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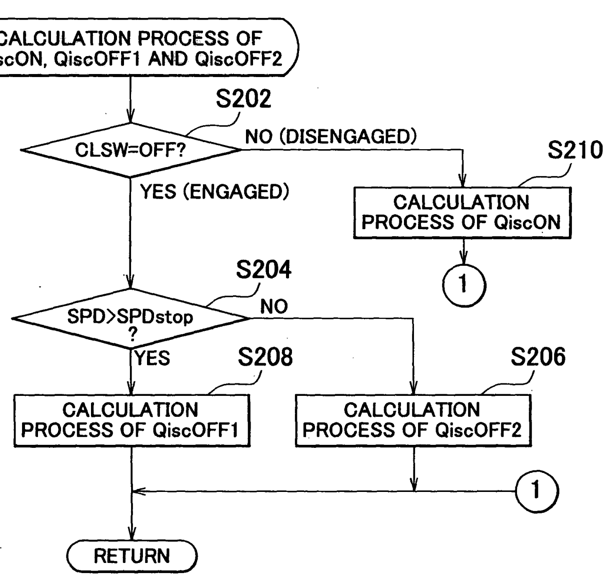
(54) **Output control apparatus of internal combustion engine**

(57) Fuel injection correction amounts QiscON, QiscOFF1 and QiscOFF2 are respectively calculated depending on the operation ranges (S206, S208, S210). However, take-off assist correction itself is performed based on the total amount of all the fuel injection correction amounts. Therefore, even when the operation range is changed while a vehicle takes off from a standstill or immediately after the vehicle takes off, all the fuel injection correction amounts are always reflected on the take-off assist correction. In addition, the gain for calculation of the fuel injection correction amount is changed such that the gain corresponds to the operation range. Accordingly, the engine operation state is reflected on the fuel injection correction amount with responsiveness appropriate for each operation range. Therefore, it is possible to prevent fluctuation in an engine rotational speed and a vehicle speed, and to minimize the sense of discomfort felt by a driver.

FIG. 3



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Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The invention relates to an output control apparatus of an internal combustion engine, which performs a process of correcting an increase in an output from an internal combustion engine for driving a vehicle (hereinafter, referred to as an "output increase correction process") by performing correction of vehicle take-off assist (hereinafter, referred to as "take-off assist correction") while vehicle takes off from a standstill (hereinafter, referred to as "during vehicle take-off).

2. Description of the Related Art

[0002] For example, Japanese Patent Laid-Open Publication No. 2001-73842 discloses a control apparatus of an internal combustion engine, which obtains an amount of an increase in an output (hereinafter, referred to as an "output increase amount") based on an accelerator opening and a rotational speed of an internal combustion engine (hereinafter, referred to as an "engine rotational speed") so as to assist vehicle take-off, and which performs take-off assist correction for an output from the internal combustion engine based on the output increase amount, in a vehicle including the internal combustion engine which serves as a drive source. This apparatus increases an output so as to deal with an abrupt increase in a load placed on the internal combustion engine during vehicle take-off, thereby preventing engine stalling and enabling smooth vehicle take-off.

[0003] However, in the above-mentioned technology, a required torque value used in an internal combustion engine operation range for vehicle take-off and a required torque value used in an internal combustion engine operation range for times other than vehicle take-off are completely different from each other. Particularly, take-off assist correction in the internal combustion engine operation range for vehicle take-off and take-off assist correction in the internal combustion engine operation range for times other than the vehicle take-off are set independently of each other.

[0004] Therefore, when the internal combustion engine operation range is changed, particularly, during vehicle take-off or immediately after vehicle take-off, calculation of the required torque value is newly started without reflecting friction of the internal combustion engine in the operation range which is used immediately before the change of the operation range. Accordingly, the engine rotational speed and the vehicle speed may decrease or increase, which makes a driver feel a sense of discomfort.

SUMMARY OF THE INVENTION

[0005] It is an object of the invention to minimize a sense of discomfort felt by a driver when an internal combustion engine operation range is changed during vehicle take-off or immediately after vehicle take-off, in an output control apparatus of an internal combustion engine, which performs take-off assist correction.

[0006] According to an aspect of the invention, there is provided an output control apparatus of an internal combustion engine, which performs a process of correcting an increase in an output from an internal combustion engine for driving a vehicle (hereinafter, referred to as an "output increase correction process") by performing correction of vehicle take-off assist (hereinafter, referred to as "take-off assist correction") while vehicle takes off from a standstill (hereinafter, referred to as "during vehicle take-off"). The output control apparatus of an internal combustion engine includes output correcting means for dividing an internal combustion engine operation range into multiple ranges, providing an output correction amount assigned to a range (hereinafter, referred to as a "range output correction amount") subjected to calculation to each of the internal combustion engine operation ranges, and performing take-off assist correction based on the total amount of the range output correction amounts, and for changing a gain for calculation of the range output correction amount such that the gain corresponds to each of the internal combustion engine operation ranges.

[0007] In this case, the output correcting means does not respectively calculate the output correction amounts for the internal combustion engine operation ranges. The output correcting means provides the range output correction amount subjected to calculation to each of the internal combustion engine operation ranges. However, the output correcting means performs take-off assist correction itself based on the total amount of all the range output correction amounts.

[0008] Accordingly, even when the internal combustion engine operation range is changed during vehicle take-off or immediately after vehicle take-off, since the range output correction amounts are totaled, the range output correction amounts are always related to each other and are reflected on take-off assist correction.

[0009] Also, since the output correcting means changes the gain for calculation of the range output correction amount such that the gain corresponds to each of the internal combustion engine operation ranges, the operation state of the internal combustion engine is reflected on the range output correction amount with responsiveness appropriate for each of the internal combustion engine operation ranges. Accordingly, even when the internal combustion engine operation range is changed, take-off assist correction can be immediately performed with responsiveness appropriate for the new internal combustion engine operation range.

[0010] Thus, it is possible to prevent fluctuation in the engine rotational speed and the vehicle speed when the internal combustion engine operation range is changed during vehicle take-off or immediately after vehicle take-off, and to minimize the sense of discomfort felt by the driver.

[0011] It is also preferable that the gain be one of the gain which is used when the range output correction amount is obtained according to an equation and the gain which is used when the range output correction amount is obtained using a map, or the gain be the gain which is used when the range output correction amount is obtained by combination of the equation and the map.

[0012] As mentioned above, the gain may be one of the gain which is used when the range output correction amount is obtained according to the equation and the gain which is used when the range output correction amount is obtained using the map, or may be the gain which is used when the range output correction amount is obtained by combination of the equation and the map.

[0013] It is also preferable that the output correcting means divide the internal combustion engine operation range into a first range where the vehicle is idle-stopped, a second range where the vehicle takes off from a standstill, and a third range for times other than idle stop and vehicle take-off, and set the gain for calculation of the range output correction amount of the second range to a large value compared with the gains for calculation of the range output correction amount of the first range and the range output correction amount of the third range.

[0014] The internal combustion engine operation range may be divided into three ranges, and the range output correction amount for calculation may be provided for each of the three ranges. In this case, the output correcting means sets the gain for calculation of the output correction amount of the second range to a large value compared with the gains for calculation of the range output correction amount of the first range and the range output correction amount of the third range. In the second range where the vehicle takes-off from a standstill, the load placed on the internal combustion engine increases abruptly. Therefore, by setting the gain for calculation of the range output correction amount of the second range to a large value compared with the gains for calculation of the other range output correction amounts, it is possible to increase the range output correction amount of the second range with high responsiveness so as to deal with the increase in the load when the internal combustion engine operation range is changed to the range where the vehicle takes off from a standstill. As a result, the total amount of all the range output correction amounts changes with high responsiveness, and take-off assist correction can be performed appropriately based on the total amount.

[0015] When the internal combustion engine operation range is further changed from the second range to another range, the gain for calculation of the range output correction amount becomes smaller. Therefore, problems such as hunting of the output are reduced.

[0016] Thus, it is possible to prevent fluctuation in the engine rotational speed and the vehicle speed when the internal combustion engine operation range is changed during vehicle take-off or immediately after vehicle take-off, and to minimize the sense of discomfort

[0017] It is also preferable that the output correcting means divide the internal combustion engine operation range into a first range where a clutch is engaged and the vehicle is at a standstill, a second range where the clutch is disengaged, and a third range where the clutch is engaged and the vehicle is running, and set the gain for calculation of the range output correction amount of the second range to a large value compared with the gains for calculation of the range output correction amount of the first range and the range output correction amount of the third range.

[0018] The internal combustion engine operation range is divided into three ranges. More particularly, the internal combustion engine operation range is divided into the first range where the clutch is engaged and the vehicle is at a standstill, the second range where the clutch is disengaged, and the third range where the clutch is engaged and the vehicle is running.

[0019] Thus, by setting the gain for calculation of the range output correction amount of the second range where the clutch is disengaged to a large value compared with the gains for calculation of the range output correction amounts of the other two ranges where the clutch is engaged, it is possible to increase the range output correction amount of the second range with high responsiveness so as to deal with the increase in the load when the internal combustion engine operation range is changed to the second range where the vehicle takes off from a standstill. As a result, the total amount of all the range output correction amounts changes with high responsiveness, and take-off assist correction can be performed appropriately based on the total amount.

[0020] When the internal combustion engine operation range is further changed from the second range to another range, the gain for calculation of the range output correction amount becomes smaller. Therefore, problems such as hunting of the output are reduced.

[0021] Thus, it is possible to prevent fluctuation in the engine rotational speed and the vehicle speed when the internal combustion engine operation range is changed during vehicle take-off or immediately after vehicle take-off, and to minimize the sense of discomfort felt by the driver.

[0022] It is also preferable to set the gain for calculation of the range output correction amount of the third range to a small value compared with the gain for calculation of the range output correction amount of the first range.

[0023] In the third range, the vehicle is running normally and the engine rotational speed does not decrease easily. Therefore, when an operation for acceleration is not performed, the vehicle needs to run stably. Accordingly, it is desirable to set the gain to a small value.

[0024] Thus, it is possible to further prevent fluctuation in the engine rotational speed and the vehicle speed, and to enhance the effect of minimizing the sense of discomfort felt by the driver.

[0025] It is also preferable that the output correcting means divide the internal combustion engine operation range into a first range where the clutch is engaged and the vehicle is at a standstill, a second range where the clutch is disengaged and the vehicle is at a standstill, a third range where the clutch is disengaged and the vehicle is running, and a fourth range where the clutch is engaged and the vehicle is running, and set the gain for calculation of the range output correction amount of the second range to a large value compared with the gains for calculation of the range output correction amount of the first range, the range output correction amount of the third range, and the range output correction amount of the fourth range.

[0026] The internal combustion engine operation range may be divided into the first range where the clutch is engaged and the vehicle is at a standstill, the second range where the clutch is disengaged and the vehicle is at a standstill, the third range where the clutch is disengaged and the vehicle is running, and the fourth range where the clutch is engaged and the vehicle is running.

[0027] In this case, by setting the gain for calculation of the range output correction amount of the second range where the clutch is disengaged and the vehicle is at a standstill to a large value compared with the gains for calculation of the range output correction amounts of the other three ranges, it is possible to increase the range output correction amount of the second range with high responsiveness so as to deal with the increase in the load when the internal combustion engine operation range is changed to the second range where the vehicle takes off from a standstill. As a result, the total amount of all the range output correction amounts changes with high responsiveness, and take-off assist correction can be performed appropriately based on the total amount.

[0028] When the internal combustion engine operation range is further changed from the second range to another range, the gain for calculation of the range output correction amount becomes smaller. Therefore, problems such as hunting of the output are reduced.

[0029] Thus, it is possible to prevent fluctuation in the engine rotational speed and the vehicle speed when the internal combustion engine operation range is changed during vehicle take-off or immediately after vehicle take-off, and to minimize the sense of discomfort felt by the driver.

[0030] It is also preferable that the gains for calculation of the range output correction amounts be set to become smaller, with the gain for calculation of the range output correction amount of the third range being the largest, the gain for calculation of the range output correction amount of the first range being smaller than the gain for calculation of the range output correction amount of the third range, and the gain for calculation of the range output correction amount of the fourth range being smaller than the gain for calculation of the range output correction amount of the first range.

