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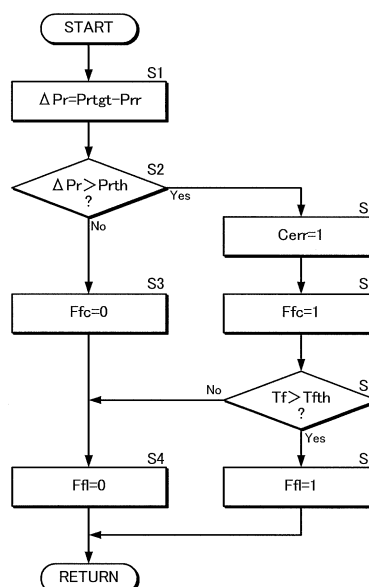
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(54) **CONTROL DEVICE FOR COMMON-RAIL SYSTEM IN ABNORMAL CONDITION**

(57) Provided is an abnormality control system for a common rail system that can prevent an incorrect abnormality detection in low temperature conditions. Upon starting of a fuel leakage determining process, the abnormality detecting unit (91) computes a pressure difference ΔPr between a target rail pressure Pr_{tgt} and a rail pressure detection value Prr in step S1, and then determines if the pressure difference ΔPr is higher than a rail pressure drop detection threshold value Pr_{th} in step S2. When the determination result of step S2 is Yes, the abnormality detecting unit (91) sets an abnormality code $Cerr$ to 1 in step S5, sets the output reduction flag Ffc to 1 in step S6, and determines if the fuel temperature Tf received from the fuel temperature sensor (73) is higher than a waxing detection threshold value Tf_{th} in step S7. When the fuel temperature Tf is relatively high, and the determination result of step S7 is thereby Yes, the abnormality detecting unit (91) sets the fuel leakage flag Ffl to 1 in step S8 as a case of leakage in the fuel system.

Fig.4



Description

TECHNICAL FIELD

5 **[0001]** The present invention relates to an abnormality control system for a common rail system, and in particular to a technology for controlling faulty detections in low temperature conditions.

BACKGROUND OF THE INVENTION

10 **[0002]** In modern automotive diesel engines, to the end of reducing harmful emissions and improving fuel economy, there is a growing use of electronically controlled fuel injection systems that can control the injection pressure, injection timing, injection period (amount of injection) at a high precision. A particularly preferred form of electronically controlled fuel injection systems for diesel engines is the common rail fuel injection system that draws fuel from a fuel tank by using a low pressure pump (feed pump), pressurizes the drawn fuel by using a high pressure pump (supply pump) which is
15 mechanically actuated by the engine, stores the pressurized fuel in a common rail, and distributes the fuel stored in the common rail to the fuel injection valves of the different cylinders.

[0003] The output of the supply pump is feedback controlled so that the pressure (rail pressure) in the common rail may be maintained at a fixed level. As a result, should fuel leakage occur in any part of the paths between the supply pump and fuel injection valves, the output of the supply pump would be increased to maintain the rail pressure, and this
20 would further increase the fuel leakage. Therefore, a common rail system is typically equipped with an abnormality detection system that detects the occurrence of fuel leakage by comparing a target output (pressure compensation value) set for a fuel output control valve for controlling the output of the supply pump with a prescribed reference value, and determining the occurrence of fuel leakage according to the result of this comparison. See patent document 1. In such an abnormality detection system, to avoid incorrectly detecting fuel leakage, the detection of fuel leakage is tem-
25 porarily prohibited under certain operating conditions of the engine which involve rapid changes in the pressure of the fuel supply system, and could cause significant changes in the target output or target pressure control value.

[patent document 1] Japanese patent No. 3147460

30 BRIEF SUMMARY OF THE INVENTION

TASKS TO BE ACCOMPLISHED BY INVENTION

[0004] In the abnormality detection system proposed in patent document 1, because diesel fuel contains paraffin for the purpose of lubrication, a correct detection of abnormality may not be possible in low temperature conditions. More
35 specifically, a drop in the ambient temperature may cause waxing (solidification of paraffin) in the fuel supply system, and the resulting partial blockage of the fuel pipe immediately following the startup of the engine may prevent the rise of the rail pressure to a prescribed level. This may be incorrectly detected by the abnormality detection system as the occurrence of fuel leakage. Such an incorrect detection of fuel leakage would activate a fuel leakage warning lamp so
40 that the vehicle operator may have to experience unnecessary discomfort and may even cause the unnecessary trouble of bringing the vehicle to a repair shop.

[0005] In view of such problems of the prior art, a primary object of the present invention is to provide an abnormality control system for a common rail system that can prevent an incorrect abnormality detection in low temperature conditions.

45 MEANS TO ACCOMPLISH THE TASK

[0006] According to a first aspect of the present invention, such an object can be accomplished by providing an abnormality control system for a common rail system that comprises a supply pump (65) for pressurizing fuel to a prescribed pressure, a common rail (7) for storing the pressurized fuel, a fuel injection valve (8) for injecting the fuel in
50 the common rail into a combustion chamber of an internal combustion engine (E), a rail pressure detector (75) for detecting a rail pressure in the common rail, and an output control unit (72) for controlling an output of the supply pump according to a result of comparison between the rail pressure detected by the rail pressure detector and a target rail pressure, the abnormality control system being configured to determine an occurrence of abnormality and to execute a prescribed abnormality control process when a difference between the rail pressure detected by the rail pressure detector and the target rail pressure exceeds an abnormality determination threshold value, characterized by that: the abnormality
55 control system comprises a fuel temperature sensor for detecting a temperature of the fuel, and an abnormality determination canceling unit that cancels an execution of the abnormality control process when a temperature detected by the fuel temperature sensor is lower than an abnormality determination canceling threshold value.

