure per unit time before the output of the valve opening command and the amount of reduction in fuel pressure per unit time after the output of the valve opening command are detected. Based on the detection results, whether the pressure reducing valve 6 is stuck closed is determined. More specifically, the amount of reduction in fuel pressure per unit time before the output of the valve opening command and the amount of reduction in fuel pressure per unit time after the output of the valve opening command are detected, and then, if there is no change in amount of reduction in fuel pressure per unit time between before and after the output of the valve opening command, it is determined that the pressure reducing valve 6 is stuck closed. This makes it possible to accurately determine whether the pressure reducing valve 6 is stuck closed, regardless of whether there has occurred fuel leakage from the fuel system due to, for example, foreign matter caught in the valve portion of the solenoid valve in the injector 7 or foreign matter caught in the spill valve of the high-pressure fuel pump 2. Therefore, according to the embodiment, it is possible to more accurately detect whether the pressure reducing valve 6 is stuck closed.

[0037] The following modifications may be made to the above embodiment. In the above embodiment, the rate of reduction in fuel pressure is calculated based on the amount of reduction in fuel pressure. Alternatively, it is possible to determine whether the pressure reducing valve 6 is stuck closed, by measuring amounts of reduction in the fuel pressure over the same period of time before and after an output of the valve opening command and directly comparing the reduction amounts with each

other. In other words, if the period TA and the period TB in FIG. 3 and FIG. 4 are set to the same length of period, it is possible to use the amounts of reduction in the fuel pressure during the period TA and the period TB as the amounts of reduction in the fuel pressure per unit time, and calculations for obtaining the rates of reduction in the fuel pressure are omitted.

[0038] In the above embodiment, the rail pressure is used as the fuel pressure in the fuel system. However, even if the fuel pressure at another portion of the fuel system such as the fuel pressure inside the injector 7 is used, it is possible to determine whether the pressure reducing valve 6 is stuck closed in a manner similar to that described above.

[0039] In the above embodiment, the malfunction detection device according to the invention is applied to the common rail diesel engine provided with the pressure reducing valve 6 which is configured as a valve that discharges fuel from the common rail 4. However, the malfunction detection device according to the invention is applicable to an engine provided with a pressure reducing valve that is provided at a portion other than a common rail in a fuel system and that discharges fuel from the fuel system to reduce the fuel pressure in the fuel system.

[0040] In the above embodiment, the malfunction detection device according to the invention is applied to the common rail diesel engine. However, the invention may be applied also to engines other than the common rail diesel engine as long as the engines have a fuel system that includes a pressure reducing valve that discharges fuel from the fuel system to reduce the fuel pressure of the fuel system.

Claims

1. A malfunction detection device for an engine, which detects whether a pressure reducing valve (6) that discharges fuel from a fuel system of an engine to reduce fuel pressure in the fuel system is stuck closed, **characterized in that** the malfunction detection device is configured to provide a valve opening command to open the pressure reducing valve (6) after the engine is stopped, detect an amount of reduction in the fuel pressure per unit time before the valve opening command is provided and an amount of reduction in the fuel pressure per unit time after the valve opening command is provided, and determine whether the pressure reducing valve (6) is stuck closed based on the detected amount of reduction in the fuel pressure per unit time before the valve opening command is provided and the detected amount of reduction in the fuel pressure per unit time after the valve opening command is provided.
2. The malfunction detection device according to claim

