



European Patent Office



(11) **EP 0 924 417 A2**

(12) **EUROPEAN PATENT APPLICATION**

(51) Int. Cl.⁶: **F02D 41/10**, F02D 41/12,
F02D 41/38

(21) Application number: 98123368.7

(22) Date of filing: 08.12.1998

(72) Inventor: **Kotani, Akira**
Toyota-shi, Aichi-ken 471-8571 (JP)

(74) Representative:
Pellmann, Hans-Bernd, Dipl.-Ing. et al
Patentanwaltsbüro
Tiedtke-Bühling-Kinne & Partner
Bavariaring 4
80336 München (DE)

(30) Priority: 22.12.1997 JP 35368197

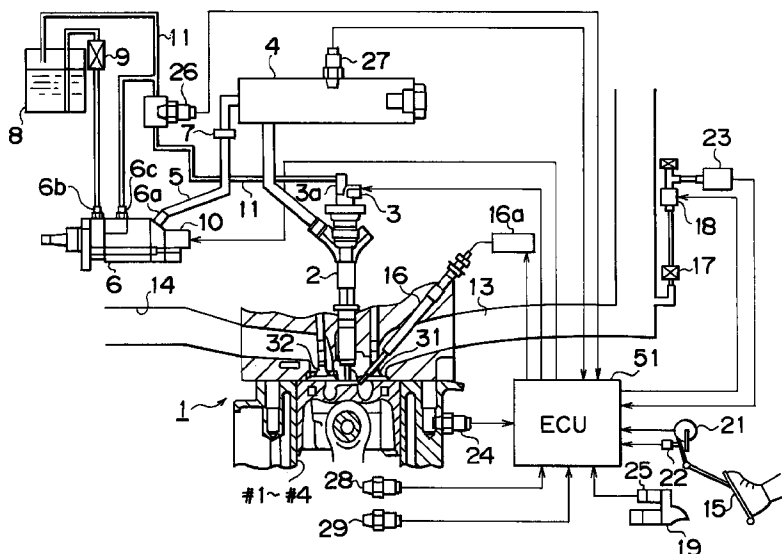
(71) Applicant:
TOYOTA JIDOSHA KABUSHIKI KAISHA
Aichi-ken 471-8571 (JP)

(54) Transient injection quantity control apparatus and method of diesel engine

(57) Even in the course of executing smoothing process of fuel injection quantity of a diesel engine (1), the increase in a basic fuel injection quantity is switched to the increased quantity having a smaller increase rate depending on an accelerator opening degree and a driver's request for deceleration so as to improve drive-

bility by intensifying the response to the driver's request for acceleration. As a result, even in the course of executing the acceleration smoothing control, the acceleration can be suppressed in quick response to the driver's request for deceleration to be immediately satisfied, resulting in excellent drivability.

FIG. 1



Description

INCORPORATION BY REFERENCE

[0001] The disclosure of Japanese Patent Application No. HEI 9-353681 filed on December 22, 1997 including the specification, drawings and abstract is incorporated herein by reference in its entirety.

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0002] This invention relates to a transient injection quantity control apparatus of a diesel engine and method, and more particularly, to a transient injection quantity control apparatus of a diesel engine and method for carrying out a smoothing control such that an actual fuel injection quantity is set based on a smoothed fuel injection quantity derived from a smoothing calculation until the smoothed fuel injection quantity reaches a request fuel injection quantity calculated corresponding to an operating condition of a diesel engine for such an instance when changing the actual fuel injection quantity of the diesel engine depending on a request for acceleration or deceleration.

2. Description of the Related Art

[0003] In order to prevent a shock owing to acceleration or deceleration in a diesel engine employed for driving a vehicle, a smoothing processing has been conventionally carried out to suppress a sharp change in torque accompanied with the increase or decrease in the fuel quantity at acceleration or deceleration of the vehicle.

[0004] For example, Examined Published Japanese Patent Application Nos. HEI 3-61013 and HEI 3-61014 disclose the art for suppressing sharp change in the fuel injection quantity calculated based on the accelerator opening degree so as to prevent a shock in acceleration or deceleration by smoothing the sharp change in an actual accelerator opening degree corresponding to an accelerator operation quantity in spite of a sudden operation of the accelerator pedal.

[0005] That is, if the actual accelerator opening degree sharply changes, an accelerator opening degree is obtained by smoothing process for smoothed change (hereinafter referred to as "smoothed accelerator opening degree") instead of the actual accelerator opening degree. Then, the fuel injection quantity is set based on the smoothed accelerator opening degree until the smoothed accelerator opening degree reaches the actual accelerator opening degree.

[0006] Further, Japanese Patent Application Laid-Open No. HEI 7-150998 discloses the art for carrying out no smoothing processing to the actual accelerator opening degree but using the smoothed fuel injection

quantity as an actual injection quantity instead of the basic fuel injection quantity upon determination of a sudden change in the basic fuel injection quantity reflecting the actual accelerator opening degree.

[0007] That is, if the fuel injection quantity requested based on the accelerator operation quantity (hereinafter referred to as "requested fuel injection quantity") sharply changes, a fuel injection quantity is derived from a smoothing calculation to smooth the change (hereinafter referred to as a "smoothed fuel injection quantity") instead of the requested fuel injection quantity, and then the fuel injection quantity is controlled based on the smoothed fuel injection quantity until the smoothed fuel injection quantity reaches the requested fuel injection quantity.

[0008] However, there has occurred a problem of insufficient response to the accelerator operation during such smoothing processing while the smoothing processing is carried out. For example, upon release of the accelerator pedal by the driver during the smoothing processing at acceleration (called "acceleration smoothing processing"), response to the accelerator pedal will be delayed after acceleration continued for a little while. On the contrary, upon depression of the accelerator pedal by the driver during deceleration smoothing processing, response to the accelerator pedal will be delayed after deceleration continued for a little while.

[0009] That is, in the former conventional art, there occurs a large difference between the smoothed accelerator opening degree and actual accelerator opening degree during smoothing processing. Therefore, even if the actual accelerator opening degree is decreased by releasing the accelerator pedal during the acceleration smoothing processing, the smoothed accelerator opening degree may still be smaller than the actual accelerator opening degree. Further, even if the actual accelerator opening degree is increased by depressing the accelerator pedal during the deceleration smoothing processing, the accelerator opening degree may still be larger than the actual accelerator opening degree. Those problems are caused on the ground that the smoothing processing is continued because the smoothed accelerator opening degree has not reached the actual acceleration opening degree yet.

[0010] This applies to the latter conventional example. Even if the requested fuel injection quantity changes reversely by the driver's operation of the accelerator pedal in a reversed way during the smoothing processing, the same smoothing processing is continued until the smoothed fuel injection quantity reaches the requested fuel injection quantity.

[0011] Therefore, in a diesel engine having the smoothing processing carried out at acceleration or deceleration, there occurs a phenomenon that may delay the response to a driver's request for acceleration or deceleration, resulting in a degraded drivability.

SUMMARY OF THE INVENTION

[0012] An object of the present invention is to improve the drivability by improving the responsiveness of a diesel engine to a driver's request for acceleration or deceleration even during a smoothing processing of fuel injection.

[0013] The above object is solved by the combination of features of the independent claims. The dependent claim disclose further advantageous embodiments of the invention.

[0014] To achieve the above object, the present invention provides a transient injection quantity control apparatus of a diesel engine that executes acceleration smoothing control for setting an actual fuel injection quantity on the basis of an acceleration smoothing fuel injection quantity derived from acceleration smoothing calculation until the acceleration smoothing fuel injection quantity reaches a requested fuel injection quantity calculated depending on an operating condition of the diesel engine when increasing the actual fuel injection quantity thereof for acceleration. The transient injection quantity control apparatus of the diesel engine is characterized by including deceleration request determining means for determining absence or presence of a deceleration request for the diesel engine; and deceleration requesting time fuel injection quantity setting means for setting the actual fuel injection quantity to be smaller than the acceleration smoothing fuel injection quantity derived from the acceleration smoothing calculation at a time when a deceleration request is detected by the deceleration request determining means during execution of the acceleration smoothing control.

[0015] The deceleration requesting time fuel injection quantity setting means sets the actual fuel injection quantity to be smaller than the acceleration smoothing fuel injection quantity calculated by the acceleration smoothing calculation if the deceleration request determining means determines that there is a request for deceleration during an execution of the acceleration smoothing control. Therefore, a quick response to a driver's request for deceleration can be realized during the acceleration smoothing control, resulting in improved drivability.

[0016] A degree of reduction of the fuel injection quantity may be set depending on, for example, the level of the deceleration request. If the deceleration request is at a low level, the degree of reduction is set to be lower. If the deceleration request is at a high level, the degree of reduction is set to be higher.

[0017] Further, according to another aspect, the present invention provides a transient injection quantity control apparatus of a diesel engine for injecting fuel to the diesel engine according to either an injection quantity calculated depending on an operating condition of the diesel engine or an acceleration smoothing injection quantity whichever smaller based on the basic injection quantity, and for executing acceleration smoothing

injection quantity control when the injection quantity becomes larger than the last injection quantity. The transient injection quantity control apparatus of the diesel engine is characterized by including deceleration request determining means for determining absence or presence of a deceleration request for the diesel engine; and further stopping the acceleration smoothing injection quantity control when a deceleration request is detected by the deceleration request determining means during the acceleration smoothing injection quantity control.