[0031] It is also preferable the gains for calculation of the range output correction amounts be set to become smaller, with the gain for calculation of the range output correction amount of the first range being the largest, the gain for calculation of the range output correction amount of the third range being smaller than the gain for calculation of the range output correction amount of the first range, and the gain for calculation of the range output correction amount of the fourth range being smaller than the gain for calculation of the range output correction amount of the third range.

[0032] There is a possibility that the state immediately after vehicle take-off is included and the load placed on the internal combustion engine during vehicle take-off still remains in one of or both of the first range and the third range. Therefore, among the three ranges, the gains for calculation of the range output correction amounts of the first range and the third range are relatively large. In the fourth range, the clutch is engaged and the vehicle is running. Therefore, the gain for calculation of the range output correction amount of the fourth is set to a small value compared with the gains for calculation of the range output correction amounts of the first range and the third range, in order to prevent abrupt acceleration. Thus, it is possible to calculate each of the range output correction amounts with appropriate responsiveness, and to perform take-off assist correction more appropriately.

[0033] It is also preferable to provide output correction amount attenuating means for attenuating the output correction amount which has become unnecessary for vehicle take-off assist in the operation state where a request for acceleration is not made or in the internal combustion engine operation range where take-off assist correction is not performed.

[0034] In the case where the range output correction amount is set to a large value, when take-off assist correction is performed again, the engine rotational speed may increase rapidly. Therefore, by attenuating the output correction amount which has become unnecessary for vehicle take-off assist in advance, it is possible to minimize the sense of discomfort felt by the driver. However, the driver may feel the sense of discomfort in the acceleration performance during acceleration operation if the output correction amount is decreased when a request for acceleration is made. Further, rotation of the internal combustion engine may become unstable if the output correction amount is decreased in the internal combustion engine operation range where take-off assist correction is performed.

[0035] Therefore, since the output correction amount attenuating means attenuates the output correction amount which becomes unnecessary for vehicle take-off assist in the operation state where a request for acceleration is not made or in the internal combustion engine operation range where take-off assist correction is not performed, it is possible to minimize the sense of discomfort felt by the driver more effectively.

[0036] It is also preferable that the internal combustion engine be a diesel engine, and the output increase correction process be the correction of an increase in the fuel injection amount.

[0037] When the internal combustion engine is a diesel engine, by using the correction of the increase in the fuel injection amount as the output increase correction process by take-off assist correction, it is possible to appropriately perform take-off assist correction as the fuel amount increase process.

BRIEF DESCRIPTION OF THE DRAWINGS

[0038] The above and other objects, features, advantages, technical and industrial significance of this invention will be better understood by reading the following detailed description of preferred embodiments of the invention, when considered in connection with the accompanying drawings, in which:

FIG. 1 is a view schematically showing a configuration of an accumulator type diesel engine, a fuel injection system and a control system thereof according to a first embodiment of the invention;
FIG. 2 is a flowchart for a fuel injection amount control process performed by an ECU according to the first embodiment;
FIG. 3 is a flowchart for a calculation process of fuel injection correction amounts QiscON, QiscOFF1, and QiscOFF2 according to the first embodiment;
FIG. 4 is a flowchart for a take-off assist correction amount attenuation process according to the first embodiment;
FIG. 5 is a flowchart for the take-off assist correction amount attenuation process according to the first embodiment;
FIG. 6 is a graph showing a governor pattern used in the fuel injection amount control process;
FIG. 7 is a graph showing a configuration of a map for obtaining a clutch OFF time second fuel injection correction amount QiscOFF2 according to the first embodiment;
FIG. 8 is a graph showing a configuration of a map for obtaining a clutch OFF time first fuel injection correction amount QiscOFF1 according to the first embodiment;
FIG. 9 is a graph showing a configuration of a map for obtaining a clutch ON time fuel injection correction amount QiscON according to the first embodiment;
FIG. 10 is a timing chart showing an example of the process according to the first embodiment;
FIG. 11 is a timing chart showing the example of the process according to the first embodiment;
FIG. 12 is a flowchart for a fuel injection amount control process according to a second embodiment of the invention;
FIG. 13 is a flowchart for a calculation process of fuel injection correction amounts QiscON1, QiscON2, QiscOFF1, and QiscOFF2 according to the second embodiment;
FIG. 14 is a flowchart for a take-off assist correction amount attenuation process according to the second embodiment;
FIG. 15 is a flowchart for the take-off assist correction amount attenuation process according to the second embodiment;
FIG. 16 is a timing chart showing an example of the process according to the second embodiment; and
FIG. 17 is a timing chart showing the example of the process according to the second embodiment.

DETAILED DESCRIPTION OF THE EXEMPLARY EMBODIMENTS

[0039] In the following description and the accompanying drawings, the present invention will be described in more detail in terms of exemplary embodiments.

[0040] FIG. 1 is a view schematically showing a configuration of an accumulator type diesel engine (a common rail type diesel engine) 2, a fuel injection system and a control system thereof according to a first embodiment of the invention. The accumulator type diesel engine 2 is mounted on a vehicle as an automobile engine.

[0041] The diesel engine 2 is provided with a plurality of cylinders #1, #2, #3, and #4 (although four cylinders are provided in the embodiment, only one cylinder is shown in FIG. 1). An injector 4 is provided on a combustion chamber of each of the cylinders #1, #2, #3 and #4. Fuel injection from the injector 4 to each of the cylinders #1, #2, #3 and #4 of the diesel engine 2 is controlled according to an ON/OFF state of an electromagnetic valve 4a for fuel injection control.

[0042] The injector 4 is connected to a common rail 6 which serves as an accumulator pipe common to the cylinders.

When the electromagnetic valve 4a for fuel injection control is open, the fuel in the common rail 6 is injected to each of the cylinders #1, #2, #3 and #4 by the injector 4. A relatively high pressure corresponding to a fuel injection pressure is accumulated in the common rail 6. In order to realize the accumulation, the common rail 6 is connected to a discharge port 10a of a supply pump 10 through a supply pipe 8. Also, a check valve 8a is provided on the supply pipe 8. Due to the check valve 8a, fuel supply from the supply pump 10 to the common rail 6 is permitted, and backflow of the fuel from the common rail 6 to the supply pump 10 is prevented.

[0043] The supply pump 10 is connected to a fuel tank 12 through an intake port 10b, and a filter 14 is provided between the fuel tank 12 and the supply pump 10. The supply pump 10 takes in the fuel from the fuel tank 12 through the filter 14. Also, the supply pump 10 reciprocates a plunger using a cam which runs in synchronization with the rotation of the diesel engine 2, increases the fuel pressure to a required pressure, and supplies the high pressure fuel to the common rail 6.

[0044] Further, a pressure control valve 10c is provided near the discharge port 10a of the supply pump 10. The pressure control valve 10c is used for controlling the pressure of the fuel to be discharged from the output port 10a toward the common rail 6. When the pressure control valve 10c is opened, the excessive fuel, which is not discharged from the discharge port 10a, is returned from a return port 10d provided on the supply pump 10 to the fuel tank 12 through a return pipe 16.

[0045] An intake passage 18 and an exhaust passage 20 are connected to the combustion chamber of each of the cylinders #1, #2, #3 and #4 of the diesel engine 2. A throttle valve is provided on the intake passage 18. By adjusting the opening of the throttle valve according to the operation state of the diesel engine 2, the amount of the air to be taken in the combustion chamber is adjusted.

[0046] Also, a glow plug 22 is provided in the combustion chamber of each of the cylinders #1, #2, #3 and #4 of the diesel engine 2. The glow plug 22 is an engine starting assist device which becomes red hot when being supplied with an electric current through a glow relay 22a immediately before the start of the diesel engine 2, and which promotes ignition/combustion when being sprayed with part of the fuel.

[0047] The diesel engine 2 is provided with the following various sensors and switches which detect the operation state of the diesel engine 2. As shown in FIG. 1, an accelerator pedal 24 is provided with an accelerator opening sensor 26 for detecting an accelerator opening ACCP. The diesel engine 2 is provided with a starter 30 for starting the diesel engine 2. The starter 30 is provided with a starter state detecting switch 30a for detecting an operation state of the starter 30. A coolant temperature sensor 32 for detecting a temperature of a coolant (a coolant temperature THW) is provided on a cylinder block of the diesel engine 2. A fuel temperature sensor 36 for detecting a fuel temperature THF is provided on the return pipe 16. A fuel pressure sensor 38 for detecting a pressure of the fuel in the common rail 6 is provided on the common rail 6.

[0048] An engine rotational speed sensor 40 for detecting a crank angle and an engine rotational speed based on the rotation of a crank shaft is provided on a crank shaft of the diesel engine 2. The rotation of the crank shaft is transmitted to the cam shafts for controlling opening/closing of an intake valve 18a and an exhaust valve 20a through a timing belt or the like. These cam shafts are set to rotate at the rotational speed which is half of that of the crank shaft. A pulsar including one tooth is provided on an intake cam shaft which controls opening/closing of the intake valve 18a, and a pickup is provided near the pulsar, whereby a cylinder determining sensor 42 is constituted. In the first embodiment, an engine rotational speed NE and a crank angle CA are calculated according to pulse signals output from the sensors 40 and 42. Also, a clutch switch 44 for detecting whether a clutch pedal is depressed is provided. On the output shaft side of the transmission, there is provided a vehicle speed sensor 46 for detecting a vehicle speed SPD based on the rotational speed of the output shaft.

[0049] In the first embodiment, there is provided an electronic control unit (ECU) 52 for performing various controls of the diesel engine 2. The ECU 52 performs various processes for controlling the diesel engine 2, such as the fuel injection amount control and the glow energization control. The ECU 52 is mainly provided with a microcomputer including a CPU; ROM which stores various programs, maps and the like; RAM which temporarily stores the result of the computation performed by the CPU and the like; backup RAM which stores the result of computation, the data stored in advance and the like; a timer counter; an input interface; an output interface, and the like. The ECU 52 reads signals from the accelerator opening sensor 26, the starter state detecting switch 30a, the coolant sensor 32, the fuel temperature sensor 36, the fuel pressure sensor 38, the engine rotational speed sensor 40, the cylinder determining sensor 42, the clutch switch 44, the vehicle speed sensor 46 and the like. Each of the electromagnetic valve 4a, the pressure control valve 10c, the glow relay 22a, and the like is connected to the ECU 52 through a drive circuit. Thus, the ECU 52 performs control computation based on the above-mentioned signal data, and controls driving of the electromagnetic valve 4a, the pressure control valve 10c, the glow relay 22a and the like.

[0050] Next, the fuel injection amount control process performed by the ECU 52 will be described. The process is performed according to the flowcharts shown in FIG. 2 to FIG. 5. The process is performed as an interrupt at the crank angle intervals, more particularly, at each 180 °CA rotation, since the diesel engine 2 is provided with four cylinders in this case.

[0051] When the process is started, initially, the accelerator opening ACCP, the engine rotational speed NE, the clutch switch state CLSW, the vehicle speed SPD and the like, which are obtained based on the signals from the above-mentioned sensors and switches, are read in a working area of the RAM of the ECU 52 (S 102).

[0052] Next, a low rotational speed side fuel injection amount Qbase1 and a medium/high rotational speed side fuel injection amount Qbase2 are calculated according to the governor pattern shown in FIG. 6 (S104). These fuel injection amounts Qbase1 and Qbase2 are calculated according to an equation using the engine rotational speed NE and the accelerator opening ACCP as parameters.

[0053] As shown in FIG. 6, the low rotational speed side fuel injection amount Qbase1 for each accelerator opening ACCP is inclined so as to decrease with an increase in the engine rotational speed NE. The coefficient of the equation is set such that the inclination of the low rotational speed side fuel injection amount Qbase1 for each accelerator opening ACCP is steep. Therefore, as the engine rotational speed NE decreases, the value of the low rotational speed side fuel injection amount Qbase1 increases rapidly. The medium/high rotational speed side fuel injection amount Qbase2 is inclined so as to decrease with an increase in the engine rotational speed NE. The coefficient of the equation is set such that the inclination of the medium/high rotational speed side fuel injection amount Qbase2 is moderate compared with that of the low rotational speed side fuel injection amount Qbase1. Therefore, as the engine rotational speed NE decreases, the value of the medium/high rotational speed side fuel injection amount Qbase2 increases. However, the increase in the medium/high rotational speed side fuel injection amount Qbase2 is moderate compared with that in the low rotational side fuel injection amount Qbase1. As will be described later, the larger of the value of "Qbase1+QiscON+QiscOFF" and "Qbase2" is used. Thus, on the low rotational speed side, the value of "Qbase1+QiscON+QiscOFF" is used, and on the medium/high rotational speed side, "Qbase2" is used.