[0007] According to a second aspect of the present invention, in addition to the features of the first aspect of the present invention, the output control unit (72) reduces an output of the supply pump when the temperature detected by the fuel temperature sensor is lower than the abnormality determination canceling threshold value, and the abnormality determination canceling unit ceases the execution of the abnormality control process until a prescribed time period has elapsed since the start-up of engine.

[0008] According to a third aspect of the present invention, in addition to the features of the first aspect of the present invention, the abnormality control process comprises lighting of an alarm lamp.

[0009] According to a fourth aspect of the present invention, in addition to the features of the first aspect of the present invention, the common rail system comprises a fuel heater.

EFFECT OF THE INVENTION

[0010] According to a first aspect of the present invention, in low temperature conditions when the rail pressure does not rise to a prescribed level owing the occurrence of waxing in the fuel supply system, even when a state indicative of fuel leakage is detected, the abnormality determination canceling unit cancels the execution of the abnormality control process so that the vehicle operator is prevented from experiencing anxiety or being otherwise discomforted by an unnecessary warning such as lighting of a fuel leakage warning lamp. According to a second aspect of the present invention, even when a partial blockage of the fuel piping system should occur, the output of the supply pump is reduced so that the load of the supply pump is reduced, and an erroneous detection of fuel leakage can be avoided because the abnormality control process is executed only after the rail pressure has risen to a prescribed level. According to a third aspect of the present invention, the vehicle operator is notified of an abnormal condition of the fuel supply system, and is allowed to bring the vehicle to a repair shop. According to a fourth aspect of the present invention, as the operation of the engine continues, the fuel temperature progressively rises, and the blockage of the fuel piping system due to waxing can be eliminated in a relatively short period of time.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0011] Two embodiments of the present invention applied to a common rail system of an automotive diesel engine are described in the following with reference to the appended drawings.

[First Embodiment]

[0012] Figure 1 generally illustrates the overall structure of the engine system of the first embodiment, Figure 2 is a block diagram showing how an engine ECU is connected to various components in the first embodiment, and Figure 3 is a simplified block diagram showing the overall structure of an abnormality detecting unit of the first embodiment.

<Structure of the First Embodiment>

[0013] Referring to Figure 1, the engine system 1 of the first embodiment comprises, in association with an inline four-cylinder diesel engine (internal combustion engine; referred to simply as "engine" in the following description) E, an intake system including an air cleaner 2, an intake pipe 3 and an intake manifold 4, an exhaust system including an exhaust manifold 5 and an exhaust pipe 6 and a fuel supply/injection system (common rail system) including a common rail 7 and electronically controlled fuel injection valves 8. In the illustrated vehicle, an engine ECU (electronic control unit) 9 is provided inside the cabin of the vehicle, and an accelerator pedal 10 is provided adjacent to the driver's seat for a vehicle operator to use. Each cylinder of the engine E is fitted with a glow plug 48 to warm up the cylinder head when cold starting the engine.

<Structure of the Intake and Exhaust Systems>

[0014] Between the intake pipe 3 and exhaust pipe 6 is interposed a variable geometry turbocharger (VG turbo) 11 to supply pressurized air to the engine E by using the energy of the exhaust gas. The intake pipe 3 is provided with an intercooler 12 for cooling the intake air which is heated as a result of pressurization by the VG turbo 11 and an electrically actuated intake shutter 13 for restricting the intake air flow in a prescribed operating range. Between the intake pipe 3 and intake manifold 4 is provided an electrically actuated swirl control valve 14 for increasing the intake flow velocity by narrowing the cross section of the flow passage in a prescribed low-rpm, low load operating range.

[0015] The intake manifold 4 and exhaust manifold 5 are connected to each other via an EGR (exhaust gas recirculation) passage 21 to conduct hot exhaust gas to the combustion chambers. A middle part of the EGR passage 21 is branched into an EGR cooler 21a and a bypass passage 21b, and a converging part of these two passages is provided with a

switch valve 22. To the downstream end of the switch valve 22 is connected an EGR control valve 23 for adjusting the amount of exhaust gas (EGR gas) that flows into the combustion chambers.

[0016] The exhaust pipe 6 is connected to an exhaust gas cleaning device 34 including a DOC (diesel oxide catalyst) 31, a DPF (diesel particulate filter) 32 and a LNC (lean Nox catalyst) 33 which are connected in series along the direction of the exhaust gas flow.

[0017] The engine E is provided with a crank angle sensor 41 for detecting a crank angle of the engine and a water temperature sensor 42 for detecting a cooling water temperature of the engine. The accelerator pedal 10 is provided with an accelerator pedal sensor 43 that detects a depression stroke of the accelerator pedal 10.

[0018] The intake system includes an intake flow rate sensor 44 and an intake air temperature sensor 45 provided immediately downstream of the air cleaner 2, and an upstream end intake pressure sensor 46 and an upstream end intake air temperature sensor 47 provided between the intercooler 12 and intake shutter 13. Although not shown in the drawing, the intake system further comprises a shutter opening angle sensor for detecting an opening angle of the intake shutter 13, a downstream end intake pressure sensor for detecting an intake pressure downstream of the intake shutter 13 and a downstream end intake air temperature sensor for detecting an intake temperature downstream of the intake shutter 13.

[0019] The exhaust system includes a first exhaust temperature sensor 51 and a first LAF (linear air fuel ratio) sensor 52 provided immediately downstream of the VG turbo 11, a second exhaust temperature sensor 53 provided between the DOC 31 and DPF 32, a second LAF sensor 54 provided between the DPF 32 and LNC 33, and a third exhaust temperature sensor 55 and a third LAF sensor 56 provided downstream of the LNC 33.