[0018] In the above embodiment, the deceleration request determining means may be constructed to determine an absence or presence of the deceleration request for the diesel engine based on the accelerator opening degree or any physical quantity corresponding thereto. If an absence or presence of the deceleration request for the diesel engine is determined based on the accelerator opening degree, a driver's request is directly clarified, an excellent responsiveness can be obtained.

[0019] Further, according to still another aspect, the present invention provides a transient injection quantity control apparatus of a diesel engine that executes deceleration smoothing control for setting an actual fuel injection quantity on the basis of a deceleration smoothing fuel injection quantity derived from deceleration smoothing calculation until the deceleration smoothing fuel injection quantity reaches a requested fuel injection quantity calculated depending on an operating condition of the diesel engine (1) when decreasing the actual fuel injection quantity thereof for deceleration. The transient injection quantity control apparatus of the diesel engine is characterized by including acceleration request determining means for determining absence or presence of an acceleration request for the diesel engine; and acceleration requesting time fuel injection quantity setting means for setting the actual fuel injection quantity to be larger than the deceleration smoothing fuel injection quantity derived from the deceleration smoothing calculation at a time when an acceleration request is detected by the acceleration request determining means during execution of the deceleration smoothing control.

[0020] If the acceleration request determining means determines the presence of an acceleration request during an execution of the deceleration smoothing control, the acceleration requesting time fuel injection quantity setting means sets the actual fuel injection quantity to be larger than that of the deceleration smoothing fuel injection quantity calculated by the deceleration smoothing calculation. This makes it possible to respond to the driver's request for the acceleration immediately during the deceleration smoothing control, resulting in improved drivability.

[0021] A degree of increase of the fuel injection quantity may be set depending on, for example, the level of the acceleration request. If the acceleration request is at

a low level, the degree of increase is set to be lower. If the acceleration request is at a high level, the degree of increase is set to be higher.

[0022] Further, according to a further aspect, the present invention provides a transient injection quantity control apparatus of a diesel engine for injecting fuel to a diesel engine according to either an injection quantity calculated depending on an operating condition of the diesel engine or an deceleration smoothing injection quantity whichever smaller based on the basic injection quantity, and for executing deceleration smoothing injection quantity control when the injection quantity becomes smaller than the last injection quantity. The transient injection quantity control apparatus of the diesel engine is characterized by including deceleration request determining means for determining absence or presence of a deceleration request for the diesel engine; and further stopping the acceleration smoothing injection quantity control when a deceleration request is detected by the deceleration request determining means during the acceleration smoothing injection quantity control.

[0023] In the above embodiment, the acceleration request determining means may determine absence or presence of an acceleration request for the diesel engine based on an accelerator opening degree or a physical quantity corresponding thereto. If the absence or presence of the acceleration request for the diesel engine is determined based on the accelerator opening degree, a driver's request is directly clarified, thus providing an excellent response.

[0024] As the physical quantity corresponding to the accelerator opening degree, for example, the requested fuel injection quantity calculated depending on the operating condition of the diesel engine can be used. As the driver's request for acceleration or deceleration reflects the operating condition of the diesel engine, the request for acceleration or deceleration is represented by the requested fuel injection quantity. Therefore, if the absence or presence of the acceleration request is determined by the requested fuel injection quantity, an excellent response can also be obtained. As the operating condition of the diesel engine in this case, for example, a combination of the accelerator opening degree and diesel revolution can be used. That is, the requested fuel injection quantity may be derived from the accelerator opening degree and diesel revolution.

[0025] In the case where the requested fuel injection quantity is set to the actual fuel injection quantity, the actual fuel injection quantity is identical to the requested fuel injection quantity. Therefore in such a case, it is permissible to use the actual fuel injection quantity as the physical quantity corresponding to the accelerator opening degree.

[0026] If the aforementioned diesel engine is used, for example, for driving a vehicle, the transient injection quantity control apparatus of the diesel engine is capable of providing the above described effect in driving the

vehicle.

[0027] This summary of the invention does not necessarily describe all necessary features so that the invention may also reside in a sub-combination of these described features.

BRIEF DESCRIPTION OF THE DRAWINGS

[0028]

FIG. 1 is a schematic structural diagram of a transient injection quantity control apparatus of an accumulator type diesel engine according to a first embodiment of the present invention;

FIG. 2 is a block diagram showing an electrical configuration of an ECU used in the first embodiment;

FIG. 3 is a flow chart showing a basic injection quantity calculation routine executed by the ECU of the first embodiment;

FIG. 4 is a flow chart showing a basic injection quantity calculation routine executed by the ECU of the first embodiment;

FIG. 5 is an explanatory diagram of a C table used for calculating a governor injection quantity QGOV; FIG. 6 is an explanatory diagram of a table on road load injection quantity corresponding to a revolution NE; and

FIG. 7 is a timing chart showing an effect of the first embodiment.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0029] FIG. 1 is a schematic configuration diagram showing an embodiment of a transient injection quantity control apparatus of an accumulator type diesel engine (common-rail diesel engine) to which the present invention is applied. The accumulator type diesel engine 1 is mounted on a vehicle and used as a driving power source for driving the vehicle.

[0030] The diesel engine 1 has a plurality of cylinders (four cylinders in this embodiment) #1, #2, #3, #4. An injector 2 constituting a fuel injection means is disposed for a fuel chamber of each of the cylinders #1-#4. Injection of fuel from the injector 2 to each of the cylinders #1-#4 of the diesel engine 1 is controlled by ON/OFF of an electromagnetic valve 3 for injection control.

[0031] The injector 2 is connected to a common rail 4 serving as an accumulator pipe common to the respective cylinders, such that fuel in the common rail 4 is injected to each of the cylinders #1-#4 through the injector 2 when the electromagnetic valve 3 for injection control is opened. A relatively high pressure equivalent to fuel injection pressure is accumulated continuously in the common rail 4. The common rail 4 is connected to an outlet port 6a of a supply pump 6 through a supply pipe 5 for such accumulation. The supply pipe 5 is provided with a check valve 7 at an intermediate portion

thereof. This check valve 7 permits fuel supply from the supply pump 6 to the common rail 4 and restricts a counter flow of the fuel from the common rail 4 to the supply pump 6.

[0032] The aforementioned supply pump 6 is connected to a fuel tank 8 through an intake port 6b and provided with a filter 9 at an intermediate portion thereof. The supply pump 6 induces fuel from the fuel tank 8 through the filter 9. Further, the supply pump 6 raises a fuel pressure to a requested predetermined pressure level by reciprocating a plunger by means of a cam (not shown) in synchronization with a rotation of the diesel engine 1. Then, the supply pump 6 supplies high pressure fuel to the common rail 4.

[0033] A pressure control valve 10 is provided in the vicinity of the outlet port 6a of the supply pump 6. This pressure control valve 10 controls the pressure of fuel (or discharge quantity) to be discharged from the outlet port 6a to the common rail 4. If the pressure control valve 10 is opened, excessive fuel that has not been discharged from the outlet port 6a is returned to the fuel tank 8 from a return port 6c provided in the supply pump 6 through a return pipe 11.

[0034] An intake path 13 and an exhaust path 14 are connected to a combustion chamber of the diesel engine 1. The intake path 13 is provided with a throttle valve (not shown) that is opened or closed depending on the operating condition so as to adjust the flow rate of intake air introduced to the combustion chamber.

[0035] A glow plug 16 is disposed in the combustion chamber of the diesel engine 1. The glow plug 16 is an auxiliary device for starting the engine for accelerating fuel combustion, which is heated by applying current thereto just before the start of the diesel engine 1 and ignites the fuel by spraying a part of injected fuel thereto.

[0036] The diesel engine 1 contains various sensors for detecting the aforementioned condition, i.e., the operating condition of the diesel engine 1 of this embodiment. That is, as shown in FIG. 1, an accelerator sensor 21 for detecting an accelerator opening degree ACCPF is provided in the vicinity of an accelerator pedal 15. A full-close switch 22 is provided in the vicinity of the accelerator sensor 21 for outputting a full-close signal when a depression quantity of the accelerator pedal 15 is zero.

[0037] An intake pressure sensor 23 is provided in the intake path 13 via a filter 17 and a vacuum switching valve (VSV) 18. This intake pressure sensor 23 detects an intake pressure (intake air pressure PM) inside the intake path 13.

[0038] A water temperature sensor 24 for detecting a temperature of cooling water (cooling water temperature THW) is provided in the cylinder block of the diesel engine 1.

[0039] Further, the diesel engine 1 is provided with a starter 19 for the start thereof. The starter 19 contains a starter switch 25 for detecting its operating condition.

The starter switch 25 is operated by a driver from a position in which an ignition switch (not shown) is OFF position to its start position when starting the diesel engine 1. When the starter is actuated (when it is in cranking state), a starter signal STA ON is output.

[0040] If, after the start of the diesel engine 1 is completed (in complete combustion state), the ignition switch is returned from the start position to the ON position, the starter switch 25 outputs the starter signal STA "OFF".

[0041] Additionally, the aforementioned return pipe 11 is provided with a fuel temperature sensor 26 for detecting a fuel temperature THF. The common rail 4 contains a fuel pressure sensor 27 as a fuel pressure detecting means for detecting the fuel pressure PC inside the common rail 4.