[0054] When these fuel injection amounts Qbase1 and Qbase2 are calculated, a target engine rotational speed NEisc is then set (S106). The target engine rotational speed NEisc is set based on the friction of the diesel engine 2, the vehicle running resistance, electric load and the like or the estimation of their occurrence.

[0055] For example, when the clutch for connecting the diesel engine 2 to the transmission side is disengaged (including partial clutch engagement) (CLSW="ON"), and also the vehicle is at a standstill (vehicle speed SPD≤SPEDstop), the target engine rotational speed NEisc is set to 850 rpm (NEisc="850rpm") on the assumption that the vehicle will take off from a standstill with the clutch partially engaged. When the clutch is engaged (CLSW="OFF") and also the vehicle is running (vehicle speed SPD> SPDstop), the target rotational peed NEisc is set to 850 rpm (NEisc="850rpm") in consideration of the running resistance. When the clutch is engaged (CLSW="OFF"), and the vehicle is at a standstill (vehicle speed SPD≤SPDstop), the target engine rotational speed NEisc is set to 800 rpm (NEisc="800rpm"). The vehicle stop determining speed SPDstop is set to a value between "0km/h" to "3km/h". In this case, the vehicle stop determining speed SPDstop is set to "0km/h" (SPDstop="0km/h"). The value of "0km/h" includes a state where the vehicle is running at the speed of "3km/h" or lower, due to accuracy of the vehicle speed sensor 46.

[0056] Next, the three fuel injection correction amounts, QiscON, QiscOFF1, and QiscOFF2 are calculated and updated according to the circumstances (S108). FIG. 3 shows a flowchart for the calculation process of these fuel injection correction amounts, QiscON, QiscOFF1, and QiscOFF2.

[0057] In this process, it is initially determined whether the clutch switch state CLSW is the "OFF (engaged)" state (S202). When it is determined that the clutch switch state CLSW is the "OFF (engaged)" state ("YES" in S202), it is then determined whether the vehicle is running, that is, whether the vehicle speed SPD is higher than vehicle stop determining speed SPDstop (SPD>SPDstop) (S204). In this case, as the detection value of the vehicle speed sensor 46, the vehicle stop determining speed SPDstop is set to 0km/h.

[0058] When the vehicle is at a standstill or is running considerably slowly, that is, when the vehicle speed SPD is equal to the vehicle stop determining speed (SPD=SPDstop) ("NO" in S204), the calculation process of the clutch OFF time second fuel injection correction amount QiscOFF2 is performed (S206). In the calculation process of the clutch OFF time second fuel injection correction amount QiscOFF2, a proportional correction amount Qa2 is obtained using the map a2 in FIG. 7 based on ΔNE (ΔNE=NEisc-NE). When ΔNE is lower than "0" (ΔNE<"0"), Qa2 is fixed to "0" (Qa2="0"). Namely, the proportional correction amount Qa2 is set according to a degree of decrease in the engine rotational speed NE with respect to the target engine rotational speed NEisc.

[0059] Then, an integral value Sqb2 is obtained using a map b2 in FIG. 7 based on ΔNE. Then, the clutch OFF time second fuel injection correction amount QiscOFF 2 is calculated according to the following equation 1.

$$\text{QiscOFF2} \leftarrow \text{Qa} + \Sigma\text{qb2} \qquad \text{(Equation 1)}$$

Here, the integral correction value Σqb2 is a value obtained by adding the integral value Sqb2 to the previous integral correction value Σqb2 every time calculation according to the equation 1 is performed.

[0060] The process thus exits the calculation process of the fuel injection correction amounts QiscON, QiscOFF1 and QiscOFF2 (S108). Accordingly, when the clutch OFF time second fuel injection correction amount QiscOFF2 is calculated in step S206, the calculation processes of the other two fuel injection correction amounts QiscON and QiscOFF1 are not performed. Therefore, the two fuel injection correction amounts, QiscON and QiscOFF1 are not updated, and the values which have been obtained before calculation of the clutch OFF time second fuel injection correction amount QiscOFF2 are continuously used.

[0061] When it is determined that the vehicle speed SPD is higher than the vehicle stop determining speed SPDstop (SPD>SPDstop) ("YES" in S204), the calculation process of the clutch OFF first fuel injection correction amount QiscOFF1 is performed (S208). In the calculation process of the clutch OFF first fuel injection correction amount QiscOFF1, a proportional correction amount Qa1 is obtained using a map a1 in FIG. 8 based on ΔNE (ΔNE=NEisc-NE). When ΔNE is lower than "0" (ΔNE<"0"), Qa1 is fixed to "0" (Qa1="0"). Namely, the proportional correction amount Qa1 is set according to the degree of the decrease in the engine rotational speed NE with respect to the target engine rotational speed NEisc.

[0062] Then, an integral value Sqb1 is obtained using a map b1 in FIG. 8 based on ΔNE. The gain of the proportional correction amount Qa1 with respect to ΔNE in the map a1 in FIG. 8 is set to be smaller than the gain of the proportional correction amount Qa2 with respect to ΔNE in the map a1 in FIG. 7. Similarly, the gain of the integral value Sqb1 with respect to ΔNE in the map b1 in FIG. 8 is set to be smaller than the gain of the integral value Sqb2 with respect to ΔNE in the map b1 in FIG. 7.

[0063] Then, the clutch OFF time first fuel injection correction amount QiscOFF1 is calculated according to the following equation 2.

$$QiscOFF1 \leftarrow Qa1 + \Sigma Sqb1 \qquad \text{(Equation 2)}$$

Here, the integral correction amount ∑Sqb1 is a value obtained by adding the integral value Sqb1 to the previous integral correction amount ∑Sqb1 every time calculation according to the equation 2 (∑Sqb1 ∑Sqb1 +Sqb1) is performed.

[0064] Thus, the process exits the calculation process of the fuel injection correction amounts QiscON, QiscOFF1 and QiscOFF2 (S108). Therefore, when the clutch OFF time first fuel injection correction amount QiscOFF1 is calculated in step S208, the calculation processes of the other fuel injection correction amounts QiscON and QiscOFF2 are not performed. Accordingly, the two fuel injection correction amounts QiscON and QiscOFF2 are not updated, and the values which have been calculated before calculation of the clutch OFF time first fuel injection correction amount QiscOFF1 are continuously used.

[0065] When it is determined that the clutch switch state CLSW is the "ON" state (CLSW="ON" (disengaged) in step S202 ("NO" in S202), the calculation process of the clutch ON time fuel injection correction amount QiscON is then performed (S210). In the calculation process of the clutch ON time fuel injection correction amount QiscON, a proportional correction amount Qas is obtained using a map as in FIG. 9 based on ΔNE (ΔNE=NEisc-NE). When ΔNE is lower than "0" (ΔNE<"0"), Qas is fixed to "0" (Qas="0"). Namely, the proportional correction amount Qas is set according to the degree of the decrease in the engine rotational speed NE with respect to the target engine rotational speed NEisc.

[0066] Then, an integral value Sqbs is obtained using a map bs in FIG. 9 based on ΔNE. Also, a differential correction amount Qcs is obtained using a map cs in FIG. 9 based on the time change ΔNE/dt of ΔNE. When the time change ΔNE/dt is smaller than "0" (ΔNE/dt<"0"), the differential correction amount Qcs is fixed to "0" (Qcs="0"). Namely, the differential correction amount Qcs is set according to the degree of the decrease in the engine rotational speed NE with respect to the target engine rotational speed NEisc.

[0067] The gain of the proportional correction amount Qas with respect to ΔNE in the map as in FIG. 9 is set to be larger than the gain of the proportional correction amount Qa2 with respect to ΔNE in the map a2 in FIG. 7. Similarly, the gain of the integral value Sqbs with respect to ΔNE in the map bs in FIG. 9 is set to be larger than the gain of the integral value Sqbs with respect to ΔNE in the mapb2 in FIG. 7. Thus, the degree of the decrease in the engine rotational speed NE with respect to the target engine rotational speed NEisc is largely reflected on the proportional correction amount Qas and the integral value Sqbs.

[0068] Then, the clutch ON time fuel injection correction amount QiscON is calculated according to the following equation 3.

$$QiscON \leftarrow Qas + \Sigma Sqbs + Qcs \qquad \text{(Equation 3)}$$

Here, the integral correction value ΣSqbs is a value obtained by adding the integral value Sqbs to the previous integral correction value ΣSqbs every time calculation according to the equation 3 (ΣSqbs←ΣSqbs+Sqbs) is performed. As mentioned above, in calculation of the clutch ON time fuel injection correction amount QiscON, ΔNE is largely reflected on the proportional correction amount Qas and the integral value Sqbs, compared with calculation of the other two fuel injection correction amounts QiscOFF1 and QiscOFF2. Therefore, the change in ΔNE is largely reflected on the clutch ON time fuel injection correction amount QiscON.

[0069] The process then exits the calculation process of the fuel injection correction amounts QiscON, QiscOFF1 and QiscOFF2 (S108). Accordingly, when the clutch ON time fuel injection correction amount QiscON is calculated in step S210, the calculation processes of the other two fuel injection correction amounts QiscOFF1 and QiscOFF2 are not performed. Therefore, the two fuel injection correction amounts QiscOFF1 and QiscOFF2 are not updated, and the values which have been calculated before calculation of the clutch ON time fuel injection correction amount QiscON are continuously used.

[0070] Thus, any one of the fuel injection correction amounts QiscON, QiscOFF1 and QiscOFF2 is calculated and updated in step S108. Namely, when the clutch is engaged and also the vehicle is at a standstill or is running considerably slowly, the clutch OFF time second fuel injection correction amount QiscOFF2 is updated. When the clutch is engaged and also the vehicle is running at a speed which is equal to or higher than a predetermined speed, the clutch OFF time first fuel injection correction amount QiscOFF1 is updated. When the clutch is disengaged, the clutch ON time fuel injection correction amount QiscON is updated.

[0071] Each of the fuel injection correction amounts QiscON, QiscOFF1 and QiscOFF2, and each of the integral correction amounts ΣSqb1, ΣSqb2 and ΣSqb3 are set to "0" at the initial setting when the ignition is in the "ON" state.

[0072] When the calculation process of the fuel injection correction amounts QiscON, QiscOFF1 and QiscOFF2 (S108) is thus completed, the take-off assist correction amount attenuation process is performed (S110). The take-off assist correction amount attenuation process is shown in the flowcharts in FIG. 4 and FIG. 5. When the process is started, it is initially determined whether the clutch switch state CLSW is the "OFF" state (CLSW="OFF" (engaged)) (S302). For example, the vehicle is at a standstill waiting for the light to change at the intersection while the transmission is in the neutral state and the clutch is engaged. In this case, since the clutch switch state CLSW is the "OFF" state (CLSW ="OFF" (engaged)) ("YES" in S302), it is then determined whether the accelerator opening ACCP is equal to "0" (%), that is, whether the driver has not depressed the accelerator pedal 24 (S304). When it is determined that the accelerator opening ACCP is equal to "0" ("YES" in S304), it is then determined whether the engine rotational speed NE is equal to or higher than the target engine rotational speed NEisc which is set in the state where the clutch switch state CLSW is the "OFF" state (CLSW="OFF") (S306). When it is determined that the engine rotational speed NE is equal to or higher than the target engine rotational speed NEisc (NE≥NEisc) ("YES" in S306), it is then determined whether the clutch OFF time fuel injection correction amount QiscOFF is larger than "0"(mm^3) (QiscOFF >"0"(mm^3)), that is, whether the increase amount correction by the clutch OFF time fuel injection correction amount QiscOFF has been made (S308).