<Structure of the Common Rail System>

[0020] The common rail system essentially consists of a feed pump 62 provided inside a fuel tank 61, a fuel filter 64 for removing moisture and foreign matters contained in the fuel, a supply pump (two-cylinder plunger pump) 65 actuated by the engine to pressurize the fuel and the common rail 7 for storing the pressurized fuel.

[0021] The fuel filter 64 is provided with a fuel heater 71 for heating the fuel in low temperature conditions. The supply pump 65 is provided with an output control valve 72 for controlling the pump output and a fuel temperature sensor 73 for detecting the temperature of the fuel. The common rail 7 is provided with a rail pressure control valve 74 for controlling the rail pressure and a rail pressure sensor 75 for detecting the rail pressure.

[0022] The feed pump 62, fuel filter 64 and supply pump 65 are connected to one another by feed pipes 81 and 82, and the supply pump 65 is connected to the common rail 7 via supply pipes 83 and 84. The common rail 7 is connected to the fuel injection valves 8 via delivery pipes 85. The output control valve 72 and rail pressure control valve 74 are connected to the fuel tank 61 via a drain pipe 86 to return excess fuel back to the fuel tank 61.

<Engine ECU>

[0023] The engine ECU 9 essentially consists of a microcomputer, ROM, RAM, peripheral circuits, an input/output interface and various drivers. As shown in Figure 2, the engine ECU 9 receives detection signals from the above mentioned sensors, and forwards drive signals to the above mentioned components such as the fuel injection valves 8, VG turbo, supply pump 65 and so on. The engine ECU 9 is also connected to various other sensors and engine control devices, but it is omitted from the description.

<Abnormality Detecting Unit>

[0024] The engine ECU 9 includes an abnormality detecting unit 91 which is outlined in Figure 3. As shown in Figure 3, the abnormality detecting unit 91 includes a pressure difference detector 92, a waxing detecting unit (abnormality determination canceling unit) 93, and a fuel leakage detecting unit 94 that detects the occurrence of fuel leakage according to the outputs of the pressure difference detector 92 and waxing detecting unit 93. The pressure difference detector 92 computes a pressure difference ΔP_r between the target rail pressure P_{rtgt} and detected rail pressure P_{rr} , and forwards the pressure difference to the fuel leakage detecting unit 94. The waxing detecting unit 93 forwards a waxing detection signal to the fuel leakage detecting unit 9 typically when the fuel temperature is low, and additionally forwards an output reduction flag to the output control unit.

<<Mode of Operation of the First Embodiment>>

[0025] Once the engine system 1 is started up, and the engine E is cranked up by the vehicle operator, the engine ECU 9 controls the operation of the engine by looking up the target fuel injection amount, target supercharge pressure and target rail pressure by using maps not shown in the drawings or otherwise determining such variables according to

the detections signals of the various sensors, and drives the fuel injection valves 8, VG turbo 11 and supply pump 65 in a corresponding manner. The engine ECU 9 of the illustrated embodiment cyclically executes a fuel leakage determining process as depicted in the flowchart of Figure 4 at a prescribed processing interval (10 ms, for instance) in parallel with the startup and operation control of the engine

<<Fuel Leakage Determining Process>>

[0026] Upon starting of a fuel leakage determining process, the abnormality detecting unit 91 computes a pressure difference ΔPr between a target rail pressure $Prtgt$ received from a rail pressure setting unit not shown in the drawings and a rail pressure detection value Prr received from the rail pressure sensor 75 in step S1 in the flowchart of Figure 4, and then determines if the pressure difference ΔPr is higher than a rail pressure drop detection threshold value (abnormality detection threshold value) $Prth$ in step S2. If this determination result is No, the abnormality detecting unit 91 determines that there is no abnormality in the fuel system, and resets an output reduction flag Ffc (which is described hereinafter) having an initial value of 0 and a fuel leakage flag Ffl (which is described hereinafter) both back to 0 in step S3 and step S4, respectively. Thereafter, the program flow returns to start.

[0027] When the determination result of step S2 is Yes, the abnormality detecting unit 91 sets an abnormality code $Cerr$ to 1 in step S5, sets the output reduction flag Ffc to 1 in step S6, and determines if the fuel temperature Tf received from the fuel temperature sensor 73 is higher than a waxing detection threshold value $Tfth$ in step S7. The abnormality code $Cerr$ is a code indicating the possibility of leakage in the fuel system, and is stored in a storage device (not shown in the drawings) of the engine ECU 9. The output reduction flag Ffc is a flag forwarded to an output control unit (not shown in the drawings) of the engine ECU 9. When the value of the output reduction flag Ffc is 1, an output reduction command is forwarded from the output control unit to the output control valve 72 so that the load of the supply pump 65 is prevented from being excessive even when there is blockage in the fuel piping system caused by waxing.

[0028] When the fuel temperature Tf is relatively high, and the determination result of step S7 is thereby Yes, the abnormality detecting unit 91 sets the fuel leakage flag Ffl to 1 in step S8 as a case of leakage in the fuel system. The fuel leakage flag Ffl is forwarded to a fuel leakage processing unit (not shown in the drawings) of the engine ECU 9. When the value of the fuel leakage flag Ffl is 1, an abnormality process (such as lighting up a fuel leakage warning lamp, special rail pressure control at the time of fuel leakage, etc.) is executed. Thereby, the vehicle operator may be notified of an abnormal condition by the lighting up of the fuel leakage warning lamp in the instrument panel, and allowed to bring the vehicle to a repair shop.

[0029] When the fuel temperature Tf is low typically due to a low ambient temperature, and this has caused the determination result of step S7 to be No, the abnormality detecting unit 91 determines that the fuel piping (such as the feed pipes 81 and 82 and supply pipe 83) may be blocked up due to waxing, and sets the fuel leakage flag Ffl to 0 in step S4 as a measure to prevent an erroneous leakage detection. Thereafter, the program flow returns to start.