[0042] Further, according to this embodiment, an NE sensor 28 is provided in the vicinity of a pulser disposed in a crank shaft (not shown) of the diesel engine 1. A rotation of the crank shaft is transmitted to a cam shaft (not shown) for opening or closing an intake valve 31 and outlet valve 32 via a timing belt or the like. This cam shaft is set to rotate at a rotation speed lower than that of the crankshaft by 1/2. A G sensor 29 is provided in the vicinity of the pulser provided in this cam shaft. According to this embodiment, revolution NE, crank angle CA and top dead center (TDC) of each of the cylinders #1-#4 are calculated according to the pulse signal output from both the sensors 28, 29.

[0043] In this embodiment, an electronic control unit (ECU) 51 for performing various controls of the diesel engine 1 is provided. The ECU 51 executes processing for controlling the diesel engine 1 such as fuel injection quantity control.

[0044] An electrical configuration of the ECU 51 will be described referring to a block diagram of FIG. 2.

[0045] The ECU 51 includes a central processing unit (CPU) 52, a read-only memory (ROM) 53 containing a predetermined program, map or the like preliminarily memorized therein, a random access memory (RAM) 54 for temporarily memorizing a result of computation executed by the CPU 52, a backup RAM 55 for storing preliminarily memorized data, a timer counter 56, and further contains an input interface 57 and an output interface 58. The respective components 52 to 56 are connected to the input interface 57 and output interface 58 through a bus 59.

[0046] The aforementioned accelerator sensor 21, intake pressure sensor 23, water temperature sensor 24, fuel temperature sensor 26, fuel pressure sensor 27 and the like are connected to the input interface 57 through a buffer, multiplexer and A/D converter (not shown), respectively.

[0047] Further, the NE sensor 28 and G sensor 29 are connected to the input interface 57 through a waveform shaping circuit (not shown). The full-close switch 22 and starter switch 25 are directly connected to the input interface 57.

[0048] The CPU 52 reads a signal applied from each of the aforementioned sensors 21 to 29 through the input interface 57.

[0049] The electromagnetic valve 3, pressure control valve 10 and VSV 18 are connected to the output interface 58 through each driving circuit (not shown). The CPU 52 controls the electromagnetic valve 3, pressure control valve 10, VSV 18 and the like based on input values read through the input interface 57 in a preferred manner via the output interface 58.

[0050] Next, the fuel injection control processing of controls executed by the ECU 51 in this embodiment will be described. FIGs. 3 and 4 are flow charts showing a basic injection quantity calculation routine executed by the ECU 51. This routine is executed by interruption at each crank angle of 180° (each explosion step). Each step of the flow chart corresponding to the respective processing is expressed by "S".

[0051] At the start of the basic injection quantity calculation routine processing, firstly a governor injection quantity QGOV (equivalent to a requested fuel injection quantity and also a physical quantity corresponding to accelerator opening degree ACCPF) is obtained (S100). This governor injection quantity QGOV can be derived from the revolution NE of the diesel engine 1 detected by the NE sensor 28 and accelerator opening degree ACCPF detected by the accelerator sensor 21. For example, the governor injection quantity QGOV is calculated by the following equation (1).

$$QGOV = A + B \times ACCPF - C \times NE \quad (1)$$

where A is a constant, B is a positive constant, and C is a positive value derived from Table indicating a tendency thereof in a graph shown in FIG. 5 depending on the accelerator opening degree ACCPF. Meanwhile, the value of C may be obtained based on the accelerator opening degree ACCPF using an equation for calculating the value C so as to have the same tendency as indicated by FIG. 5.

[0052] Next, it is determined whether or not the governor injection quantity QGOV obtained in step S100 is equal to or more than the last basic fuel injection quantity QBASEOL (S110).

[0053] For example, if the governor injection quantity QGOV calculated in step S100 is equal to or more than the last basic fuel injection quantity QBASEOL through depression of the accelerator pedal 15 by a driver ("YES" at S110), it is determined whether or not any positive value is set to the governor injection quantity QGOV (S140).

[0054] If governor injection quantity QGOV $0 \leq 0$ ("NO" in S140), the governor injection quantity QGOV is set to the basic fuel injection quantity QBASE (corresponding to the actual fuel injection quantity) (S150). Then the basic fuel injection quantity QBASE is set as the value of the last basic fuel injection quantity QBASEOL (S160). Further, as the last accelerator opening degree

ACCPFOL, an accelerator opening degree ACCPF presently detected is set (S162). The processing is terminated.

[0055] As described above, if the governor injection quantity $QGOV \leq 0$, a negative value or 0 is set as the basic fuel injection quantity QBASE and no fuel injection is conducted. That is, if the governor injection quantity $QGOV \leq 0$, the presence of the driver's request for acceleration cannot be assumed. Therefore, if the processing of the steps S170 to S230 are executed while the governor injection quantity $QGOV \leq 0$, the processing for increasing the basic fuel injection quantity QBASE, for example, steps S210, S230 are executed against the driver's intention. Such processing may result in a complete waste. A determination in step S140, thus, is executed for the purpose of eliminating the waste fuel injection.

[0056] In step S140, if it is determined $QGOV > 0$ ("YES" in S140), that is, the presence of a request for acceleration is assumed, it is determined whether or not the governor injection quantity QGOV exceeds a road load injection quantity QRL (S170). The road load injection quantity QRL used herein stands for a fuel injection quantity capable of achieving a current revolution NE under no load condition. For example, the road load injection quantity QRL is calculated from a table having the revolution NE as a parameter as shown in FIG. 6.

[0057] If $QRL \geq QGOV$ ("NO" in S170), the road load injection quantity QRL is set as the acceleration smoothing fuel injection quantity QSMA (S180).

[0058] Next, it is determined whether or not an accelerator opening degree ACCPF presently detected is less than the value obtained by subtracting the tolerance width α from the last accelerator opening degree ACCPFOL (S200). Here, the tolerance width α is a positive value and set to detect whether or not the accelerator opening degree ACCPF has been changed enough to its decreasing side. If the acceleration is being operated or the acceleration is terminated, that is, the driver is depressing the accelerator pedal 15 or the depressing is stopped under a stabilized condition, the accelerator opening degree ACCPF is increased or maintained, resulting in "NO" in step S200.

[0059] Then, it is determined whether or not the governor injection quantity QGOV exceeds the acceleration smoothing fuel injection quantity QSMA (S220). In the preceding step S180, the road load injection quantity QRL is set as the acceleration smoothing fuel injection quantity QSMA while maintaining $QRL \geq QGOV$ ("NO" in S220), the governor injection quantity QGOV is set as the basic fuel injection quantity QBASE (S150).

[0060] Next, the basic fuel injection quantity QBASE is set as the last basic fuel injection quantity QBASEOL (S160), then the accelerator opening degree ACCPF presently detected is set as the last accelerator opening degree ACCPFOL (S162). The processing is terminated.

[0061] If the driver is depressing the accelerator pedal

15 to accelerate a vehicle and the governor injection quantity QGOV has not reached the road load injection quantity QRL yet, the each processing of the step S100, S110, S140, S170, S180, S200, S220, S150, S160, S162 are continued. That is, each time when the basic injection quantity calculation routine is executed, the governor injection quantity QGOV is always set as the basic fuel injection quantity QBASE by the processing executed in step S150.

[0062] This means that even if the driver accelerates sharply, a sharp increase in the fuel injection quantity is permitted until the governor injection quantity QGOV reaches the road load injection quantity QRL. No acceleration shock occurs because substantially no accelerating torque occurs even if a sharp fuel quantity increase is executed, until the road load injection quantity QRL is reached, and further the response is delayed if the smoothing processing is started before the road load injection quantity QRL is reached in spite of acceleration. Therefore, the sharp increase in the fuel injection quantity is permitted until the governor injection quantity QGOV reaches the road load injection quantity QRL.

[0063] If the above acceleration is continued so that the governor injection quantity QGOV exceeds the road load injection quantity QRL, "YES" is determined in step S170 subsequent to steps S100, S110, S140 and then the acceleration smoothing fuel injection quantity QSMA is calculated by the acceleration smoothing calculation as shown in the equation (2) (S190).

$$QSMA = QBASEOL + QSMA1 \quad (2)$$

[0064] Here, the first acceleration smoothing quantity QSMA 1 is a positive value and derived from a map or equation using the accelerator opening degree ACCPF, revolution NE and shift position as the parameter. This map or equation is set such that the first acceleration smoothing quantity QSMA1 increases as the increase in the accelerator opening degree ACCPF. The value of the first acceleration smoothing quantity QSMA1 corresponding to the revolution NE and shift position is set so as to achieve an appropriate operation of the diesel engine 1 corresponding to the measure for emission control or other functional design with respect to the diesel engine 1.

[0065] Next, if "NO" in step S200, determination is executed in step S220. In this step, if the governor injection quantity QGOV has sharply increased to be larger than the acceleration smoothing fuel injection quantity QSMA ("YES" in S220), the acceleration smoothing fuel injection quantity QSMA is set as the basic fuel injection quantity QBASE (S230) and the processing passes through steps S160, S162, and is terminated.