[0073] When the clutch OFF time fuel injection correction amount QiscOFF is equal to "0" (QiscOFF="0") ("NO" in S308), it is then determined whether the clutch ON time fuel injection correction amount QiscON is larger than "0" (mm^3) (QiscON>"0"(mm^3)), that is, whether the increase amount correction by the clutch ON time fuel injection correction amount QiscON has been made (S312). Even when it is determined that the engine rotational speed NE is lower than the target engine rotational speed NEisc (NE<NEisc) ("NO" in S306), the determination in step S312 is made.

[0074] When it is determined that the clutch ON time fuel injection correction amount QiscON is equal to "0" (QiscON="0") ("NO" in S312), the process exits the take-off assist correction amount attenuation process, returns to the process in FIG. 2, and the clutch OFF time fuel injection correction amount QiscOFF is calculated based on the two fuel injection correction amounts QiscOFF1 and QiscOFF2 according to the following equation 4.

$$\text{QiscOFF} \leftarrow \text{QiscOFF1} + \text{QiscOFF2} \qquad \text{(Equation 4)}$$

Next, a final fuel injection amount Qfin is calculated based on the clutch OFF time fuel injection correction amount QiscOFF and the clutch ON time fuel injection correction amount QiscON according to the following equation 5 (S 114).

$$\text{Qfin} \leftarrow \text{MAX (Qbase1+QiscON+QiscOFF, Qbase2)} \qquad \text{(Equation 5)}$$

Here, MAX ( ) is the operator for extracting the larger of the values in the parenthesis. The value of "Qbase1+QiscON+QiscOFF" is as shown by a dashed line in FIG. 6.

[0075] The process thus ends temporarily. In an idle state such as waiting for the light to change (CLSW="OFF" (engaged), ACCP="0", SPD="0"), the fuel injection amount adjustment when the engine rotational speed NE becomes lower than the target engine rotational speed NEisc is performed by calculating the clutch OFF time second fuel injection correction amount QiscOFF2 (S206 in FIG. 3). As mentioned above, the gain for calculation of the clutch OFF time second fuel injection correction amount QiscOFF2 corresponding to ΔNE is smaller than the gain for calculation of the clutch ON time fuel injection correction amount QiscON. Accordingly, hunting in the idle speed control can be prevented.

However, the gain for caclulation of the clutch OFF time second fuel injection correction amount QiscOFF 2 is larger than the gain for calculation of the clutch OFF time first fuel injection correction amount QiscOFF1. Accordingly, the decrease in the engine rotational speed NE when the vehicle is at a standstill in the idle state can be prevented with high responsiveness compared with the case where the vehicle is running, and engine stalling can be prevented effectively.

[0076] In the above-mentioned state, the driver depresses the clutch pedal so as to make an idle start of the vehicle, and the clutch switch state CLSW then becomes the "ON" state (CLSW="ON" (disengaged)) ("NO" in S302). In this case, when it is determined that the accelerator opening ACCP is equal to "0" (ACCP="0") ("YES" in S318), and the load during vehicle take-off is not placed on the diesel engine 2 and the engine rotational speed NE is equal to or higher than the target engine rotational speed NEisc (NE≥NEisc) ("NO"in S320), a negative determination is made in step S312. Accordingly, calculation of the clutch OFF time fuel injection correction amount QiscOFF according to the equation 4 (S112), and calculation of the final fuel injection amount Qfin according to equation 5 (S114) are performed. Also, the calculation process of the clutch ON time fuel injection correction amount QiscON (S210 in FIG. 3) is performed. However, since the engine rotational speed NE is not lower than the target engine rotational speed NEisc, the value is not actually increased.

[0077] Then, the transmission is changed to the first speed while the clutch switch state CLSW remains "ON" (CLSW="ON" (engaged)), the clutch is partially engaged, and the load during vehicle take-off is placed on the diesel engine 2. Therefore the engine rotational speed NE is lower than the target engine rotational speed NEisc (NE<NEisc) ("YES" in S320). Thus, calculation of the clutch OFF time fuel injection correction amount QiscOFF according to the equation 4 (S112) and calculation of the final fuel injection amount Qfin according to the equation 5 (S114) are performed.

[0078] In the vehicle take-off state where the clutch switch CLSW is the "ON" state (CLSW="ON" (disengaged)), the fuel injection amount adjustment for making the engine rotational speed NE substantially equal to the target engine rotational speed NEisc is performed at the value of the clutch ON time fuel injection correction amount QiscON by performing step S210 (FIG. 3). As mentioned above, the gain for calculation of the clutch ON time fuel injection correction amount QiscON with respect to ΔNE is larger than the gains for calculation of the clutch OFF time first fuel injection correction amount QiscOFF1 and the clutch OFF time second fuel injection correction amount QiscOFF2. Further, since the differential correction amount Qcs is also added, the clutch ON time fuel injection correction amount QiscON rapidly increases, and the sufficient output can be generated from the diesel engine 2 in order to deal with the load during vehicle take-off. Even when the gain for calculating the clutch ON time fuel injection correction amount QiscON is large, since the clutch ON time fuel injection correction amount QiscON is used for dealing with the load during vehicle take-off, hunting in the output control hardly occurs.

[0079] When the clutch is changed from the partially engaged state to the fully state by the clutch pedal operation performed by the driver, the clutch switch state CLSW is changed to the "OFF" state (CLSW="OFF" (engaged)) ("YES" in S302). Then, it is determined whether the accelerator opening ACCP is equal to "0", that is, whether the driver is performing the acceleration operation (S304).

[0080] In this case, since the idle start is performed, that is, the driver is not performing the acceleration operation (ACCP="0") ("YES" in S304), determination in step S306 is then made. When it is determined that the engine rotational speed NE is equal to or higher than the target engine rotational speed NEisc (NE ≥NEisc) ("YES" in S306) and also the clutch OFF time fuel injection correction amount QiscOFF is equal to "0" (QiscOFF="0") ("NO" in S308), or when it is determined that the engine rotational speed NE is lower than the target engine rotational speed NEisc (NE<NEisc) ("NO" in S306), it is then determined whether the clutch ON time fuel injection correction amount QiscON is larger than "0" (QiscON>"0") (S312). In this case, the clutch ON time fuel injection correction amount QiscON has increased rapidly during the latest vehicle take-off. Accordingly, since the clutch ON time fuel injection correction amount QiscON is larger than "0" ("YES" in S312), the attenuation process of the clutch ON time fuel injection correction amount QiscON is performed (S314).

[0081] The attenuation process of the clutch ON time fuel injection correction amount QiscON is performed so as to gradually decrease the clutch ON time fuel injection correction amount QiscON to "0" from a value larger than "0". More particularly, the process for subtracting a predetermined amount from the clutch ON time fuel injection correction amount QiscON is performed until the QiscON becomes equal to "0" at each control cycle of the fuel injection amount control process. The process for subtracting the predetermined amount from the clutch ON time fuel injection correction amount QiscON may be performed until the QiscON becomes equal to "0" periodically. Also, instead of subtracting the predetermined amount from the clutch ON time fuel injection correction amount QiscON, the following process may be performed. In this process, the attenuation coefficient which is smaller than "1" is multiplied by the clutch ON time fuel injection correction amount QiscON, and when the clutch ON time fuel injection correction amount QiscON comes close to "0" at a certain degree, the attenuation process is completed on the assumption that QiscON is equal to "0" (QiscON="0").

[0082] Then, calculation of the clutch OFF time fuel injection correction amount QiscOFF according to the equation

4 (S112) and calculation of the final fuel injection amount Qfin according to the equation 5 (S114) are performed, and the process temporarily ends. When the accelerator opening ACCP is continuously "0" (ACCP="0") ("YES" in S304), the attenuation process of the clutch ON time fuel injection correction amount QiscON (S314) continues while QiscON is larger than "0" (QISCON>"0") ("YES" in S312).

[0083] When the clutch ON time fuel injection correction amount QiscON is being attenuated after the vehicle take-off, as long as an affirmative determination is made in step S202 in FIG. 3, and the vehicle speed SPD is equal to "0" ("NO" in S204), the clutch OFF time second fuel injection correction amount QiscOFF 2 is updated (S206). When the vehicle speed SPD is higher than "0" ("YES" in S204), the clutch OFF time fuel injection correction amount QiscOFF1 is updated (S208). Accordingly, when the engine rotational speed NE is lower than the target engine rotational speed NEisc, the clutch OFF time fuel injection correction amount QiscOFF is increased instead of the clutch ON time fuel injection correction amount QiscON, and engine stalling can be prevented.

[0084] Meanwhile, the driver depresses the clutch pedal so as to make the clutch switch state CLSW the "ON" state (CLSW="ON") ("NO" in S302), and then depresses the accelerator pedal 24 so as to make the vehicle take off. In this case ("NO" in S318), it is then determined whether the value of "Qbase1+QiscON+QiscOFF1+QiscOFF2" is larger than Qbase2 (S322). Namely, it is determined whether the value of "Obase1+QiscON+QiscOFF" is extracted in step S114 when the current fuel injection amounts Qbase1 and Qbase2, and the fuel injection correction amounts QiscON, QiscOFF1 and QiscOFF2 are used.

[0085] When it is determined that the value of "Qbase1+QiscON+QiscOFF1+QiscOFF2" is larger than Qbase2 ("YES" in S322), the value of "Qbase1+QiscON+QiscOFF" needs to be used as the final fuel injection amount Qfin. In this case, calculation of the clutch OFF time fuel injection correction amount QiscOFF according to the equation 4 (S112), and calculation of the final fuel injection amount Qfin according to the equation 5 (S114) are performed, and the process temporarily ends. Thus, the value of "Qbase1+QiscON+QiscOFF" is used as the final fuel injection amount Qfin.

[0086] At this time, since the clutch switch state CLSW is the "ON" state (CLSW="ON") ("NO" in S202 in FIG. 3), the clutch ON time fuel injection correction amount QiscON increases particularly in the partial clutch engagement time due to a large gain (S210).

[0087] When the clutch is fully engaged and the clutch switch state CLSW is changed to the "OFF" state (CLSW="OFF") ("YES" in S302), since the accelerator opening ACCP is larger than "0" (ACCP>"0") ("NO" in S304), it is determined whether the value of "Qbase1+QiscON+QiscOFF1+QiscOFF2" is larger than Qbase2 (S316). The determination is the same as that in step S322 (FIG. 5). When it is determined that the value of "Qbase1+QiscON+QiscOFF1+QiscOFF2" is larger than Qbase2 ("YES" in S316), calculation according to the equation 4 (S112) and calculation according to the equation 5 (S114) are performed, and the process temporarily ends. Thus, the value of "Qbase1+QiscON+QiscOFF" is used as the final fuel injection amount Qfin.

[0088] When the clutch switch state CLSW is the "OFF" state (CLSW="OFF") ("YES" in S202 in FIG. 3), and the vehicle is running at a considerably low speed and the vehicle speed SPD is equal to "0" (SPD="0") in the detection by the vehicle speed sensor 46 ("NO" in S204), the clutch OFF time second fuel injection correction amount QiscOFF2 is calculated (S206). However, the clutch OFF time second fuel injection correction amount QiscOFF2 is not actually increased since the clutch ON time fuel injection correction amount QiscON is sufficiently large. Then, when the vehicle speed becomes higher than "0" ("YES" in S204), the clutch OFF time first fuel injection correction amount QiscOFF 1 whose gain is the smallest is calculated (S208). However, even in this case, since the clutch ON time fuel injection correction amount QiscON is sufficiently large, the clutch OFF time first fuel injection correction amount QiscOFF1 is not actually increased.

[0089] The driver depresses the accelerator pedal 24, the engine rotational speed NE increases and the value of "Qbase1+QiscON+QiscIFF1+QiscOFF2" is equal to or smaller than Qbase2 ("NO" in S316). At this time, the engine rotational speed NE is higher than the target engine rotational speed NEisc ("YES" in S306). Therefore, when the clutch OFF time fuel injection correction amount QiscOFF is larger than "0" ("YES" in S308), the attenuation process of the clutch OFF time fuel injection correction amount QiscOFF is performed (S310). The attenuation process is the same as the attenuation process of clutch ON time fuel injection correction amount QiscON (S314).