- 1, wherein the malfunction detection device is configured to determine that the pressure reducing valve (6) is stuck closed when there is no change between the detected amount of reduction in the fuel pressure per unit time before the valve opening command for the pressure reducing valve (6) is provided and the detected amount of reduction in the fuel pressure per unit time after the valve opening command for the pressure reducing valve (6) is provided.
3. The malfunction detection device according to claim 1, wherein the malfunction detection device is configured to determine whether the pressure reducing valve (6) is stuck closed based on a difference between the detected amount of reduction in the fuel pressure per unit time before the valve opening command is provided and the detected amount of reduction in the fuel pressure per unit time after the valve opening command is provided.
4. The malfunction detection device according to claim 1, wherein the malfunction detection device is configured to determine whether the pressure reducing valve (6) is stuck closed based on a ratio of the detected amount of reduction in the fuel pressure per unit time after the valve opening command is provided to the detected amount of reduction in the fuel pressure per unit time before the valve opening command is provided.
5. The malfunction detection device according to any one of claims 1 to 4, wherein the pressure reducing valve (6) is configured as a valve which discharges fuel from a common rail (4) of a common rail diesel engine.
6. A malfunction detection method for an engine, for detecting whether a pressure reducing valve (6) that discharges fuel from a fuel system of an engine to reduce fuel pressure in the fuel system is stuck closed, **characterized by** comprising:
- detecting an amount of reduction in the fuel pressure per unit time after the engine is stopped;
providing a valve opening command to open the pressure reducing valve (6);
detecting an amount of reduction in the fuel pressure per unit time after the valve opening command is provided; and
determining whether the pressure reducing valve (6) is stuck closed based on the detected amount of reduction in the fuel pressure per unit time before the valve opening command is provided and the detected amount of reduction in the fuel pressure per unit time after the valve opening command is provided.
7. The malfunction detection method according to claim 6, wherein it is determined that the pressure reducing valve (6) is stuck closed when there is no change between the detected amount of reduction in the fuel pressure per unit time before the valve opening command for the pressure reducing valve (6) is provided and the detected amount of reduction in the fuel pressure per unit time after the valve opening command for the pressure reducing valve (6) is provided.
8. The malfunction detection method according to claim 6, wherein whether the pressure reducing valve (6) is stuck closed is determined based on a difference between the detected amount of reduction in the fuel pressure per unit time before the valve opening command is provided and the detected amount of reduction in the fuel pressure per unit time after the valve opening command is provided.
9. The malfunction detection method according to claim 6, wherein whether the pressure reducing valve (6) is stuck closed is determined based on a ratio of the detected amount of reduction in the fuel pressure per unit time after the valve opening command is provided to the detected amount of reduction in the fuel pressure per unit time before the valve opening command is provided.