[0066] The purpose of the above described processing of steps (S100, S110, S140, S170, S190, S200, S220, S230, S160 and S162) is to prevent the acceleration shock. Specifically, if the governor injection quan-

tity QGOV exceeds the road load injection quantity QRL to increase the fuel injection quantity sharply, the acceleration shock occurs owing to a sharp increase in the engine torque. The acceleration shock can be prevented by restricting an increase in the basic fuel injection quantity QBASE below the acceleration smoothing fuel injection quantity QSMA. If the accelerating operation is at a lower level to cause gentle increase in the governor injection quantity QGOV so as not to exceed the acceleration smoothing fuel injection quantity QSMA ("NO" in S220), a governor injection quantity QGOV is set as the basic fuel injection quantity QBASE (S150) such that the acceleration smoothing control is not executed.

[0067] Next, if the depression of the accelerator pedal 15 is loosened during the acceleration smoothing control and the governor injection quantity QGOV is stabilized, the acceleration smoothing fuel injection quantity QSMA may reach the governor injection quantity QGOV in the course of executing the above described processing (S100, S110, S140, S170, S190, S200, S220, S230, S160, S162). That is, the determination in step S220 becomes "NO" and the process is returned to a condition where the governor injection quantity QGOV is set as the basic fuel injection quantity QBASE (S150). Then the acceleration smoothing processing is terminated.

[0068] If the accelerator pedal 15 is released during the above described acceleration smoothing processing, the following processing will be executed.

[0069] If an accelerator opening degree ACCPF presently detected is lower than the value of (last accelerator opening degree ACCPFOL - the tolerance α) in the course of repeating the processing (S100, S110, S140, S170, S190, S200, S220, S230, S160, S162) as acceleration smoothing processing, a determination in step S200 becomes "YES". Then, a value derived from the following equation (3) is set as the acceleration smoothing fuel injection quantity QSMA (S210).

$$QSMA = QBASEOL + QSMA2 \quad (3)$$

where the second acceleration smoothing quantity QSMA2 is a predetermined positive value and smaller than a value which can be taken by the aforementioned first acceleration smoothing quantity QSMA1.

[0070] Therefore, subsequent to the determination "YES" in step S220, in step S230, an acceleration smoothing fuel injection quantity QSMA to which the second acceleration smoothing quantity QSMA2 is added is set as the basic fuel injection quantity QBASE. Namely, the acceleration smoothing fuel injection quantity QSMA having reduced change rate is set as the basic fuel injection quantity QBASE.

[0071] As a result, even if the driver releases the accelerator pedal 15 during the acceleration smoothing processing, step S210 is executed based on the determination "YES" in step S200. In quick response to the execution, the increase in the fuel injection quantity can

be restrained.

[0072] Next, the deceleration smoothing processing will be described.

[0073] When release of the accelerator pedal 15 owing to deceleration is detected by the accelerator sensor 21 and the governor injection quantity QGOV is reduced to realize $QGOV < QBASEOL$ ("NO" in S110), the process proceeds to step S300 where it is determined whether or not the last basic fuel injection quantity QBASEOL exceeds the road load injection quantity QRL.

[0074] As far as the last basic fuel injection quantity QBASEOL exceeds the road load injection quantity QRL ("YES" in S300), the deceleration smoothing fuel injection quantity QSMD is set by the deceleration smoothing calculation as shown in the following equation (4) (S310).

$$QSMD = QBASEOL - QSMD1 \quad (4)$$

where the first deceleration smoothing quantity QSMD1 is a positive value, which can be derived from a map or equation using the accelerator opening degree ACCPF, revolution NE and shift position as a parameter. This map or equation is set such that the first deceleration smoothing quantity QSMD1 increases as the accelerator opening degree ACCPF increases. The revolution NE and the first deceleration smoothing quantity QSMD1 with respect to a shift position are set such that an appropriate operation of the diesel engine 1 is achieved corresponding to emission control of the diesel engine 1 and other functional design.

[0075] Next, it is determined whether or not the currently detected accelerator opening degree ACCPF exceeds the value of (the last accelerator opening degree ACCPFOL + tolerance β) (S320). Here, the tolerance β is a positive value and set to detect whether or not the accelerator opening degree ACCPF has been changed sufficiently to the increase side. The tolerance β may be the same value as the tolerance α used for the acceleration smoothing control or a different value. Like the tolerance α , the tolerance β is appropriately set in the process of control design.

[0076] If deceleration is being done or decelerating operation has been terminated, that is, the driver is releasing the accelerator pedal 15 or the release has been stopped to realize stable condition, the accelerator opening degree ACCPF is reduced or remained. Therefore step S320 determines "NO".

[0077] Next it is determined whether or not the governor injection quantity QGOV exceeds the deceleration smoothing fuel injection quantity QSMD (S340). If the driver is quickly releasing the accelerator pedal 15 and the decrease in the governor injection quantity QGOV is faster than the decrease in the deceleration smoothing fuel injection quantity QSMD set in step S310, the relationship becomes $QSMD > QGOV$ ("NO" in S340). The deceleration smoothing fuel injection quantity QSMD is

set as the basic fuel injection quantity QBASE (S360). If the driver is releasing the accelerator pedal 15 slowly and the decrease in the governor injection quantity QGOV is slower than the decrease in the deceleration smoothing fuel injection quantity QSMD set in step S310, the relationship becomes $QSMD < QGOV$ ("YES" in S340). The governor injection quantity QGOV is set as the basic fuel injection quantity QBASE (S350).

[0078] Next, the basic fuel injection quantity QBASE is set as the last basic fuel injection quantity QBASEOL (S160), and an accelerator opening degree ACCPF currently detected is set as the last accelerator opening degree ACCPFOL (S162) and then the processing is terminated.

[0079] If the driver is releasing the accelerator pedal 15 for deceleration and the governor injection quantity QGOV has not decreased to reach the road load injection quantity QRL, the processing executed in steps S100, S110, S300, S310, S340, S350 (or S360), S160, S162 will be continued. That is, each time when the basic injection quantity calculation routine is executed, either the governor injection quantity QGOV or deceleration smoothing fuel injection quantity QAMD which is larger fuel injection quantity is set as the basic fuel injection quantity QBASE by execution in step S350 or step S360.

[0080] If the fuel injection quantity is reduced sharply in a fuel injection quantity range exceeding the road load injection quantity QRL, a deceleration shock is caused by the quick drop of a driving torque. Therefore, this may restrict the decrease in the basic fuel injection quantity QBASE to be the deceleration smoothing fuel injection quantity QSMD or less. That is, determination of "NO" in step S340 and execution of step S360 carries out the deceleration smoothing processing, thus preventing the deceleration shock.

[0081] In the course of repeating the processing in steps S100, S110, S300, S310, S320, S340, S350 (or S360), S160, S162, if the last basic fuel injection quantity QBASEOL becomes equal to or less than the road load injection quantity QRL owing to the release of the accelerator pedal 15 ("NO" in S300), the deceleration smoothing fuel injection quantity QSMD is set to 0 (S315).

[0082] In a state where the accelerator opening degree ACCPF is decreased ("NO" in S320), determination is executed in step S340. If it is determined that the governor injection quantity QGOV has been set to the value exceeding 0, the relationship becomes $QSMD < QGOV$ ("YES" in step 340). Therefore the governor injection quantity QGOV is set as the basic fuel injection quantity QBASE (S350).

[0083] If the deceleration smoothing fuel injection quantity QSMD is set as the basic fuel injection quantity QBASE just before a quick release of the accelerator pedal 15, the governor injection quantity QGOV has become smaller than the deceleration smoothing fuel injection quantity QSMD at the time of processing the

basic injection quantity calculation routine just before the quick release of the accelerator pedal 15. Therefore, if the governor injection quantity QGOV is set as the basic fuel injection quantity QBASE in step S350, the fuel injection quantity will decrease stepwise. However, such stepwise decrease occurs only in a state where the basic fuel injection quantity QBASE has become equal to or less than the road load injection quantity QRL. Therefore torque substantially affecting the vehicle speed is not changed by the decrease in the fuel injection quantity, resulting in no deceleration shock.

[0084] In this way, the governor injection quantity QGOV is returned to a state reflecting the basic fuel injection quantity QBASE. Under the condition where the basic fuel injection quantity QBASE exceeds the road load injection quantity QRL, if the decrease in the governor injection quantity QGOV is slower than the decrease in the deceleration smoothing fuel injection quantity QSMD set in step S310 to allow the deceleration smoothing fuel injection quantity QSMD to reach the governor injection quantity QGOV, the relationship becomes $QSMD < QGOV$ ("YES" in S340). As a result, the governor injection quantity QGOV is set as the basic fuel injection quantity QBASE (S350).

[0085] As described above, under the condition where the deceleration smoothing fuel injection quantity QSMD is set as the basic fuel injection quantity QBASE, i.e., the deceleration smoothing control is being executed upon quick release of the accelerator pedal 15, if the driver depresses the accelerator pedal 15 for acceleration, the following process will be carried out.