[0090] Since the clutch ON time fuel injection correction amount QiscON is larger than "0" ("YES" in S312), the attenuation process of the clutch ON time fuel injection correction amount. QiscON is performed (S314). Then, calculation according to the equation 4 (S112) and calculation according to the equation 5 (S114) are performed, and the process temporarily ends.

[0091] When the clutch OFF time fuel injection correction amount QiscOFF is equal to "0" (QiscOFF="0") ("NO" in S308), the attenuation process of the clutch OFF time fuel injection correction amount QiscOFF (S310) is stopped. Similarly, when the clutch ON time fuel injection correction amount QiscON is equal to "0" (QiscON="0") ("NO" in S312), the attenuation process of the clutch ON time fuel injection correction amount QiscON (S314) is stopped.

[0092] When the accelerator opening ACCP is changed from a value larger than "0" to "0" ("YES" in S304), as long as the engine rotational speed NE is equal to or higher than the target engine rotational speed NEisc (NE≥NEisc)

("YES" in S306), and the clutch OFF time fuel injection correction amount QiscOFF is larger than "0" (QiscOFF>"0") ("YES" in S308), the attenuation process of the clutch OFF time fuel injection correction amount QiscOFF (S310) is continuously performed. Also, as long as the clutch ON time fuel injection correction amount QiscON is larger than "0" (QiscON>"0") ("YES" in S312); the attenuation process of the clutch ON time fuel injection correction amount QiscON (S314) is continuously performed.

[0093] An example of the process by the above-mentioned fuel injection amount control process (FIG.2 to FIG. 5) is shown in the timing chart in FIG. 10 and FIG.11. FIG. 10 shows the case of idle start. FIG. 11 shows the case where the vehicle takes off from a standstill while the driver depresses the accelerator pedal 24.

[0094] In the case of FIG. 10, until time t1, the vehicle is at a standstill waiting for the light to change while the transmission is in the neutral state and the clutch is engaged. Therefore, until time t1, calculation of the clutch OFF time second fuel injection correction amount QiscOFF 2 (S206) is performed, and the calculation processes of the other fuel injection correction amounts QiscON and QiscOFF1 are stopped. Then, in order to make the vehicle take off from a standstill, the clutch is disengaged at time t1, and the transmission is changed to the first speed. From time t1, calculation of the clutch ON time fuel injection correction amount QiscON whose gain is large is performed (S210), and the calculation processes of the other fuel injection correction amounts QiscOFF1 and QiscOFF2 are stopped. Therefore, the clutch ON time fuel injection correction amount QiscON is increased with an increase in the target engine rotational speed NEisc, and the actual engine rotational speed NE becomes substantially equal to the target engine rotational speed NEisc with high responsiveness.

[0095] Since the operation for engaging the clutch is started at time t2, the rotational load placed on the diesel engine 2 is increased and the engine rotational speed NE decreases from the target engine rotational speed NEisc from time t2. However, since the clutch ON time fuel injection correction amount QiscON is increased with high responsiveness, take-off assist correction amount "QiscON+QiscOFF" is rapidly increased, and the engine rotational speed NE comes close to the target engine rotational speed NEisc. Due to such an increase in take-off assist correction amount, the engine stalling during vehicle take-off is prevented, and the vehicle can take off from a standstill smoothly.

[0096] Then, the vehicle starts running, the clutch is fully engaged at time t3, and the clutch switch state CLSW is changed to the "OFF" state. At this time, the vehicle speed SPD detected by the vehicle speed sensor 46 is still equal to "0". Therefore, calculation of the clutch ON time fuel injection correction amount QiscON (S210 in FIG. 3) is stopped, and the process proceeds to calculation of the clutch OFF time second fuel injection correction amount QiscOFF2 (S206). Further, since the accelerator pedal 24 has not been depressed at time t3 (ACCP="0"), attenuation of the clutch ON time fuel injection correction amount QiscON is immediately started (S314 in FIG. 4). Then, the vehicle speed SPD becomes higher than "0" (SPD>"0") at time t4. Therefore, calculation of the clutch OFF time second fuel injection correction amount QiscOFF 2 (S206) is stopped, and calculation of the clutch OFF time first fuel injection correction amount QiscOFF1 (S208) is started.

[0097] Then, since the clutch ON time fuel injection correction amount QiscON becomes equal to "0" at time t5 ("NO" in S312 in FIG. 4), attenuation of the clutch ON time fuel injection correction amount QiscON (S314) is stopped.

[0098] Then, the accelerator pedal 24 is depressed at time t6 ("NO" in S304), the engine rotational speed NE further increases, and the vehicle speed SPD increases with the increase in the engine rotational speed NE. However, as long as it is determined that the engine rotational speed is in the low rotational speed range ("YES" in S316), the attenuation process of the clutch OFF time fuel injection correction amount QiscOFF (S310) is not performed (time t6 to time t7). When the engine rotational speed enters the medium/high rotational speed range due to the increase in the engine rotational speed NE ("NO" in S316), the engine rotational speed NE is equal to or higher than the target engine rotational speed NEisc (NE≥NEisc) ("YES" in S306) and the clutch OFF time fuel injection correction amount QiscOFF is larger than "0" (QiscOFF>"0") ("YES" in S308). Therefore, attenuation of the clutch OFF time fuel injection correction amount QiscOFF (S310) is performed (time t7 to time t8).

[0099] In the case of FIG. 11, the state until the engagement of the clutch is started (time t12) is the same as that until time t2 in FIG. 10. In FIG. 11, the accelerator pedal is depressed before the clutch switch state CLSW is changed to the "OFF" state (CLSW="OFF") (time t13). Therefore, even when the clutch switch state CLSW is changed to the "OFF" state (CLSW="OFF") at time t14 ("YES" in S302 in FIG. 4), the accelerator opening ACCP is larger than "0" (ACCP>"0") ("NO" in S304), and the engine rotational speed is still in the low rotational speed range ("YES" in S316). Therefore, attenuation of the clutch ON time fuel injection correction amount QiscON (S314) is not started. Accordingly, the value of the clutch ON time fuel injection correction amount QiscON is continuously used, and the clutch OFF time fuel injection correction amount QiscOFF is also continuously used.

[0100] When the engine rotational speed then enters the medium/high rotational speed range ("NO" in S316), or when the accelerator pedal 24 is fully released ("YES" in S304), attenuation of the clutch ON time fuel injection correction amount QiscON and the clutch OFF time fuel injection correction amount QiscOFF is performed (time t15 to time t16). Therefore, in this case, high acceleration performance can be obtained compared with the case where attenuation of the clutch ON time fuel injection correction amount QiscON is started immediately after the vehicle take-off as shown by a dashed line.

[0101] In the above-mentioned configuration, the internal combustion engine operation range is divided into three ranges. Namely, the operation range where the clutch switch state CLSW is the "OFF" state (CLSW="OFF") and the vehicle speed SPD is equal to "0" (SPD="0") corresponds to a first range where the vehicle is idle stopped. The operation range where the clutch switch state CLSW is the "ON" state (CLSW="ON") corresponds to a second range where the vehicle takes off from a standstill. The operation range where the clutch switch state CLSW is the "OFF" state (CLSW="OFF") and the vehicle speed SPD is higher than "0" (SPD>"0") corresponds to a third range which is the range other than the first range and the second range. Each of the clutch OFF time first fuel injection correction amount QiscOFF1, the clutch OFF time second fuel injection correction amount QiscOFF2, and the clutch ON time fuel injection correction amount QiscON corresponds to the range output correction amount. The value of "QiscON+QiscOFF" corresponds to the total amount of the range output correction amounts. Steps S108, S112 and S114 in the fuel injection amount control process (FIG. 2 to FIG. 5) correspond to the process as the output correcting means, and step S110 corresponds to the process as the output correction amount attenuating means.

[0102] According to the first embodiment, the following effects can be obtained. (a) The fuel injection correction amounts QiscON, QiscOFF1 and QiscOFF 2 are respectively assigned to the corresponding internal combustion operation ranges, are subjected to calculation, and updated respectively. However, take-off assist correction itself is performed in all the ranges using the total amount of all the fuel injection correction amounts QiscON, QiscOFF1 and QiscOFF2.

[0103] Therefore, even when the internal combustion engine operation range is changed during vehicle take-off or immediately after vehicle take-off, by totaling the fuel injection correction amounts, QiscON, QiscOFF1 and QiscOFF2, they are always related to each other and reflected on take-off assist correction.

[0104] Further, the gain for calculation of each of the fuel injection correction amounts QiscON, QiscOFF1 and QiscOFF2 is changed to the appropriate value so as to correspond to each of the internal combustion engine operation ranges. Thus, the operation state of the diesel engine 2 is reflected on the fuel injection correction amounts QiscON, QiscOFF1 and QiscOFF 2 with responsiveness appropriate for each of the internal combustion engine operation ranges. Accordingly, even when the internal combustion engine operation range is changed, take-off assist correction can be immediately performed with responsiveness appropriate for the new internal combustion engine operation range.

[0105] Thus, it is possible to prevent fluctuation in the engine rotational speed NE and the vehicle speed SPD when the internal combustion engine operation range is changed during vehicle take-off or immediately after vehicle take-off, and to minimize the sense of discomfort felt by the driver.

[0106] (b) The gain for calculation of the clutch ON time fuel injection correction amount QiscON is set to the largest value among the gains for calculation of the fuel injection correction amounts. During vehicle take-off, an abrupt increase in the load placed on the diesel engine 2 occurs. Therefore, by setting the gain for calculation of the clutch ON time fuel injection correction amount QiscON to a large value compared with the gains for calculation of the other fuel injection correction amounts QiscOFF1 and QiscOFF2, the clutch ON time fuel injection correction amount QiscON can be increased with high responsiveness so as to deal with the increase in the load when the vehicle takes off from a standstill. As a result, the total amount of the fuel injection correction amounts QiscON, QiscOFF1 and QiscOFF2 changes with high responsiveness, and the appropriate take-off assist correction can be performed based on the total amount.

[0107] Further, when the internal combustion engine operation range is changed from the range where the vehicle takes off from a stand still to another range, the gains for calculation of the clutch OFF time fuel injection correction amounts QiscOFFI and QiscOFF2 decrease. Therefore, problems such as hunting of the output can be prevented, and the engine rotational speed NE and the vehicle speed SPD are stabilized.

[0108] Thus, it is possible to prevent fluctuation in the engine rotational speed NE and the vehicle speed SPD when the internal combustion engine operation range is changed during vehicle take-off or immediately after vehicle take-off, and to minimize the sense of discomfort felt by the driver.

[0109] (c) Further, the gain for the operation range where the clutch switch CLSW is the "OFF" state (CLSW="OFF") and the vehicle speed SPD is higher than "0" (SPD>"0") is smaller than the gain for the operation range where the clutch switch CLSW is the "OFF" state (CLSW="OFF") and the vehicle speed SPD is equal to "0" (SPD="0"). In the range where the clutch switch CLSW is the "OFF" state (CLSW="OFF") and the vehicle speed SPD is higher than "0" (SPD>"0"), the vehicle is running normally, and the engine rotational speed NE does not decrease easily. When acceleration operation is not performed, it is necessary to make the vehicle run stably. Therefore, by making the gain for the operation range where the clutch switch state CLSW is the "OFF" state (CLSW="OFF") and the vehicle speed SPD is higher than "0" (SPD>"0") larger than the gain for the operation range where the clutch switch state CLSW is the "OFF" state (CLSW="OFF") and the vehicle speed SPD is equal to "0" (SPD="0"), it is possible to prevent fluctuation in the engine rotational speed NE and the vehicle speed SPD, and to enhance the effects of minimizing the sense of discomfort felt by the driver.

[0110] (d) In the case where the fuel injection correction amounts QiscON, QiscOFF1 and QiscOFF 2 are set to large values, when take-off assist correction is performed again, the engine rotational speed NE may rapidly increase. Therefore, it is desirable to attenuate the fuel injection correction amounts QiscON, QiscOFF1 and QiscOFF2, which have become unnecessary as take-off assist, in advance in order to minimize the sense of discomfort felt by the driver. However, if the fuel injection correction amounts QiscON, QiscOFF1 and QiscOFF 2 are decreased when there is a request for acceleration, the driver may feel a sense of discomfort on the acceleration performance during the acceleration operation. Also, in the internal combustion engine operation range where take-off assist correction is performed, if the fuel injection correction amounts QiscON, QiscOFF1 and QiscOFF2 are decreased, the engine rotational speed NE and the vehicle speed SPD may become unstable.