<Rise in Fuel Temperature>

[0030] As the engine E warms up, the fuel forwarded from the feed pump 62 to the supply pump 65 is in part supplied to the fuel injection valves 8 via the common rail 7, and the remaining part of the fuel returns to the fuel tank 61 via the output control valve 72, rail pressure control valve 74 and drain pipe 86. By the time the fuel has returned to the fuel tank 61, the fuel is warmed up by the fuel heater 71 provided in the fuel filter 64 and other heat sources. As the engine E continues to run, the fuel temperature Tf progressively rises.

[0031] Eventually, the rise in the fuel temperature Tf eliminates waxing, and the resulting reduction in the pressure difference ΔPr causes the determination result of step S2 to No. The abnormality detecting unit 91 then resets the output reduction flag Ffc to 0 in step S3, and the program flow returns to start. As a result, the output reduction command ceases to be forwarded to the output control valve 72, and the supply pump 65 is operated so as to achieve the target rail pressure $Prtgt$. At this time, because the abnormality code $Cerr$ is not reset, the abnormality code $Cerr$ is kept stored in a storage device of the engine ECU 9 until the engine E is shut down.

[0032] When the rail pressure detection value Prr remains at a low level and the pressure difference ΔPr exceeds the rail pressure drop detection threshold value $Prth$ even after the fuel temperature Tf has risen above the waxing detection threshold value $Tfth$, as the determination results of steps S2 and S7 are both Yes, the abnormality detecting unit 91 sets the fuel leakage flag Ffl to 1 in step S8. In such a case, the vehicle operator is notified of an abnormal condition by the lighting up of the fuel leakage warning lamp in the instrument panel, and allowed to bring the vehicle to a repair shop.

<Structure of the Second Embodiment>

[0033] The second embodiment is similar to the first embodiment except for a part of the fuel leakage determining process. Therefore, the part of the structure of the second embodiment similar to that of the first embodiment, including

the flags in the fuel leakage determining process, is omitted from the following description.

<<Fuel Leakage Determining Process>>

[0034] Upon starting of the fuel leakage detecting process, the abnormality detecting unit 91 computes a pressure difference ΔPr between a target rail pressure P_{tgt} received from a rail pressure setting unit not shown in the drawings and a rail pressure detection value P_{rr} received from the rail pressure sensor 75 in step S11 in the flowchart of Figure 5. It is then determines if the pressure difference ΔPr is greater than a rail pressure drop detection threshold value (abnormality detection threshold value) P_{rth} in step S12. If this determination result is No, the abnormality detecting unit 91 determines that there is no abnormality in the fuel system, and resets an output reduction flag F_{fc} having an initial value of 0 and a fuel leakage flag F_{fl} both back to 0 in step S13 and step S14, respectively, similarly as in the first embodiment. Thereafter, the program flow likewise returns to start.

[0035] When the determination result of step S12 is Yes, the abnormality detecting unit 91 sets an abnormality code C_{err} to 1 in step S15, sets the output reduction flag F_{fc} to 1 in step S16, and determines if the fuel temperature T_f is higher than a waxing detection threshold value T_{fth} in step S17. If the determination result of step S17 is also Yes, the abnormality detecting unit 91 sets the fuel leakage flag F_{fl} to 1 in step S18. Thereby, the vehicle operator may be notified of an abnormal condition by the lighting up of the fuel leakage warning lamp in the instrument panel, and allowed to bring the vehicle to a repair shop.

[0036] If the fuel temperature T_f is low typically owing to a low ambient temperature, and the determination result of step S17 is therefore No, the abnormality detecting unit 91 increments a determination delay timer T_d which has an initial value of 0 by 1 in step S19, and determines if the value of the determination delay timer T_d has reached a count-up value T_{dmax} in step S20. The count-up value T_{dmax} is set such that the fuel temperature has risen to a sufficient level by the operation of the engine E. As the determination result of step S20 is initially No, the abnormality detecting unit 91 sets the fuel leakage flag F_{fl} to 0 in step S14 as there may be a blockage in the fuel piping owing to waxing before the program flow returns to start.

<Rise in Fuel Temperature>

[0037] As the fuel temperature T_f rises, and waxing disappears, the pressure difference ΔPr diminishes, and the determination result of step S12 eventually changes to No. The abnormality detecting unit 91 then resets the output reduction flag F_{fc} to 0 in step S13, and the program flow returns to start. As a result, the output reduction command ceases to be forwarded to the output control valve 72, and the supply pump 65 is operated so as to achieve the target rail pressure P_{tgt} .

[0038] When the rail pressure detection value P_{rr} remains at a low level and the pressure difference ΔPr exceeds the rail pressure drop detection threshold value P_{rth} even after the fuel temperature T_f has risen above the waxing detection threshold value T_{fth} , as the determination results of steps S12 and S17 are both Yes, the abnormality detecting unit 91 increments a determination delay timer T_d which has an initial value of 0 by 1 in step S19, and determines if the value of the determination delay timer T_d has reached a count-up value T_{dmax} in step S20. The count-up value T_{dmax} is set such that the fuel temperature has risen to a sufficient level by the operation of the engine E. As the determination result of step S20 is initially No, the abnormality detecting unit 91 sets the fuel leakage flag F_{fl} to 0 in step S14 as there may be a blockage in the fuel piping owing to waxing before the program flow returns to start.

[0039] When the rail pressure detection value P_{rr} remains at a low level and the pressure difference ΔPr exceeds the rail pressure drop detection threshold value P_{rth} even after elapsing of a certain time period from the start-up of the engine E, as the determination results of steps S12 and S20 are both Yes, the abnormality detecting unit 91 sets the fuel leakage flag F_{fl} to 1 in step S18. Thereby, the vehicle operator may be notified of an abnormal condition by the lighting up of the fuel leakage warning lamp in the instrument panel, and allowed to bring the vehicle to a repair shop.