[0086] First, as the deceleration smoothing control, a series of the processing in step S100, S110, S300, S310, S320, S340, S360, S160, S162 is repeated. Here, it is assumed that the driver has accelerated in accordance with the relationship of accelerator opening degree $ACCPF > \text{last accelerator opening degree } ACCPFOL + \beta$. At this time, as the governor injection quantity QGOV is far smaller than the deceleration smoothing fuel injection quantity QSMD. Therefore, the governor injection quantity QGOV is smaller than the last basic fuel injection quantity QBASEOL as the deceleration smoothing fuel injection quantity QSMD. In step S110, the determination becomes "NO" such that the deceleration processing (S300 to S360) will be continued.

[0087] Meanwhile if the relationship becomes accelerator opening $ACCPF > \text{last opening degree } ACCPFOL + \beta$ ("YES" in S320), the process proceeds to step S330 where the deceleration smoothing fuel injection quantity QSMD is set as expressed in the following equation (5).

$$QSMD = QBASEOL - QSMD2 \quad (5)$$

where the second deceleration smoothing quantity QSMD2 is a predetermined positive value and smaller than a value taken by the aforementioned first deceleration smoothing quantity QSMD1.

[0088] Therefore subsequent to "NO" in step S340, in step S360, the deceleration smoothing fuel injection quantity QSMD having the second deceleration smoothing quantity QSMD2 decreased is set as the basic fuel injection quantity QBASE. That is, the deceleration smoothing fuel injection quantity QSMD having increased change rate (i.e., an absolute value of the change rate as a negative value becomes a small value) is set as the basic fuel injection quantity QBASE.

[0089] As a result, even in the case of depression of the accelerator pedal 15 by the driver during the deceleration smoothing processing, the decrease in the fuel injection quantity can be restrained in quick response to execution of the process in step S330 after determination "YES" in step S320.

[0090] According to this embodiment, the following advantageous effects can be obtained. That is, referring to a timing chart of Fig. 7, when the driver depresses the accelerator pedal 15 for acceleration (time T0), at 180° CA timing subsequent to acceleration, "YES" is determined in steps both S110 and S140 for the basic injection quantity calculation routine. At an initial state, the relationship becomes road load injection quantity QRL > governor injection quantity QGOV, "NO" is determined in step S170. Therefore the road load injection quantity QRL is set as the acceleration smoothing fuel injection quantity QSMA (S180). Subsequent to "NO" in step S200, "NO" is determined in step S220 as the relationship becomes governor injection quantity QGOV < acceleration smoothing fuel injection quantity QSMA. The process proceeds to step S150 where the governor injection quantity QGOV is set as the basic fuel injection quantity QBASE.

[0091] Thus, until the time T1 when the relationship becomes road load injection quantity QRL = governor injection quantity QGOV, the basic fuel injection quantity QBASE (indicated by a solid line) is set based on the governor injection quantity QGOV. Even if the governor injection quantity QGOV increases sharply, the vehicle is not accelerated until the road load injection quantity QRL is reached, resulting in no acceleration shock. Further, as the fuel injection quantity increases sharply up to the road load injection quantity QRL in accordance with the accelerating operation, excellent response to the accelerating operation can be obtained.

[0092] As the governor injection quantity QGOV exceeds the road load injection quantity QRL at the time T1 onward ("YES" in S170), the increase in acceleration smoothing fuel injection quantity QSMA is suppressed by an quantity equivalent to the first acceleration smoothing quantity QSMA1 at every processing cycle in step S190. Then, either the governor injection quantity QGOV or acceleration smoothing fuel injection quantity QSMA whichever smaller is set as the basic fuel injection quantity QBASE by processing in steps S220, S150, S230. Referring to Fig. 7, if the sharp increase in the governor injection quantity QGOV (indicated by a chain line) is faster than the decrease in the accelera-

tion smoothing fuel injection quantity QSMA, the basic fuel injection quantity QBASE is suppressed to the increase by an quantity equivalent to the first acceleration smoothing quantity QSMA 1, that is, acceleration smoothing control starts at the time T1 onward.

[0093] If the relationship of accelerator opening degree ACCPF < last accelerator opening degree ACCPFOL - α is attained (at time T3: "YES" in S200) during the acceleration smoothing control, the acceleration smoothing fuel injection quantity QSMA is switched to be increased by an quantity equivalent to the second acceleration smoothing quantity QSMA2 at every processing cycle (S210). Even in case of a driver's request for deceleration, the governor injection quantity QGOV is still larger than the last basic fuel injection quantity QBASEOL and, according to the conventional art, the basic fuel injection quantity QBASE is expected to keep the increase by an quantity equivalent to the first deceleration smoothing quantity QSMA1 (indicated by a broken line). However, according to this embodiment, in response to a driver's request for deceleration, the increase in the basic fuel injection quantity QBASE is switched to the smaller increase equivalent to the second deceleration smoothing quantity QSMA2.

[0094] As a result, the driver's request for acceleration can be satisfied even at a time for the deceleration smoothing control. That is, according to the conventional art, if the driver switches the operation from deceleration to acceleration, the driver may have uncomfortable feeling because the acceleration is continued for a while. However, according to this embodiment, acceleration is immediately suppressed in response to decelerating operation, resulting in quick response to the driver's request for deceleration. Therefore, this embodiment provides excellent drivability without giving uncomfortable feeling to the driver.

[0095] The quick response to the driver's request for deceleration, additional effects as reduction of exhaust gas and smoke can be obtained.

[0096] This applies to the case of switching the operation from deceleration to acceleration. Referring to Fig. 7, if the relationship of governor injection quantity QGOV < last basic fuel injection quantity QBASEOL is attained upon decelerating operation (time T4: "NO" in step S110), the deceleration smoothing fuel injection quantity QSMD is set to be decreased by an quantity equivalent to the first deceleration smoothing quantity QSMD1 at every cycle of the processing in step S310 in the region of a fuel injection quantity larger than the road load injection quantity QRL. Then, by processing in steps S340, S350, S360, either the governor injection quantity QGOV or deceleration smoothing fuel injection quantity QSMD whichever smaller is set as the basic fuel injection quantity QBASE. Therefore if the sharp decrease in the governor injection quantity QGOV (indicated by a chain line) is faster than the decrease in the deceleration smoothing fuel injection quantity QSMD, the basic fuel injection quantity QBASE is suppressed

to be decreased by a quantity equivalent to the first deceleration smoothing quantity QSMD, i.e., the deceleration smoothing control starts at the time T4 onward.

[0097] If the relationship of accelerator opening degree ACCPF > last accelerator opening degree ACCPFOL + β is attained during the deceleration smoothing control (time T5: "YES" in S320), the deceleration smoothing fuel injection quantity QSMD is switched to be decreased by a quantity equivalent to the second deceleration smoothing quantity QSMD at every cycle of processing (S330). Even in case of the driver's request for acceleration, the governor injection quantity QGOV is still smaller than the last basic fuel injection quantity QBASEOL, the decreased quantity equivalent to the first deceleration smoothing quantity QSMD1 (indicated by a broken line) is kept in the conventional art. However, in this embodiment, the decrease in the basic fuel injection quantity QBASE is switched to the quantity equivalent to the second deceleration smoothing quantity QSMD2 having a smaller change rate in response to the driver's request for acceleration. That is, the change rate of the basic fuel injection quantity QBASE is increased.

[0098] As a result, the driver's request for acceleration can be satisfied even at a time of the deceleration smoothing control. If the driver switches the operation from deceleration to acceleration, in the conventional art, the driver may have uncomfortable feeling because deceleration is continued for a while even after switching the operation. However, in this embodiment, the deceleration can be suppressed in quick response to the driver's request for acceleration. Thus, the driver does not have uncomfortable feeling, resulting in improved drivability.

[0099] As described above, in both acceleration smoothing control and deceleration smoothing control, the acceleration or deceleration can be changed immediately responding to the change of the driver's request, thus achieving excellent drivability over an entire range of driving operation.

[0100] In the above described embodiment, the ECU 51 corresponds to the deceleration request determining means, deceleration requesting time fuel injection quantity setting means, acceleration request determining means and acceleration requesting time fuel injection quantity setting means, and step S200 corresponds to a processing executed by deceleration request determining means, step S210 corresponds to a processing by deceleration requesting time fuel injection quantity setting means, step S320 corresponds to a processing by acceleration request determining means and step S330 corresponds to a processing by acceleration requesting time fuel injection quantity setting means.

[0101] According to the above embodiment, "0" or a negative value may be set as the second acceleration smoothing quantity QSMA2. Further, the value of the second acceleration smoothing quantity QSMA2 may be determined depending on a level of the decelerating

operation (difference between the accelerator opening degree ACCPF and the last accelerator opening degree ACCPFOL).

[0102] Further, according to the above embodiment, "0" or a positive value may be set as the second deceleration smoothing quantity QSMD2. The value of the second deceleration smoothing quantity QSMD2 may be determined depending on a level of the decelerating operation (difference between the accelerator opening degree ACCPF and last accelerator opening degree ACCPFOL).

[0103] Although, according to the above embodiment, a deceleration request or an acceleration request during the smoothing control is detected by the change in the accelerator opening degree ACCPF, arbitrary physical quantity data corresponding to the accelerator opening degree ACCPF may be used as far as the absence or presence of deceleration request for the diesel engine can be determined. For example, the governor injection quantity QGOV can be used as physical quantity data corresponding to the accelerator opening degree ACCPF as it is derived from the revolution NE of the diesel engine detected by the NE sensor 28 and the accelerator opening degree ACCPF detected by the accelerator sensor 21.