[0111] In the state where the request for acceleration is not made ("YES" in S304, "YES" in S318), or in the internal combustion engine operation range where take-off assist correction is not performed ("NO" in S316, "NO" in S322), the process for attenuating the fuel injection amounts QiscON and QiscOFF, which have become unnecessary as the take-off assist, can be performed. Thus, the sense of discomfort felt by the driver can be minimized effectively.

[0112] In the second embodiment, instead of the fuel injection amount correction process according to the first embodiment (FIG. 2 to FIG. 5), the processes in FIG. 12 to FIG. 15 are performed. In the processes shown in FIG. 12 to FIG. 15, the operation range where the clutch switch state CLSW is the "ON" state is divided into two ranges depending on whether the vehicle speed SPD is higher than "0" (SPD>"0") or the vehicle speed SPD is equal to "0" (SPD="0"). Thus, the clutch ON time fuel injection correction amount is divided into the clutch ON time first fuel injection correction amount QiscON1 which is calculated when the clutch switch state CLSW is the "ON" state (CLSW="N") and the vehicle speed SPD is higher than "0" (SPD>"0"), and the clutch ON time second fuel injection correction amount QiscON2 which is calculated when the clutch switch state CLSW is the "ON" state (CLSW="ON") and the vehicle speed SPD is equal to "0" (SPD="0").

[0113] In FIG. 12, steps S402 to S406, S412, and S414 are the same processes as steps S102 to S106, S112, and S 114 in FIG. 2, respectively. Steps S408 to S411 are different from steps S108 to S110 in FIG. 2.

[0114] The calculation process of the fuel injection correction amounts QiscON1, QiscON2, QiscOFF1 and QiscOFF2 (S408) will be described. The details of the process are shown in the flowchart in FIG. 13. Steps S502 to S508 are the same processes as steps S202 to S208 in FIG. 3, respectively. In FIG. 13, when the clutch switch state CLSW is the "ON" state ("NO" in S520) and the vehicle is running ("YES" in S510), the clutch ON time first fuel injection correction amount QiscON1 is calculated (S514). When the vehicle is at a standstill ("NO" in S510), the clutch ON time second fuel injection correction amount QiscON2 is calculated (S512).

[0115] The take-off assist correction amount attenuation process (S410) will be described. The details of the process are shown in the flowcharts in FIG 14 and FIG. 15. Steps S602 to S614, S618, and S620 are the same processes as steps S302 to S314, S318, and S320 in FIG. 4 and FIG. 5, respectively. In FIG. 14 and FIG. 15, in steps S616 and S622, it is determined whether the engine rotational speed is in the low rotational speed range according to whether the value of "Qbase1+QiscON1+QiscON2+QiscOFF1+QiscOFF2" is larger than Qbase2.

[0116] In step S411 in FIG. 12, the clutch ON time fuel injection correction amount QiscON is calculated based on the two fuel injection correction amounts QiscON1, and QiscON2 according the following equation 6.

$$QiscONE \leftarrow QiscON1+QiscON2 \qquad \text{(Equation 6)}$$

The clutch OFF time first fuel injection correction amount QiscOFF1 is calculated using the map which is the same as that shown in FIG. 8 in the first embodiment. The clutch OFF time second fuel injection correction amount QiscOFF 2 is calculated using the map which is the same as that shown in FIG. 7 in the first embodiment. The map for calculating the clutch ON time first fuel injection correction amount QiscON1 is the same as that shown in FIG. 9 in the first embodiment. As shown in FIG. 9, three maps are used for calculating the clutch ON time second fuel injection correction amount QiscON2. The maps corresponding to the maps as and bs are set such that gains larger than those in FIG. 9 can be obtained.

[0117] Namely, the gain for ΔNE of the clutch ON time second fuel injection correction amount QiscON2 is the largest. The gains for ΔNE are set to become smaller, with the gain of the clutch ON time second fuel injection correction amount QiscON2 being the largest, the clutch ON time first fuel injection correction amount QiscON1 being smaller than the gain of the clutch ON time second fuel injection correction amount QiscON2, the clutch OFF time second fuel injection correction amount QiscOFF2 being smaller than the clutch ON time first fuel injection correction amount QiscON1, and the clutch OFF time first fuel injection correction amount QiscOFF1 being smaller than the clutch OFF time second fuel injection correction amount QiscOFF2.

[0118] An example of the process by the above-mentioned fuel injection amount control processes (FIG. 12 to FIG. 15) is shown in the timing chart in FIG. 16 and FIG. 17. FIG. 16 shows the case of idle start. FIG. 17 shows the case where the vehicle takes off from a standstill while the driver depresses the accelerator pedal 24.

[0119] In the case of FIG. 16, until time t31, the clutch switch state CLSW is the "OFF" state (CLSW="OFF") ("YES" in S502 in FIG. 13) and the vehicle speed SPD is equal to "0" (SPD="0") ("NO" in S504). Accordingly, calculation of the clutch OFF time second fuel injection correction amount QiscOFF2 is performed (S506). The calculation processes of the other fuel injection correction amounts QiscON1, QiscON2 and QiscOFF1 are stopped. Then, the clutch is disengaged for shifting at time t31. From time t31, calculation of the clutch ON time second fuel injection correction amount QiscON2 whose gain is the largest is performed, and the calculation processes of the other fuel injection correction amounts QiscON1, QiscOFF1 and QiscOFF2 are stopped.

[0120] From time t32, by starting the operation for engaging the clutch in order to perform idle start, the load placed on the diesel engine 2 rapidly increases, and the engine rotational speed NE decreases from the target engine rotational speed NEisc. However, since the clutch ON time second fuel injection correction amount QiscON2 increases with high responsiveness, take-off assist correction amount "QiscON+QiscOFF" rapidly increases, and the engine rotational speed NE comes close to the target engine rotational speed NEisc. Due to such a rapid increase in take-off assist correction amount "QiscON+QiscOFF", engine stalling is prevented, and the vehicle can take off from a standstill smoothly.

[0121] Then, when it is determined that the vehicle speed SPD is higher than the vehicle stop determining speed SPDstop at time t33 as the result of the detection performed by the vehicle speed sensor 46 ("YES" in S510 in FIG. 13), the clutch ON time first fuel injection correction amount QiscON1 is calculated instead of the clutch ON time second fuel injection correction amount QiscON2. In calculation of the clutch ON time first fuel injection correction amount QiscON1, a gain with relatively high responsivenss is used. However, the gain for calculation of QiscON1 is smaller than the gain for calculation of the clutch ON time second fuel injection correction amount QiscON2. Accordingly, the increase in take-off assist correction amount slows to some degree.

[0122] When the clutch is fully engaged and the clutch switch state CLSW is changed to the "OFF" state at time t34, calculation of the clutch ON time first fuel injection correction amount QiscON1 is stopped, and the process proceeds to calculation of the clutch OFF time first fuel injection correction amount QiscOFF1 (S508 in FIG. 13). Since the accelerator pedal 24 is not depressed at time t34 (ACCP="0"), attenuation of the clutch ON time fuel injection correction amount QiscON (S614 in FIG. 14) is started immediately. Then, the clutch ON time first fuel injection correction amount QiscON becomes equal to "0" at time t36. At time t35, drop in the engine rotational speed NE is prevented due to the increase in the clutch OFF time first fuel injection correction amount QiscOFF1.

[0123] At time t37, the accelerator pedal 24 is depressed, the engine rotational speed NE further increases, and the vehicle speed SPD increases with the increase in the engine rotational speed NE. When the engine rotational speed enters the medium/high rotational speed region ("NO" in S616: t38), the engine rotational speed NE is equal to or higher than the target engine rotational speed NEisc (NE≥NEisc) ("YES" in S606). Therefore, as long as the clutch OFF time fuel injection correction amount QiscOFF is larger than "0" ("YES" in S608), attenuation of the clutch OFF time fuel injection correction amount QiscOFF is performed (S610) (t38 to t39).

[0124] In the case of FIG. 17, until engagement of the clutch is started (time t42), the state is the same as that until time t32 in FIG. 16. In FIG. 17, before the clutch switch state CLSW is changed to the "OFF" state (time t43), the accelerator pedal 24 is depressed. Therefore, even when the clutch switch state CLSW is changed to the "OFF" state at time t45 (CLSW="OFF") ("YES" in S602 in FIG. 14), the accelerator opening ACCP is larger than "0" (ACCP>"0") ("NO" in S604). Also, since the engine rotational speed is still in the low rotational speed range ("YES" in S616), attenuation of the clutch ON time fuel injection correction amount QiscON (S614) is not started. Accordingly, the value of the clutch ON time fuel injection correction amount QiscON is continuously used, and the value of the clutch OFF time fuel injection correction amount QiscOFF is also continuously used.

[0125] When the engine rotational speed enters the medium/high rotational speed range ("NO" in S616), or when the accelerator pedal 24 is fully released ("YES" in S604), attenuation of the clutch ON time fuel injection correction amount QiscON and the clutch OFF time fuel injection correction amount QiscOFF is performed (t47 to t48). Therefore, in this case, acceleration performance is enhanced compared with the case where attenuation of QiscON is started immediately after engagement of the clutch as shown by a dashed line.

[0126] In the above-mentioned configuration, the internal combustion engine operation range is divided into four ranges. The operation range where the clutch switch state CLSW is the "OFF" state (CLSW="OFF") and the vehicle speed SPD is equal to "0" (SPD="0") corresponds to the first range. The operation range where the clutch switch state CLSW is the "ON" state (CLSW="ON") and the vehicle speed SPD is equal to "0" (SPD="0") corresponds to the second range. The operation range where the clutch switch state CLSW is the "ON" state (CLSW="ON") and the vehicle speed SPD is higher than "0" (CLSW>"0") corresponds to the third range. The operation range where the clutch switch state CLSW is the "OFF" state (CLSW="OFF") and the vehicle speed SPD is higher than "0" (SPD>"0") corresponds to the fourth range.

[0127] Each of the clutch OFF time first fuel injection correction amount QiscOFF1, the clutch OFF time second fuel injection correction amount QiscOFF2, the clutch ON time first fuel injection correction amount QiscON1, and the clutch ON time second fuel injection correction amount QiscON2 corresponds to the range output correction amount. The value of "QiscON+QiscOFF" corresponds to the total amount of the range output correction amounts.

[0128] Steps S408, S411, S412 and S414 in the fuel injection amount control process "FIG. 12 to FIG. 15" correspond to the process as the output correcting means. Step S410 corresponds to the process as the output correction amount attenuating means.

[0129] According to the second embodiment, the following effects can be obtained.

(a) The effects (a) to (d) according to the first embodiment can be obtained.

(b) At the beginning of the vehicle take-off, the engine output is abruptly increased so as to deal with the abrupt increase in the load during vehicle take-off at the largest gain for the clutch ON time second fuel injection correction amount QiscON2. Then, the abrupt increase in the engine output is slowed by decreasing the gain. Accordingly, unnecessary increase in the vehicle speed after the vehicle take-off can be prevented, and the sense of discomfort felt by the driver can be minimized even after the vehicle take-off.

[0130] Hereafter, other embodiments will be described.

(a) The fuel injection correction amounts QiscOFF1, QiscOFF2, and QiscON in the first embodiment, and the fuel injection correction amounts QiscOFF1, QiscOFF2, QiscON1, and QiscON2 in the second embodiment are obtained using the map. However, instead of using the map, the fuel injection correction amounts may be obtained according to the equation constituted by the gains each of which corresponds to the internal combustion engine operation range. Also, the fuel injection correction amounts may be calculated using both the map and the equation.

[0131] (b) In the above-mentioned embodiments, the clutch is operated by the driver. However, the invention can be applied to the case of an automatic clutch, where the clutch is automatically engaged/disengaged during vehicle take-off or shifting.