FIG. 1

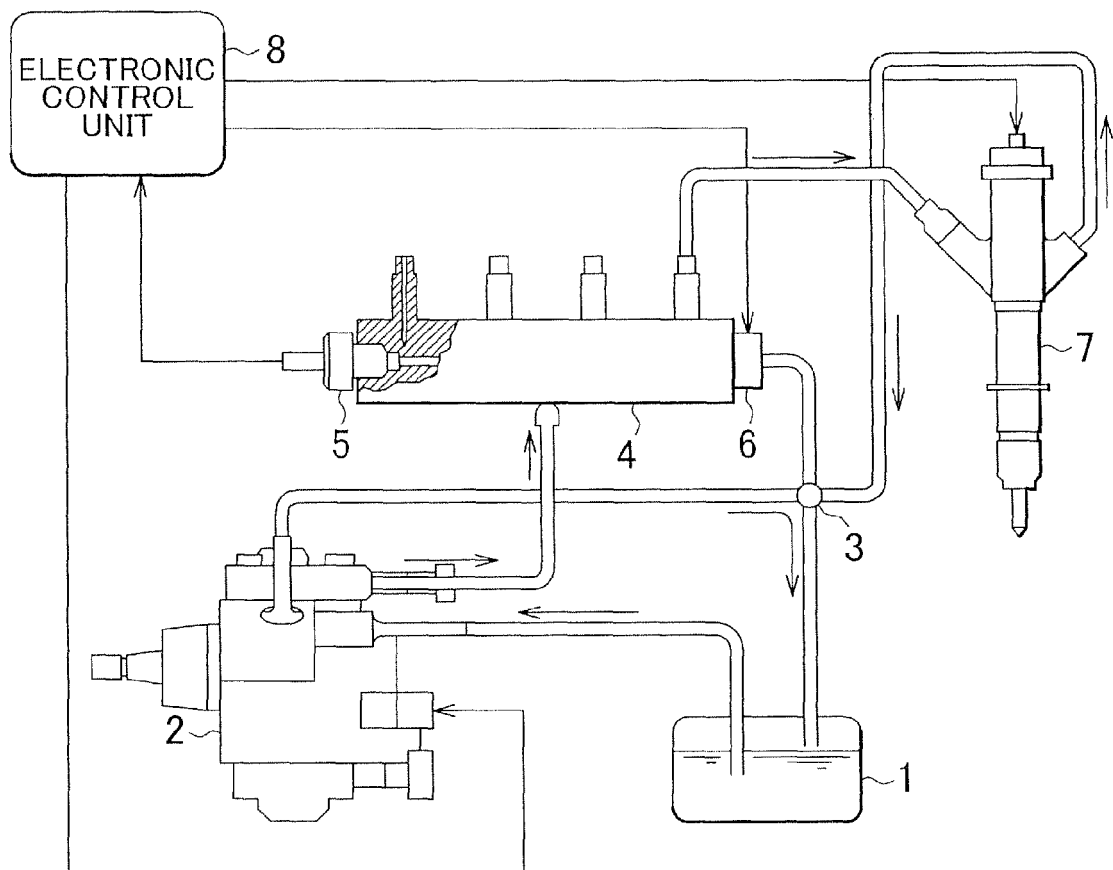


FIG. 2

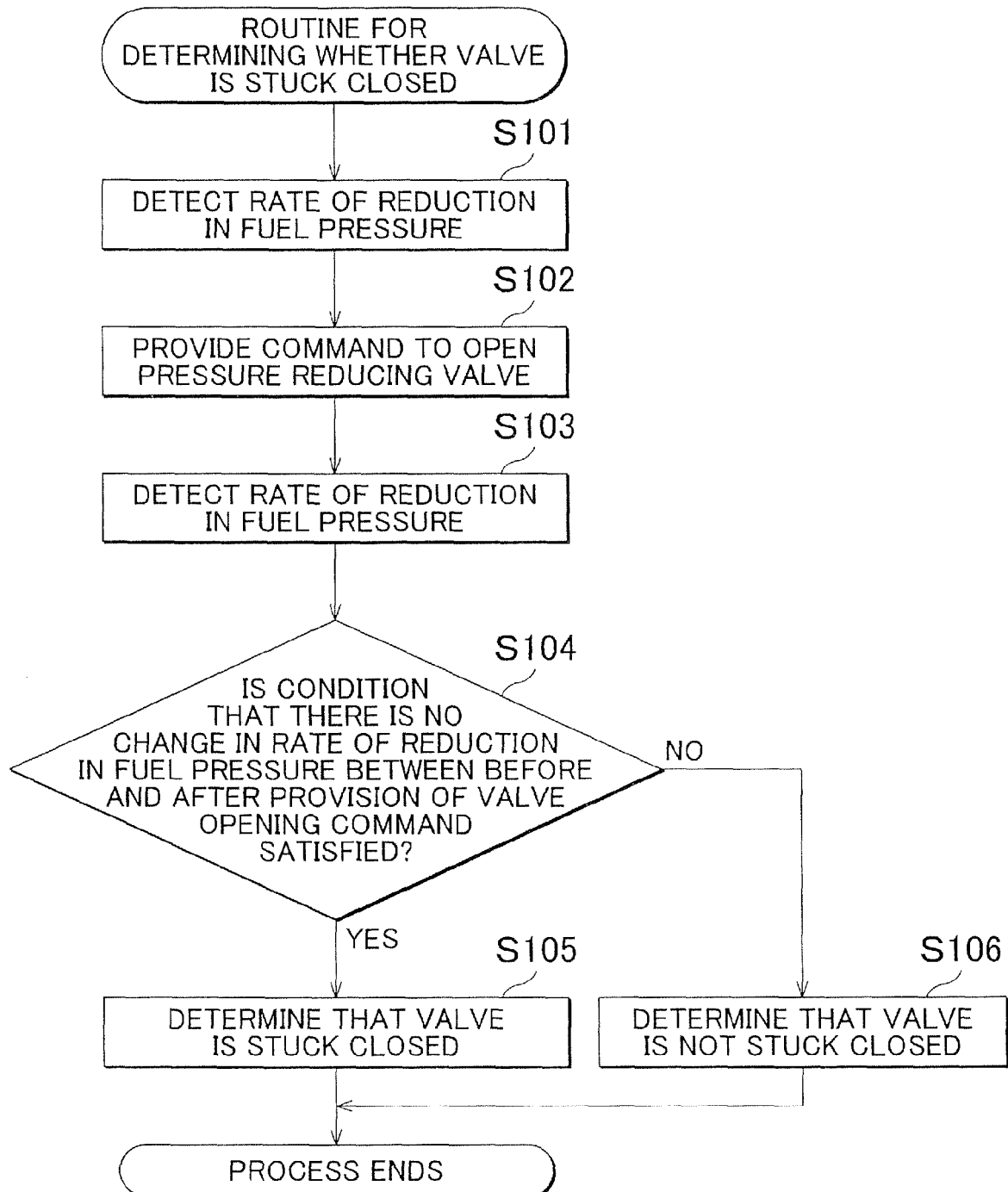


FIG. 3

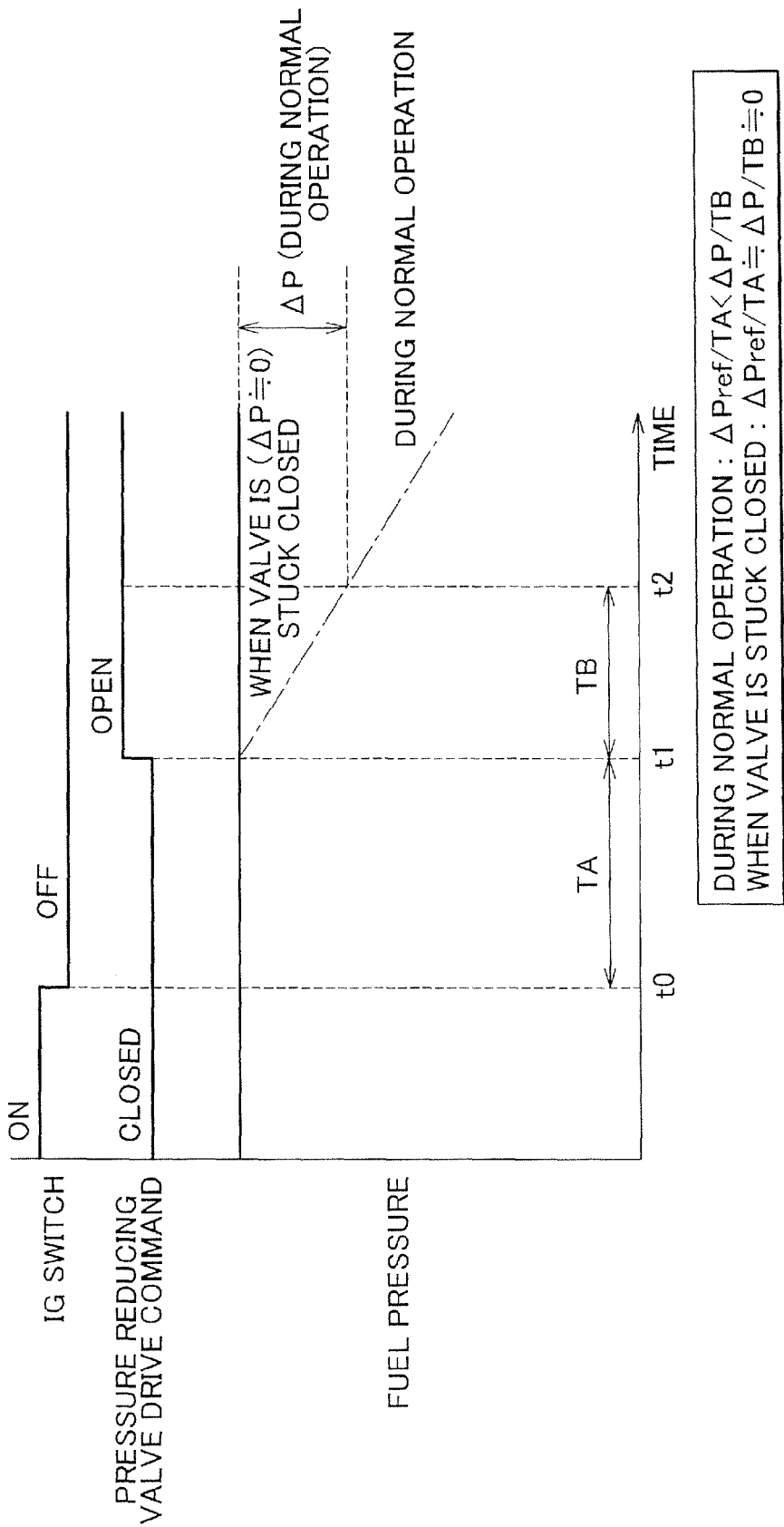
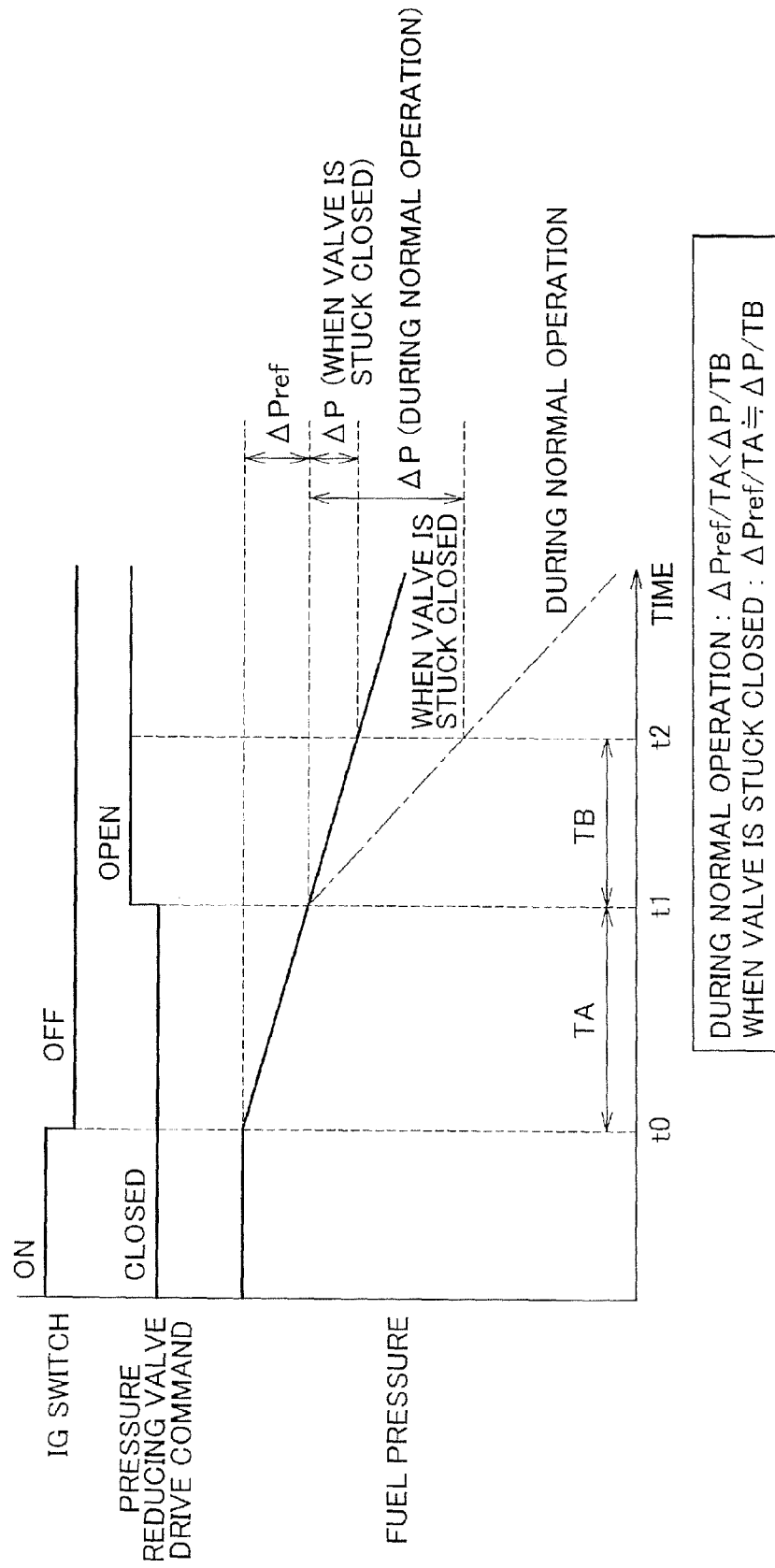


FIG. 4





EUROPEAN SEARCH REPORT

Application Number
EP 12 17 5666

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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			F02D F02M
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 21 November 2012	Examiner Calabrese, Nunziante
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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EPO FORM 1503 03.82 (P04C01)

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

EP 12 17 5666

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