[0104] Although in step S100 of the above embodiment, the governor injection quantity QGOV is derived from the equation(1) based on the revolution NE of the diesel engine 1 and accelerator opening degree ACCPF, it can be derived from a map based on the revolution NE and accelerator opening degree ACCPF.

[0105] Although the first acceleration smoothing quantity QSMA1 used in step S190 of the above embodiment and the first deceleration smoothing quantity QSMD1 used in step S310 are obtained based on the accelerator opening degree ACCPF, the revolution NE and shift position as the parameter, constants may be used.

[0106] The transient injection quantity control apparatus of the diesel engine according to the present invention is not restricted to the common rail type diesel engine, but can be applied to all diesel engines including distribution type and other fuel injection quantity control types.

[0107] It does not limit the claimed invention and that the discussed combination of features might not be absolutely necessary for the inventive solution.

[0108] Even in the course of executing smoothing process of fuel injection quantity of a diesel engine (1), the increase in a basic fuel injection quantity is switched to the increased quantity having a smaller increase rate depending on an accelerator opening degree and a driver's request for deceleration so as to improve drivability by intensifying the response to the driver's request for acceleration. As a result, even in the course of executing the acceleration smoothing control, the acceleration can be suppressed in quick response to the driver's request for deceleration to be immediately satisfied, resulting in excellent drivability.

Claims

1. A transient injection quantity control apparatus of a diesel engine (1) for driving a vehicle for performing a smoothing control of fuel injection for smoothly acceleration/deceleration of a vehicle, comprising:

a means for setting an actual fuel injection quantity on the basis of an acceleration/deceleration smoothing fuel injection quantity derived from an acceleration/deceleration calculation until said acceleration/deceleration smoothing fuel injection quantity reaches a requested fuel injection quantity calculated depending on an operating condition of the diesel engine when increasing/decreasing the actual fuel injection quantity thereof for acceleration/deceleration;

an acceleration/deceleration request determining means (51) for determining absence or presence of an acceleration/deceleration request for the diesel engine (1); and

acceleration/deceleration requesting time fuel injection quantity setting means (51) for setting said actual fuel injection quantity to be larger/smaller than the deceleration/acceleration smoothing fuel injection quantity derived from said acceleration/deceleration smoothing calculation at a time when an acceleration/deceleration is detected by said acceleration/deceleration requests determining means during execution of said acceleration/deceleration smoothing control.

2. A transient injection control apparatus of a diesel engine (1) for performing a smoothing control of fuel injection for smoothly acceleration/deceleration of a vehicle, comprising:

a means for setting an actual fuel injection quantity on the basis of an acceleration/deceleration smoothing fuel injection quantity derived from an acceleration/deceleration calculation until said acceleration/deceleration smoothing fuel injection quantity reaches a requested fuel injection quantity calculated depending on an operating condition of the diesel engine when increasing/decreasing the actual fuel injection quantity thereof for acceleration/deceleration;

an acceleration/deceleration request determining means (51) for determining absence or presence of an acceleration/deceleration request for the diesel engine (1) and stopping said acceleration/deceleration smoothing injection quantity control when said acceleration/deceleration request is determined.

3. A transient injection quantity control apparatus of a diesel engine (1) that executes acceleration smoothing control for setting an actual fuel injection quantity on the basis of an acceleration smoothing fuel injection quantity derived from acceleration smoothing calculation until said acceleration smoothing fuel injection quantity reaches a requested fuel injection quantity calculated depending on an operating condition of the diesel engine (1) when increasing the actual fuel injection quantity thereof for acceleration, said transient injection quantity control apparatus of the diesel engine (1) is characterized by comprising:

deceleration request determining means (51) for determining absence or presence of a deceleration request for the diesel engine (1); and
deceleration requesting time fuel injection quantity setting means (51) for setting said actual fuel injection quantity to be smaller than the acceleration smoothing fuel injection quantity derived from said acceleration smoothing calculation at a time when a deceleration request is detected by said deceleration request determining means during execution of said acceleration smoothing control.

4. A transient injection quantity control apparatus of a diesel engine (1) for injecting fuel to the diesel engine (1) according to either an injection quantity calculated depending on an operating condition of the diesel engine (1) or an acceleration smoothing injection quantity whichever smaller based on the basic injection quantity, and for executing acceleration smoothing injection quantity control when the injection quantity becomes larger than the last injection quantity, said transient injection quantity control apparatus of the diesel engine (1) is characterized by comprising:

deceleration request determining means (51) for determining absence or presence of a deceleration request for the diesel engine (1); and further stopping the acceleration smoothing injection quantity control when a deceleration request is detected by said deceleration request determining means (51) during said acceleration smoothing injection quantity control.

5. A transient injection quantity control apparatus of a diesel engine (1) as claimed in claim 3 or 4, characterized in that said deceleration request determining means (51) determines absence or presence of a deceleration request for the diesel engine (1) based on a parameter different from a beginning parameter of the acceleration smoothing injection

quantity control.

6. A transient injection quantity control apparatus of a diesel engine (1) as claimed in claim 5, characterized in that said deceleration request determining means (51) determines absence or presence of a deceleration request for the diesel engine (1) based on an accelerator opening degree or a physical quantity corresponding thereto.
7. A transient injection quantity control apparatus of a diesel engine (1) that executes deceleration smoothing control for setting an actual fuel injection quantity on the basis of a deceleration smoothing fuel injection quantity derived from deceleration smoothing calculation until said deceleration smoothing fuel injection quantity reaches a requested fuel injection quantity calculated depending on an operating condition of the diesel engine (1) when decreasing the actual fuel injection quantity thereof for deceleration, said transient injection quantity control apparatus of the diesel engine (1) is characterized by comprising:

acceleration request determining means (51) for determining absence or presence of an acceleration request for the diesel engine (1); and
acceleration requesting time fuel injection quantity setting means (51) for setting said actual fuel injection quantity to be larger than the deceleration smoothing fuel injection quantity derived from said deceleration smoothing calculation at a time when an acceleration request is detected by said acceleration request determining means during execution of said deceleration smoothing control.

8. A transient injection quantity control apparatus of a diesel engine (1) for injecting fuel to a diesel engine (1) according to either an injection quantity calculated depending on an operating condition of the diesel engine (1) or an deceleration smoothing injection quantity whichever smaller based on the basic injection quantity, and for executing deceleration smoothing injection quantity control when the injection quantity becomes smaller than the last injection quantity, said transient injection quantity control apparatus of the diesel engine (1) is characterized by comprising:

acceleration request determining means (51) for determining absence or presence of an acceleration request for the diesel engine (1); and further stopping the deceleration smoothing injection quantity control when an acceleration request is detected by said acceleration request determining means (51) during said

deceleration smoothing injection quantity control.

9. A transient injection quantity control apparatus of a diesel engine (1) as claimed in claim 7 or 8, characterized in that said deceleration request determining means (51) determines absence or presence of a deceleration request for the diesel engine (1) based on a parameter different from a beginning parameter of the deceleration smoothing injection quantity control. 5
10. A transient injection quantity control apparatus of the diesel engine as claimed in claim 9, characterized in that said acceleration request determining means determines absence or presence of an acceleration request for the diesel engine (1) based on an accelerator opening degree or a physical quantity corresponding thereto. 10
11. A transient injection quantity control apparatus of the diesel engine (1) as claimed in claim 6 or 10, characterized in that said physical quantity corresponding to the accelerator opening degree is the requested fuel injection quantity. 15
12. A transient injection quantity control apparatus of the diesel engine (1) as claimed in any one of claims 1 to 11, characterized in that said diesel engine (1) is used for driving a vehicle. 20
13. A transient fuel injection quantity control method for a diesel engine (1) comprising the following steps: 25
 - calculating a requested fuel quantity to be injected for a certain operating of the diesel engine; 35
 - calculating an acceleration/deceleration smoothing fuel injection quantity to be injected in dependence on an acceleration/deceleration smoothing control; 40
 - setting an actual fuel quantity to be injected on the basis of the acceleration/deceleration smoothing fuel injection quantity until it reaches the calculated requested fuel injection quantity; 45
 - determining whether an acceleration/deceleration request is present or absent by an acceleration/deceleration request determining means (51);
 - setting the actual fuel quantity to be injected to a larger/smaller when an acceleration/deceleration request is detected. 50
14. A transient fuel injection quantity control method for a diesel engine (1) comprising the following steps: 55
 - calculating a requested fuel quantity to be injected for a certain operating condition of the

diesel engine;

calculating an acceleration/deceleration smoothing fuel injection quantity to be injected in dependence on an acceleration/deceleration smoothing control;

setting an actual fuel quantity to be injected on the basis of the acceleration/deceleration smoothing fuel injection quantity until it reaches the calculated requested fuel injection quantity; determining whether an acceleration/deceleration request is present or absent by an acceleration/deceleration request determining means (51);

stopping said acceleration/deceleration smoothing injection quantity control when said acceleration/deceleration request is determined.

15. A transient fuel injection quantity control method according to claims 13 and 14, characterized in that the acceleration/deceleration request determining means (51) determines the absence or presence of an acceleration/deceleration request based on an accelerator opening degree or a physical quantity corresponding thereto.