[0132] (c) In the above-mentioned embodiments, the diesel engine is used as the internal combustion engine. However, the invention can be applied to the case where a gasoline engine is used. In the case of the gasoline engine, when uniform combustion is performed at the stoichiometric air-fuel ratio, the output from the engine is adjusted by adjusting the opening of an electronic throttle valve. In the case of the in-cylinder injection gasoline engine where stratified combustion is performed, the output from the engine is adjusted by adjusting the fuel injection amount, as is the case of the diesel engine.

[0133] (d) In the above-mentioned embodiments, the process for increasing the fuel injection amount for acceleration assist may be added in addition to the process for increasing the fuel injection amount for the take-off assist.

[0134] (e) In the second embodiment, the gains for calculation are set to become smaller, with the gain for QiscON2 being the largest, the gain for QiscON1 being smaller than the gain for QiscON2, the gain for QiscOFF2 being smaller than the gain for QiscON1, and the gain for QiscOFF1 being smaller than the gain for QiscOFF2. However, depending on the type of the engine, the gains for calculation may be set to become smaller, with the gain for QiscON2 being the largest, the gain for QiscOFF2 being smaller than the gain for QiscON2, the gain for QiscON1 being smaller than the gain for QiscOFF2, and the gain for QiscOFF1 being smaller than the gain for QiscON1.

[0135] Fuel injection correction amounts QiscON, QiscOFF1 and QiscOFF2 are respectively calculated depending on the operation ranges (S206, S208, S210). However, take-off assist correction itself is performed based on the total amount of all the fuel injection correction amounts. Therefore, even when the operation range is changed while a vehicle takes off from a standstill or immediately after the vehicle takes off, all the fuel injection correction amounts are always reflected on the take-off assist correction. In addition, the gain for calculation of the fuel injection correction amount is changed such that the gain corresponds to the operation range. Accordingly, the engine operation state is reflected on the fuel injection correction amount with responsiveness appropriate for each operation range. Therefore, it is possible to prevent fluctuation in an engine rotational speed and a vehicle speed, and to minimize the sense of discomfort felt by a driver.

[0136] Fuel injection correction amounts QiscON, QiscOFF1 and QiscOFF2 are respectively calculated depending on the operation ranges (S206, S208, S210). However, take-off assist correction itself is performed based on the total amount of all the fuel injection correction amounts. Therefore, even when the operation range is changed while a vehicle takes off from a standstill or immediately after the vehicle takes off, all the fuel injection correction amounts are always reflected on the take-off assist correction. In addition, the gain for calculation of the fuel injection correction amount is changed such that the gain corresponds to the operation range. Accordingly, the engine operation state is reflected on the fuel injection correction amount with responsiveness appropriate for each operation range. Therefore, it is possible to prevent fluctuation in an engine rotational speed and a vehicle speed, and to minimize the sense of discomfort felt by a driver.

Claims

1. An output control apparatus of an internal combustion engine, which performs a process of correcting an increase in an output from an internal combustion engine (2) for driving a vehicle by performing take-off assist correction while vehicle takes off from a standstill, **characterized by** comprising output correcting means (S108, S112, S114; S408, S411, S412, S414) for dividing an internal combustion engine operation range into multiple ranges, providing a range output correction amount (QiscON, QiscOFF) subjected to calculation to each of the multiple internal combustion engine operation ranges, and performing take-off assist correction based on a total amount (QiscON+QiscOFF) of the range output correction amounts (QiscON, QiscOFF), and for changing a gain for calculation of the range output correction amount (QiscON, QiscOFF) such that the gain corresponds to each of the internal combustion engine operation ranges.

2. The output control apparatus of an internal combustion engine according to claim 1, **characterized in that** the gain is any one of one of a gain which is used when the range output correction amount (QiscON, QiscOFF) is obtained according to an equation and a gain which is used when the range output correction amount is obtained using a map, and a gain which is used when the range output correction amount (QiscON, QiscIFF) is obtained by combination of the equation and the map.

3. The output control apparatus of an internal combustion engine according to claim 1 or 2, **characterized in that** the output correcting means (S108, S112, S114) divides the internal combustion engine operation range into a first range where a vehicle is idle-stopped, a second range where the vehicle takes off from a standstill, and a third range for times other than idle stop and vehicle take-off, and sets the gain for calculation of the range output correction amount of the second range (QiscON) to a large value compared with the gain for calculation of the range output correction amount of the first range (QiscOFF2) and the gain for calculation of the range output correction amount of the third range (QiscOFF1).

4. The output control apparatus of an internal combustion engine according to claim 1 or 2, **characterized in that** the output correcting means (S108, S112, S114) divides the internal combustion engine operation range into a first range where a clutch is engaged and a vehicle is at a standstill, a second range where the clutch is disengaged, and a third range where the clutch is engaged and the vehicle is running, and sets the gain for calculation of the range output correction amount of the second range (QiscON) to a large value compared with the gain for calculation of the range output correction amount of the first range (QiscOFF2) and the gain for calculation of the range output correction amount of the third range (QiscOFF1).

5. The output control apparatus of an internal combustion engine according to claim 3 or 4, **characterized in that** the gain for calculation of the range output correction amount of the third range (QiscOFF1) is set to a small value compared with the gain for calculation of the range output correction amount of the first range (QiscOFF2).

6. The output control apparatus of an internal combustion engine according to claim 1 or 2, **characterized in that** the output correcting means (S408, S411, S412, S414) divides the internal combustion engine operation range into a first range where a clutch is engaged and a vehicle is at a standstill, a second range where the clutch is disengaged and the vehicle is at a standstill, a third range where the clutch is disengaged and the vehicle is running, and a fourth range where the clutch is engaged and the vehicle is running, and sets the gain for calculation of the range output correction amount of the second range (QiscON2) to a large value compared with the gain for calculation of the range output correction amount of the first range (QiscOFF2), the gain for calculation of the range output correction amount of the third range (QiscON1), and the gain for calculation of the range output correction amount of the fourth range (QiscOFF1).

7. The output control apparatus of an internal combustion engine according to claim 6, **characterized in that** the gains for calculation of the range output correction amounts are set to become smaller, with the gain for calculation of the range output correction amount of the third range (QiscON1) being the largest, the gain for calculation of the range output correction amount of the first range (QiscOFF2) being smaller than the gain for calculation of the range output correction amount of the third range (QiscON1), and the gain for calculation of the range output correction amount of the fourth range (QiscOFF1) being smaller than the gain for calculation of the range output correction amount of the first range (QiscOFF2).

8. The output control apparatus of an internal combustion engine according to claim 6, **characterized in that** the gains for calculation of the range output correction amounts are set to become smaller, with the gain for calculation

of the range output correction amount of the first range (QiscOFF2) being the largest, the gain for calculation of the range output correction amount of the third range (QiscON1) being smaller than the gain for calculation of the range output correction amount of the first range (QiscOFF2), and the gain for calculation of the range output correction amount of the fourth range (QiscOFF1) being smaller than the gain for calculation of the range output correction amount of the third range (QiscON1).

9. The output control apparatus of an internal combustion engine according to any one of claims 1 to 8, **characterized by** further comprising output correction amount attenuating means (S110, S41) for attenuating an output correction amount which has become unnecessary for vehicle take-off assist in one of an operation state where a request for acceleration is not made and an internal combustion engine operation range where the take-off assist correction is not performed.

10. The output control apparatus of an internal combustion engine according to any one of claims 1 to 9, **characterized in that** the internal combustion engine is a diesel engine (2), and the process of correcting an increase in an output from the internal combustion engine is correction of an increase in a fuel injection amount.

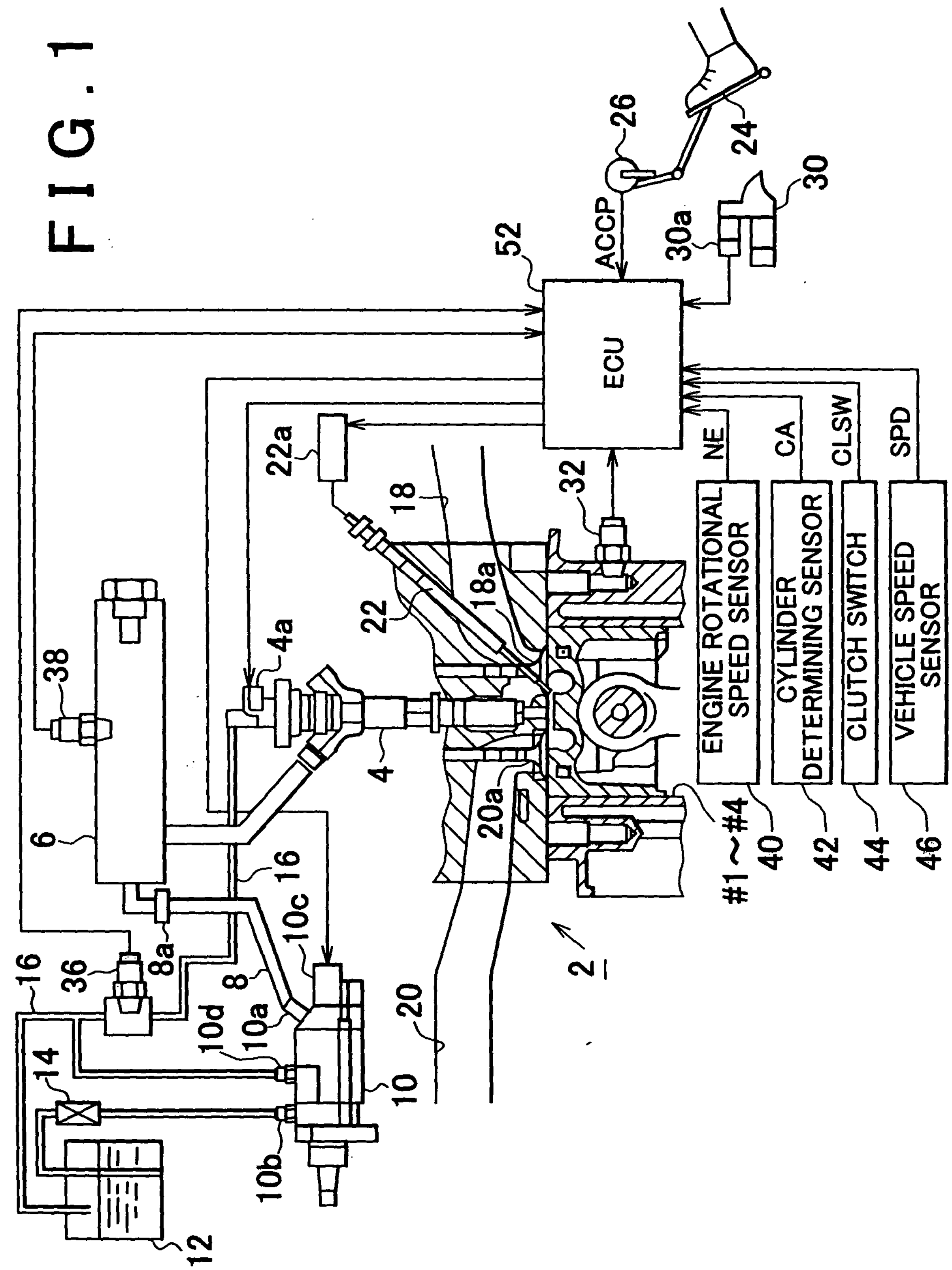

ECU
52
ACCP
26
24
30a
30
22a
18
32
NE
CA
CLSW
SPD
ENGINE ROTATIONAL SPEED SENSOR
CYLINDER DETERMINING SENSOR
CLUTCH SWITCH
VEHICLE SPEED SENSOR
#1～#4
40
42
44
46
38
6
4a
22
18a
4
20a
16
10c
8a
8
36
16
10d
10a
14
10
10b
12
20
2