[0040] In both the embodiment described above, the fuel leakage can be determined at a high precision in spite of the possible blockage of the fuel piping owing to waxing so that the vehicle operator may be prevented from experiencing unnecessary discomfort or unnecessary trouble of bringing the vehicle to a repair shop.

[0041] Although the present invention has been described in terms of a preferred embodiment thereof, it is obvious to a person skilled in the art that various alterations and modifications are possible without departing from the scope of the present invention which is set forth in the appended claims. For instance, the above described embodiments were limited the applications to inline four-cylinder diesel engines, but the present invention is equally applicable to other diesel or non-diesel engines. Also, the specific structures of the engine system and abnormality detecting unit and the specific steps of the fuel leakage determining process may be modified as required without departing from the spirit of the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0042]

Figure 1 is a simplified diagram of an engine system embodying the present invention;
 Figure 2 is a block diagram showing the relationship between an engine ECU and various other components of the first embodiment;
 Figure 3 is a simplified block diagram of an abnormality detecting unit of the first embodiment;
 Figure 4 is a flowchart showing a fuel leakage detecting process of the first embodiment; and
 Figure 5 is a flowchart showing a fuel leakage detecting process of a second embodiment.

LIST OF NUMERALS

[0043]

1	engine system	7	common rail
8	fuel injection valve	9	engine ECU
65	supply pump	71	fuel heater
72	output control valve	73	fuel temperature sensor
91	abnormality detecting unit		
93	waxing detecting unit (determination canceling unit)		
94	fuel leakage detecting unit	E	engine

Claims

1. An abnormality control system for a common rail system that comprises a supply pump (65) for pressurizing fuel to a prescribed pressure, a common rail (7) for storing the pressurized fuel, a fuel injection valve (8) for injecting the fuel in the common rail into a combustion chamber of an internal combustion engine (E), a rail pressure detector (75) for detecting a rail pressure in the common rail, and an output control unit (72) for controlling an output of the supply pump according to a result of comparison between the rail pressure detected by the rail pressure detector and a target rail pressure, the abnormality control system being configured to determine an occurrence of abnormality and to execute a prescribed abnormality control process when a difference between the rail pressure detected by the rail pressure detector and the target rail pressure exceeds an abnormality determination threshold value, **characterized by that:**

the abnormality control system comprises a fuel temperature sensor for detecting a temperature of the fuel, and an abnormality determination canceling unit that cancels an execution of the abnormality control process when a temperature detected by the fuel temperature sensor is lower than an abnormality determination canceling threshold value.

2. The abnormality control system for a common rail system according to claim 1, wherein the output control unit (72) reduces an output of the supply pump when the temperature detected by the fuel temperature sensor is lower than the abnormality determination canceling threshold value, and the abnormality determination canceling unit ceases the execution of the abnormality control process until a prescribed time period has elapsed since the start-up of engine.
3. The abnormality control system for a common rail system according to claim 1, wherein the abnormality control process comprises lighting of an alarm lamp.
4. The abnormality control system for a common rail system according to claim 1, wherein the common rail system comprises a fuel heater.