FIG. 1

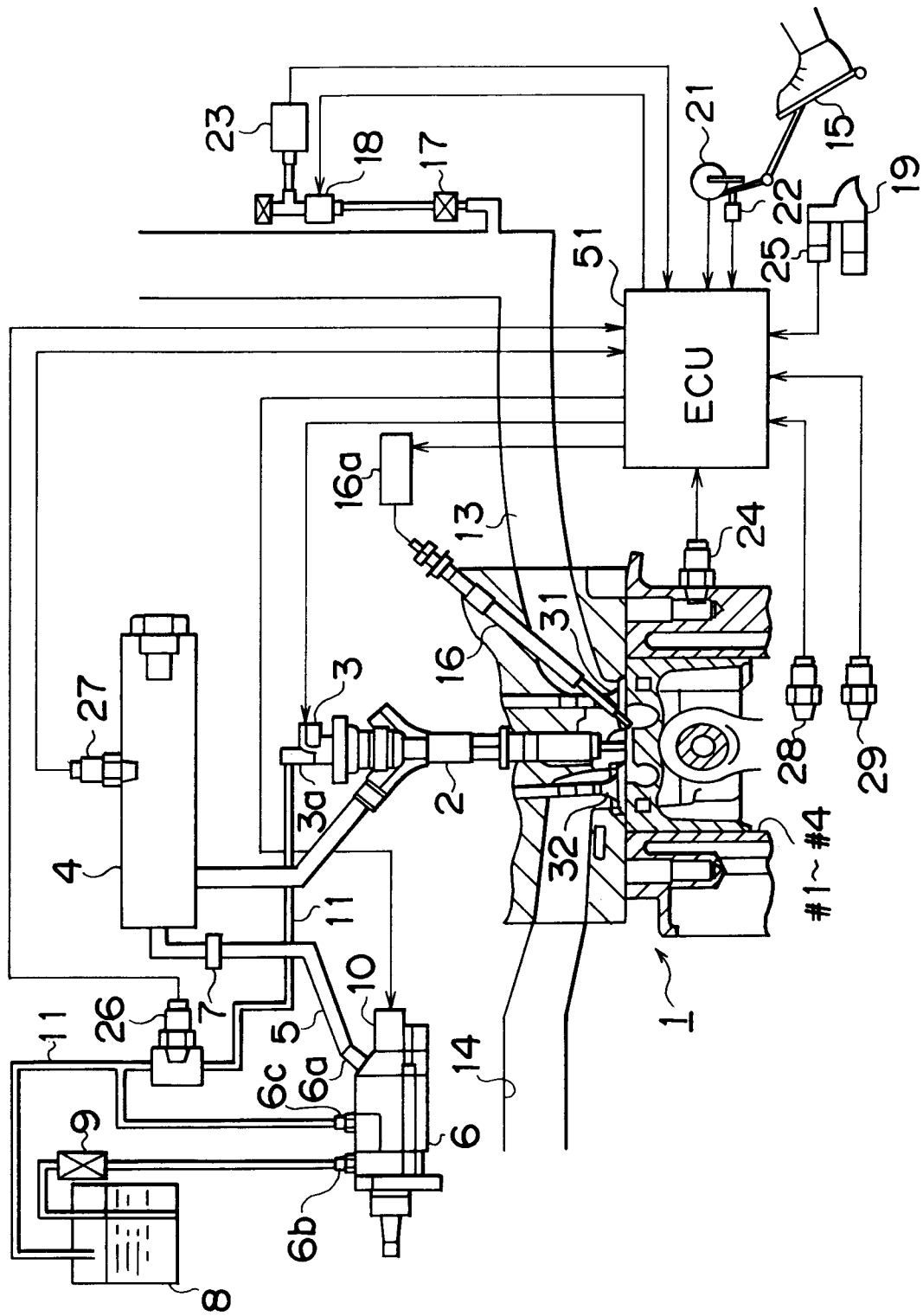


FIG. 2

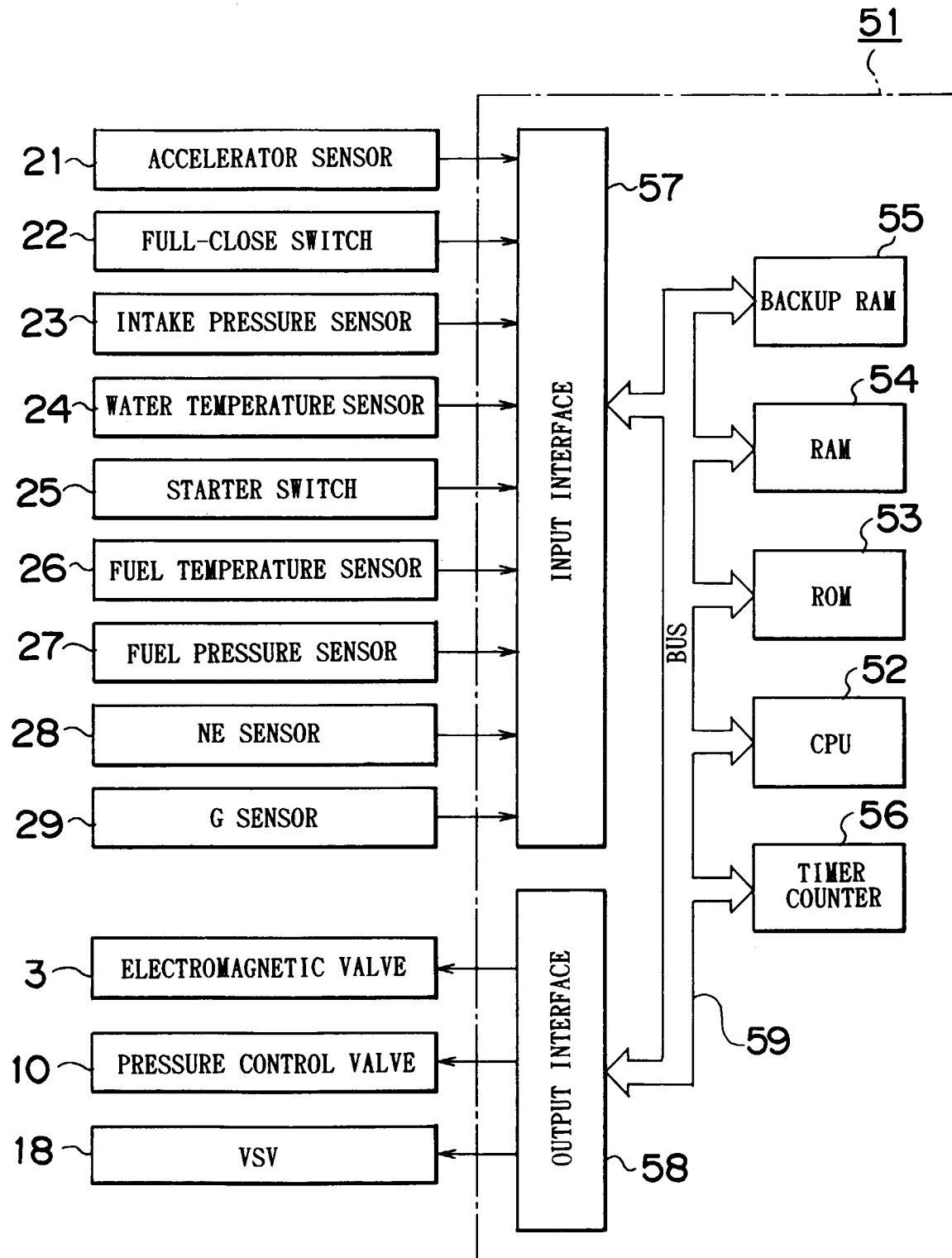


FIG. 3

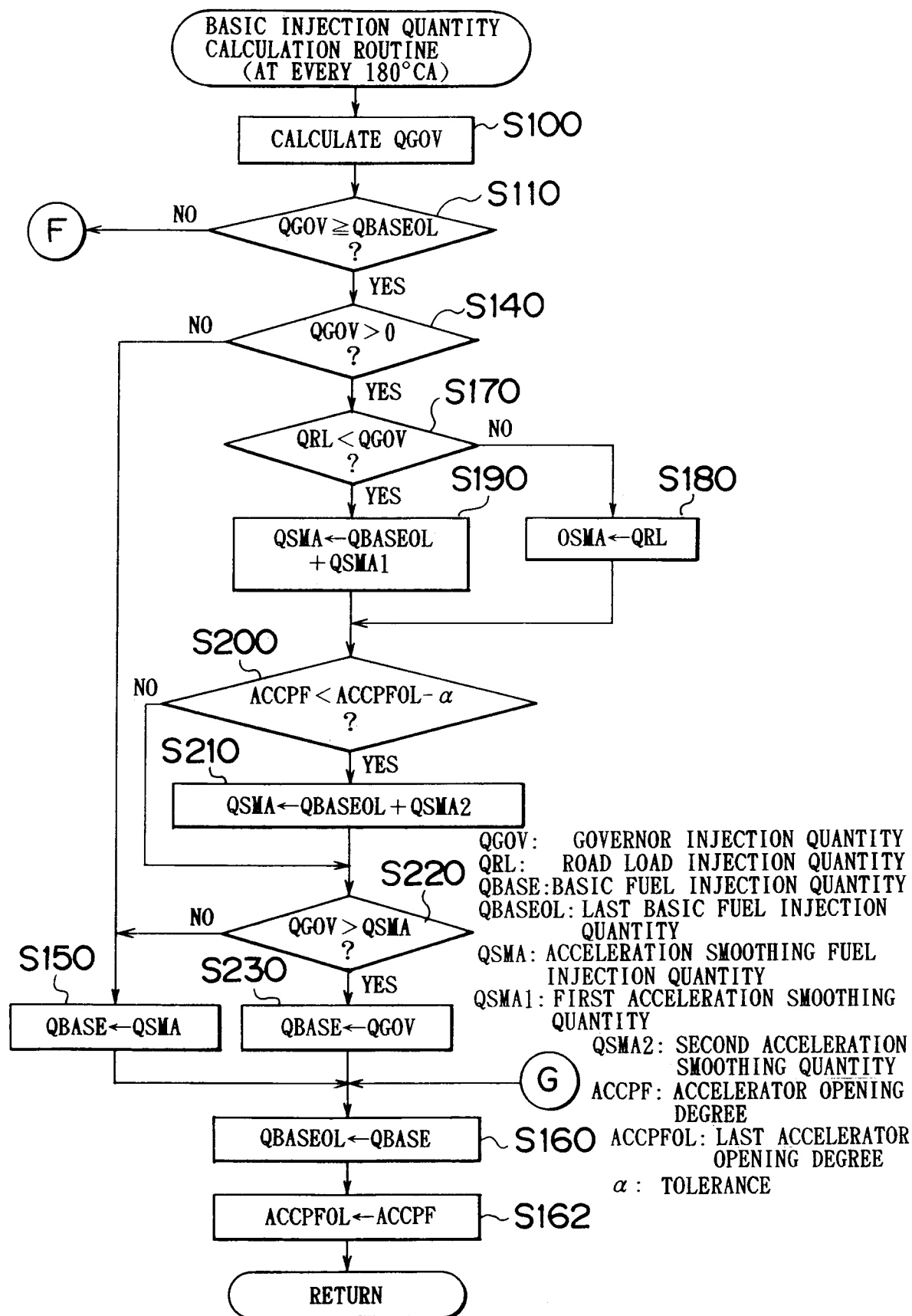


FIG. 4