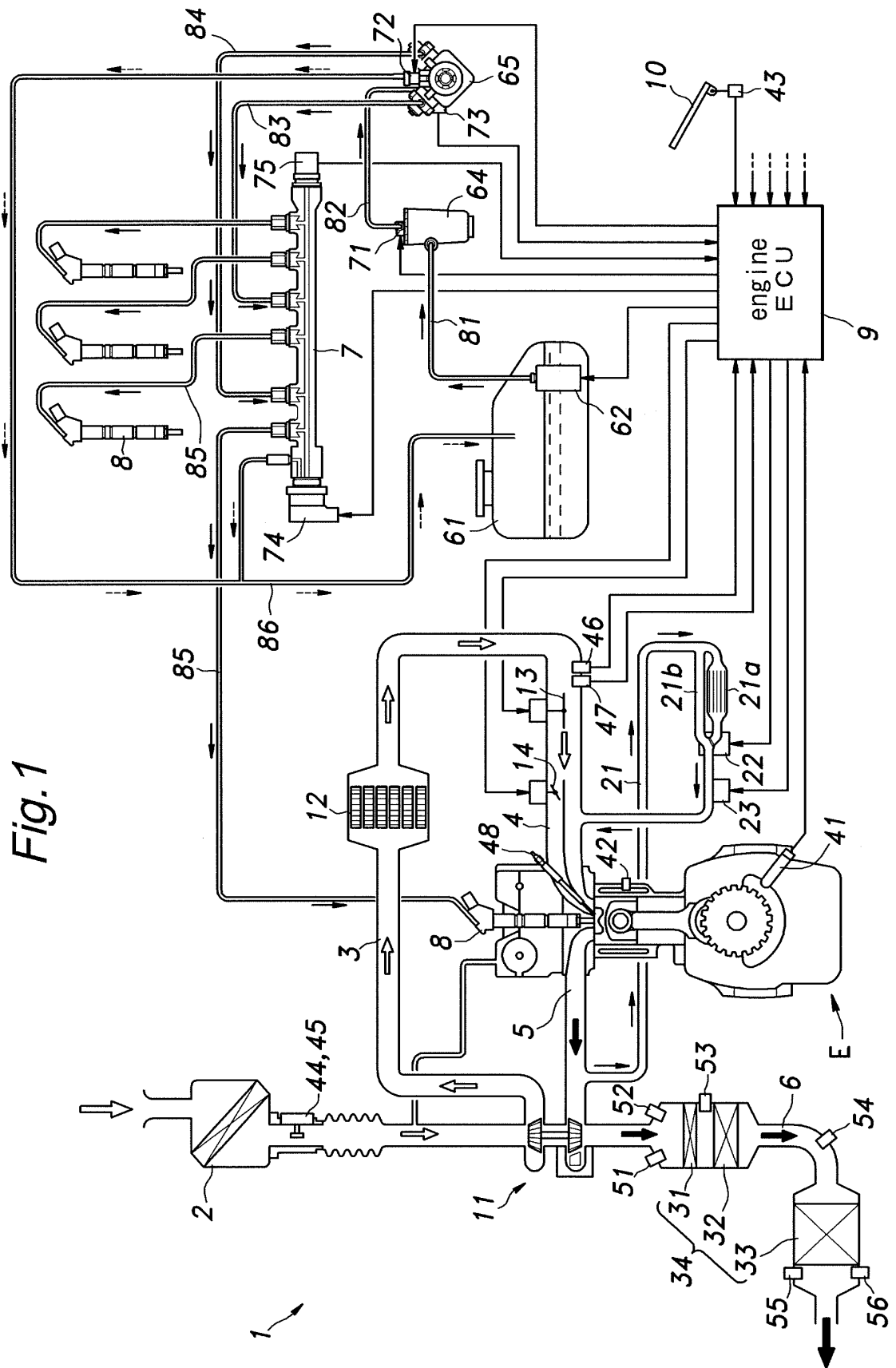


Fig. 1

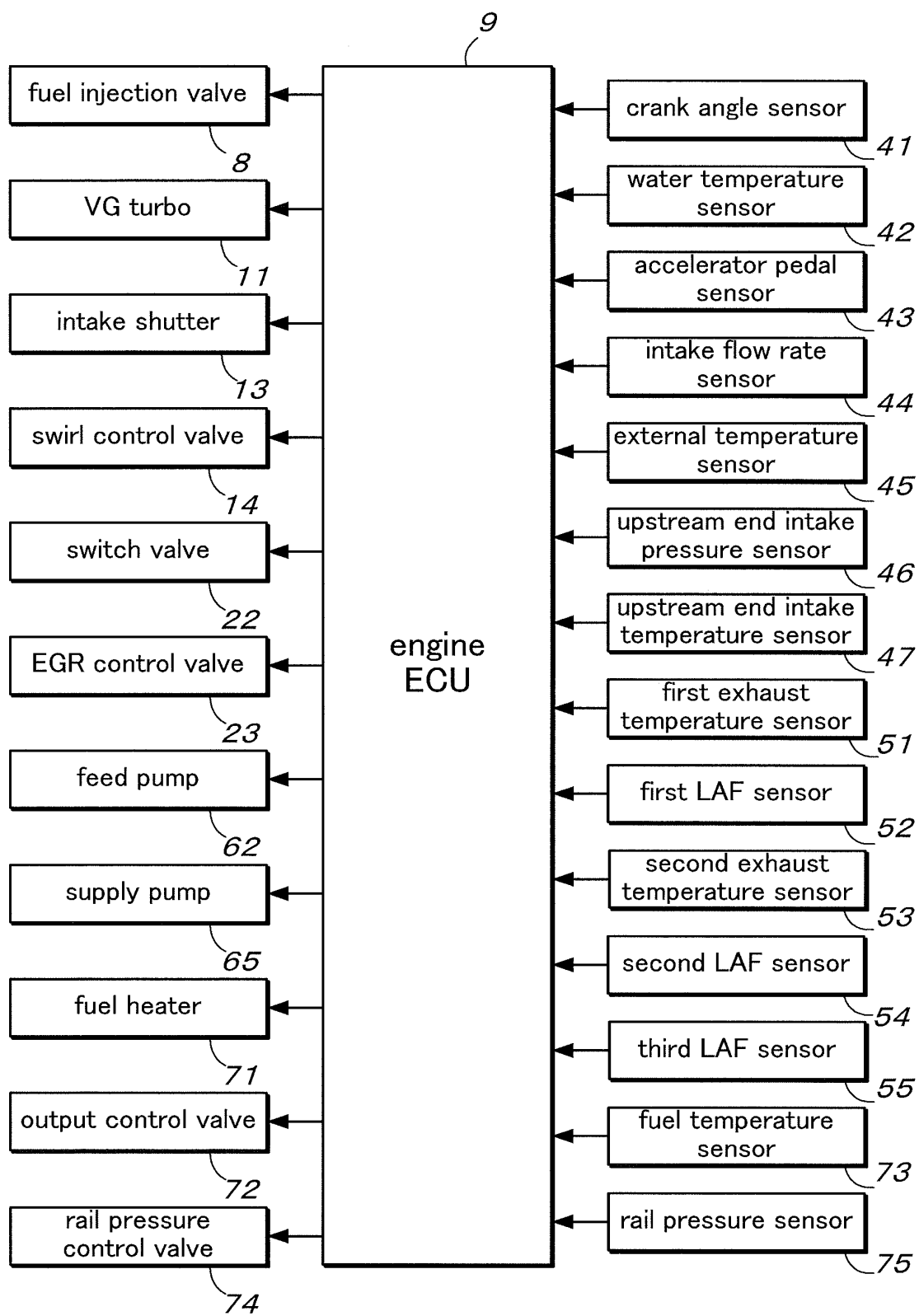
Fig.2

Fig. 3

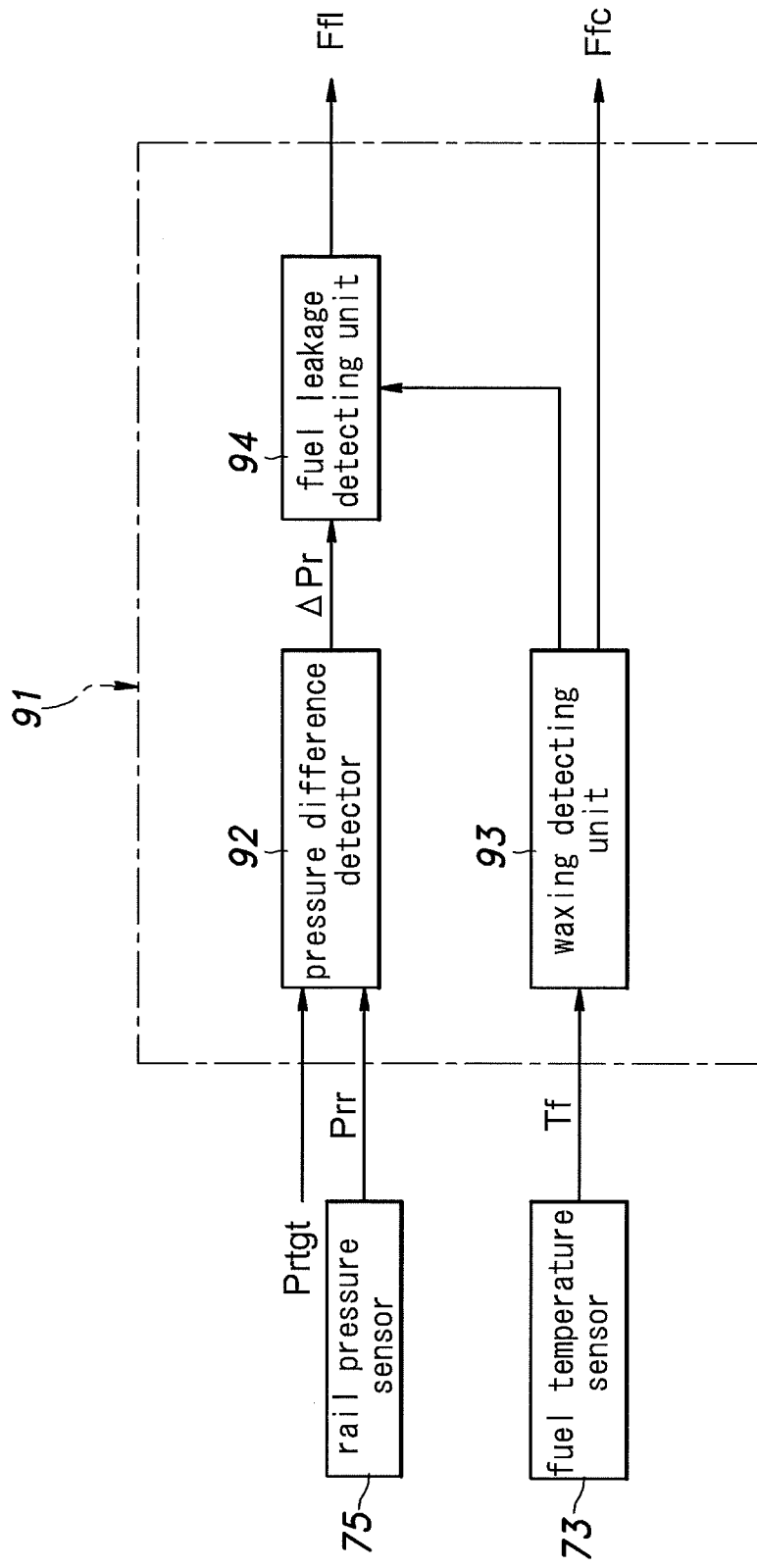


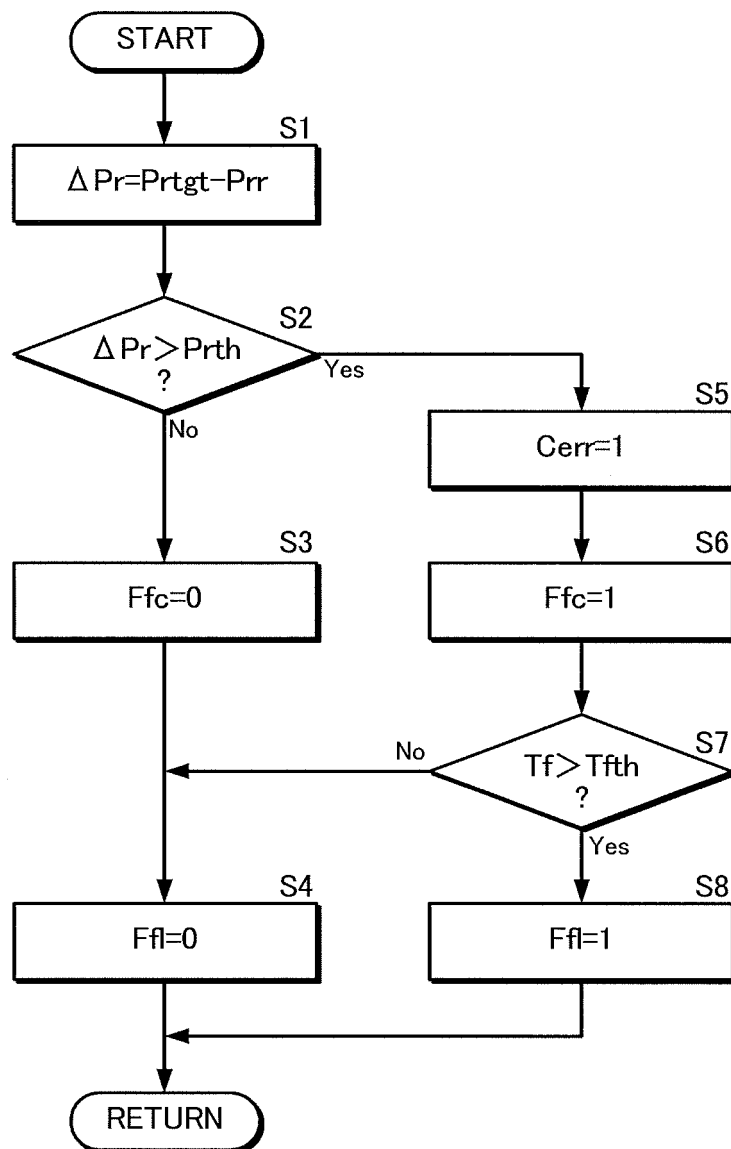
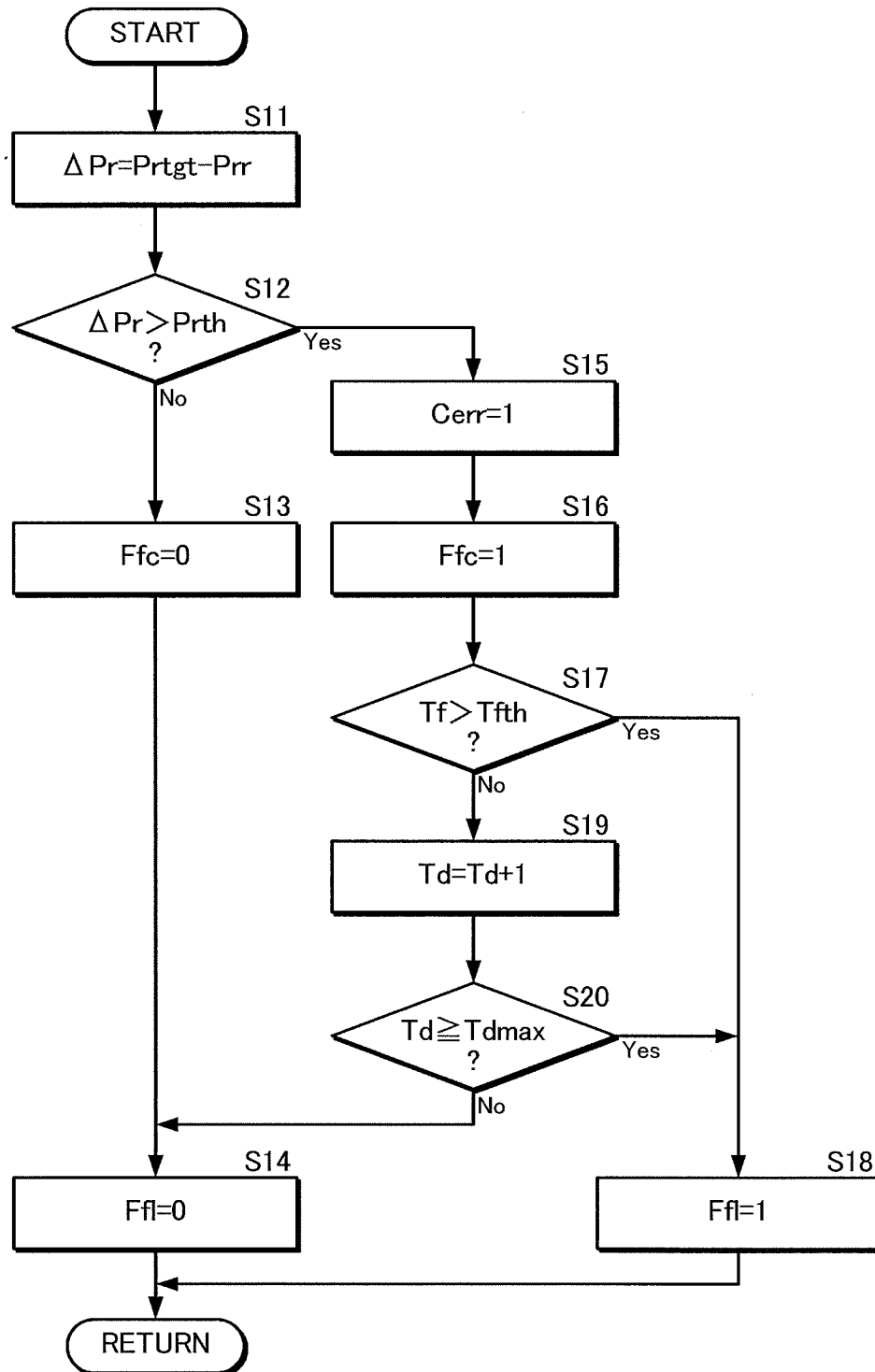
Fig.4

Fig.5

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2008/003365

A. CLASSIFICATION OF SUBJECT MATTER

F02D45/00 (2006.01) i, F02D41/22 (2006.01) i, F02M51/00 (2006.01) i, F02M55/02 (2006.01) i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

F02D45/00, F02D41/22, F02M51/00, F02M55/02

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2008
Kokai Jitsuyo Shinan Koho	1971-2008	Toroku Jitsuyo Shinan Koho	1994-2008

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 3147460 B2 (Denso Corp.), 19 March, 2001 (19.03.01), Par. Nos. [0042], [0043], [0046] (Family: none)	1-4
Y	JP 2004-225630 A (Denso Corp.), 12 August, 2004 (12.08.04), Par. No. [0049] & DE 102004003316 A1	1-4
Y	JP 8-338339 A (Isuzu Motors Ltd.), 24 December, 1996 (24.12.96), Par. No. [0004] (Family: none)	4



Further documents are listed in the continuation of Box C.



See patent family annex.

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Date of the actual completion of the international search
08 December, 2008 (08.12.08)

Date of mailing of the international search report
22 December, 2008 (22.12.08)

Name and mailing address of the ISA/
Japanese Patent Office

Authorized officer

Facsimile No.

Telephone No.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2008/003365

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 9-273443 A (Denso Corp.), 21 October, 1997 (21.10.97), Par. Nos. [0050] to [0062] (Family: none)	1-4

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 3147460 B [0003]