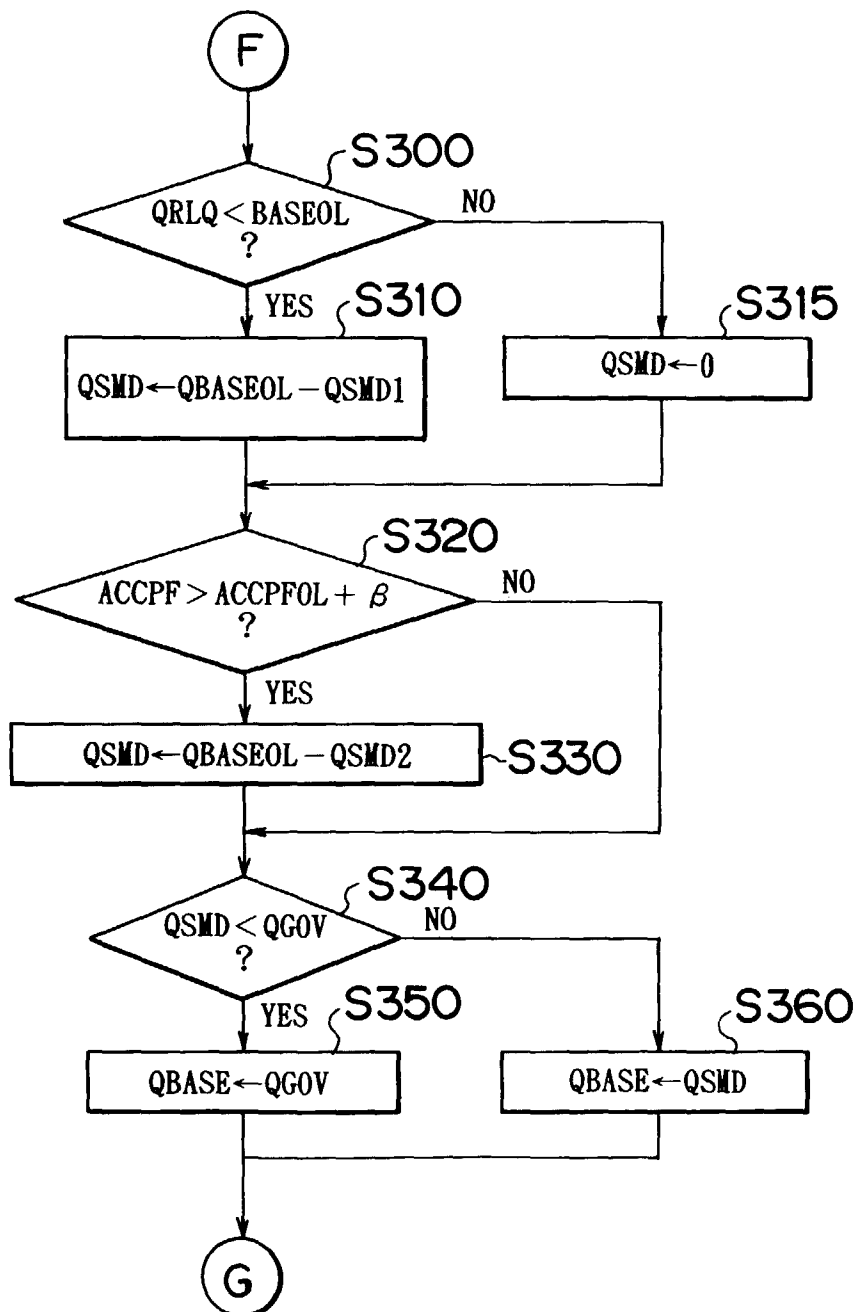
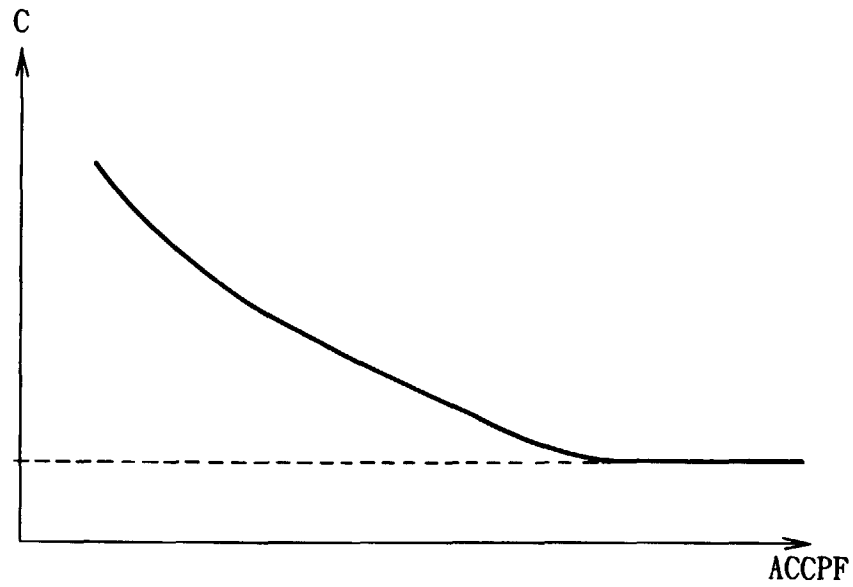


FIG. 5



FUEL INJECTION
QUANTITY

FIG. 6

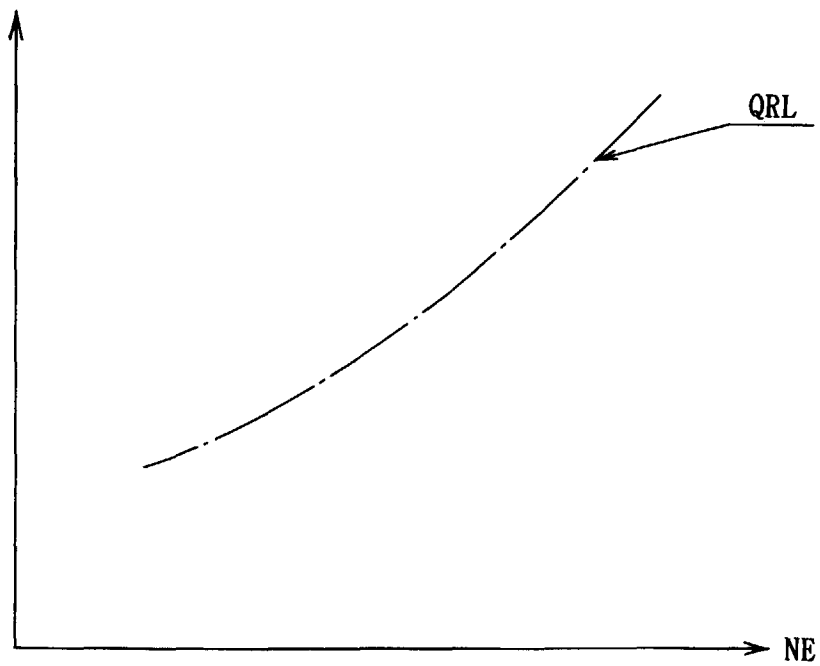


FIG. 7