FIG. 1

FIG. 2

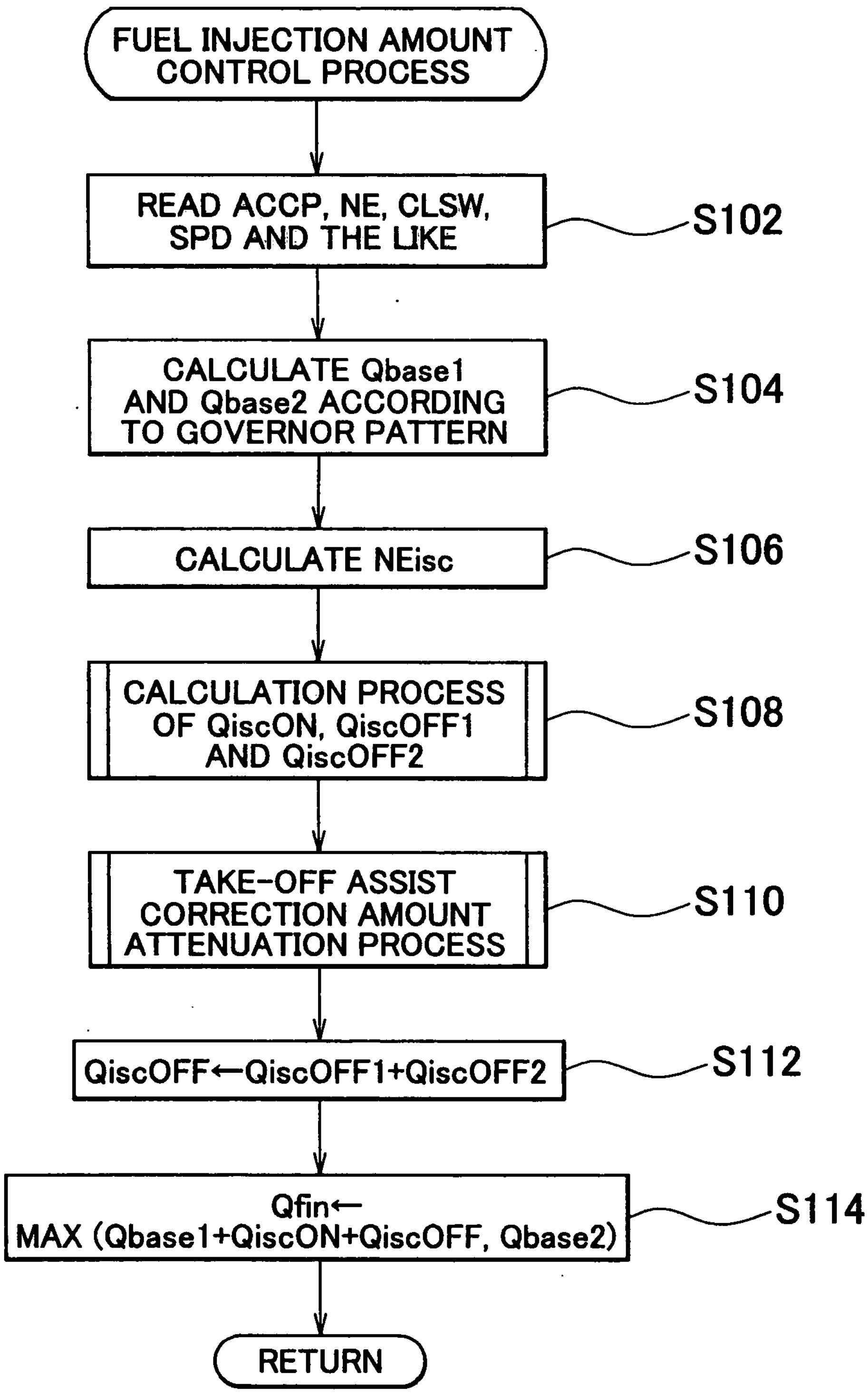
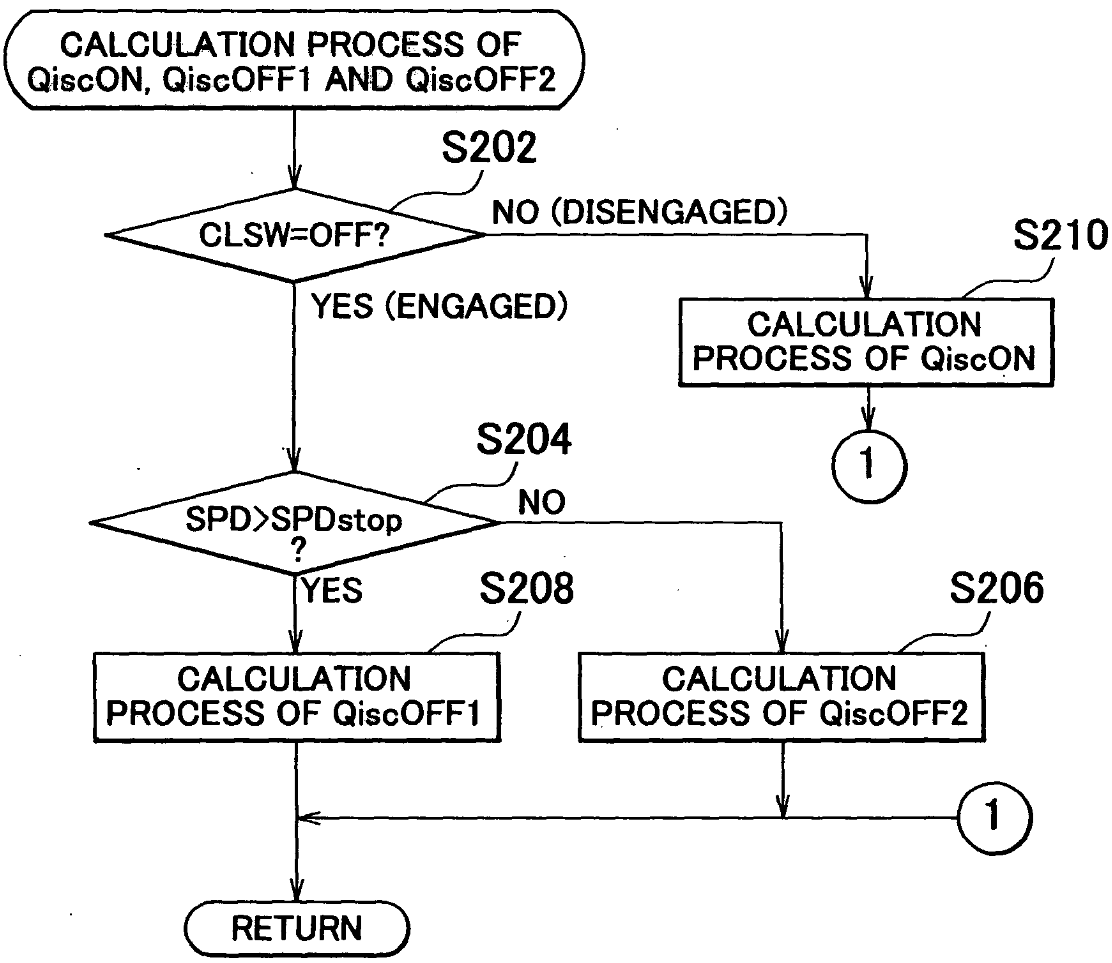

FUEL INJECTION AMOUNT CONTROL PROCESS
READ ACCP, NE, CLSW, SPD AND THE LIKE
S102
CALCULATE Qbase1 AND Qbase2 ACCORDING TO GOVERNOR PATTERN
S104
CALCULATE NEisc
S106
CALCULATION PROCESS OF QiscON, QiscOFF1 AND QiscOFF2
S108
TAKE-OFF ASSIST CORRECTION AMOUNT ATTENUATION PROCESS
S110
QiscOFF←QiscOFF1+QiscOFF2
S112
Qfin← MAX (Qbase1+QiscON+QiscOFF, Qbase2)
S114
RETURN

FIG. 3


CALCULATION PROCESS OF QiscON, QiscOFF1 AND QiscOFF2
S202
CLSW=OFF?
NO (DISENGAGED)
YES (ENGAGED)
S210
CALCULATION PROCESS OF QiscON
1
S204
SPD>SPDstop ?
NO
YES
S208
S206
CALCULATION PROCESS OF QiscOFF1
CALCULATION PROCESS OF QiscOFF2
1
RETURN

F I G . 4

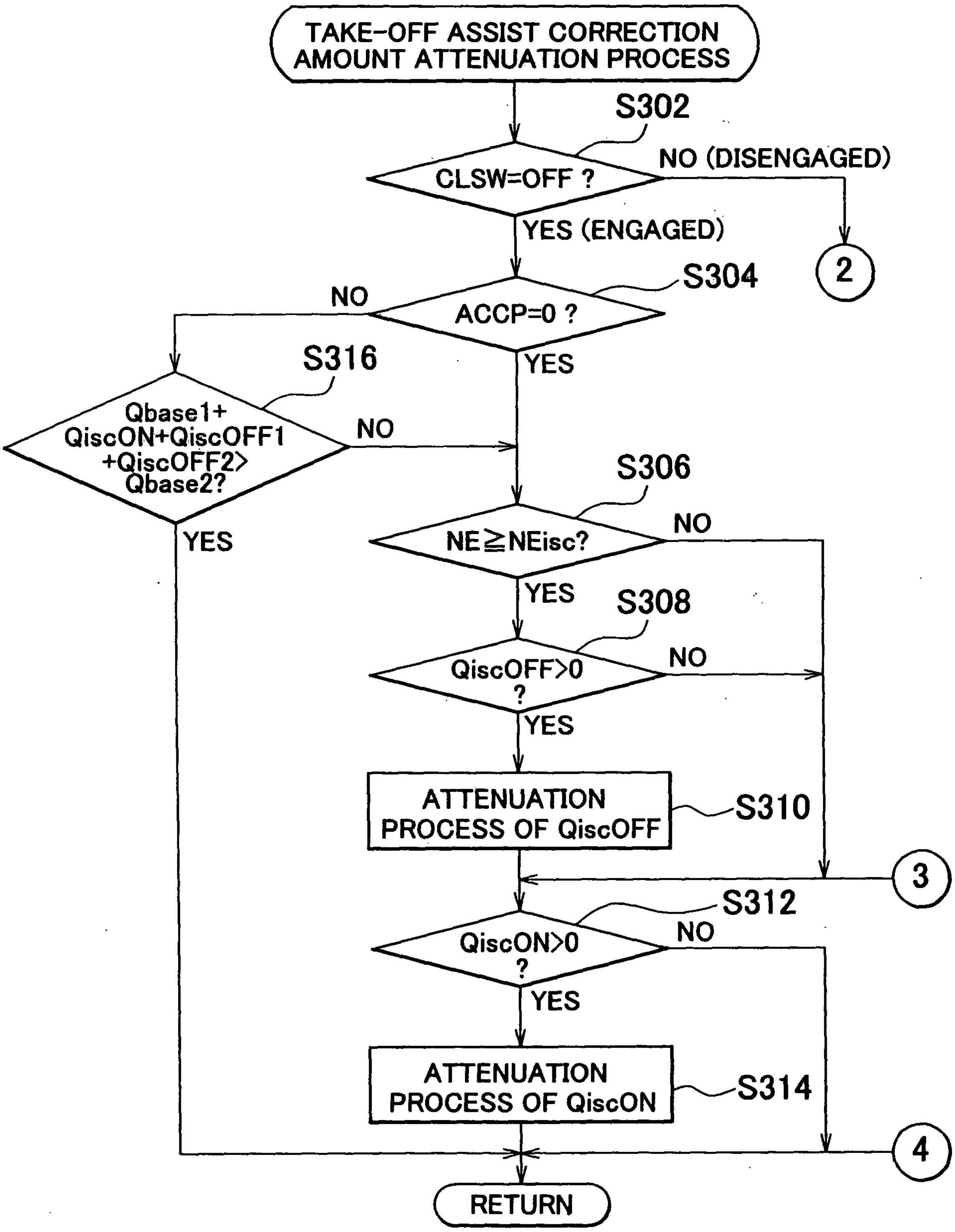

TAKE-OFF ASSIST CORRECTION AMOUNT ATTENUATION PROCESS
S302
CLSW=OFF ?
NO (DISENGAGED)
YES (ENGAGED)
2
S304
ACCP=0 ?
NO
YES
S316
Qbase1+ QiscON+QiscOFF1 +QiscOFF2> Qbase2?
NO
YES
S306
NE≧NEisc?
NO
YES
S308
QiscOFF>0 ?
NO
YES
ATTENUATION PROCESS OF QiscOFF
S310
3
S312
QiscON>0 ?
NO
YES
ATTENUATION PROCESS OF QiscON
S314
4
RETURN

FIG. 5

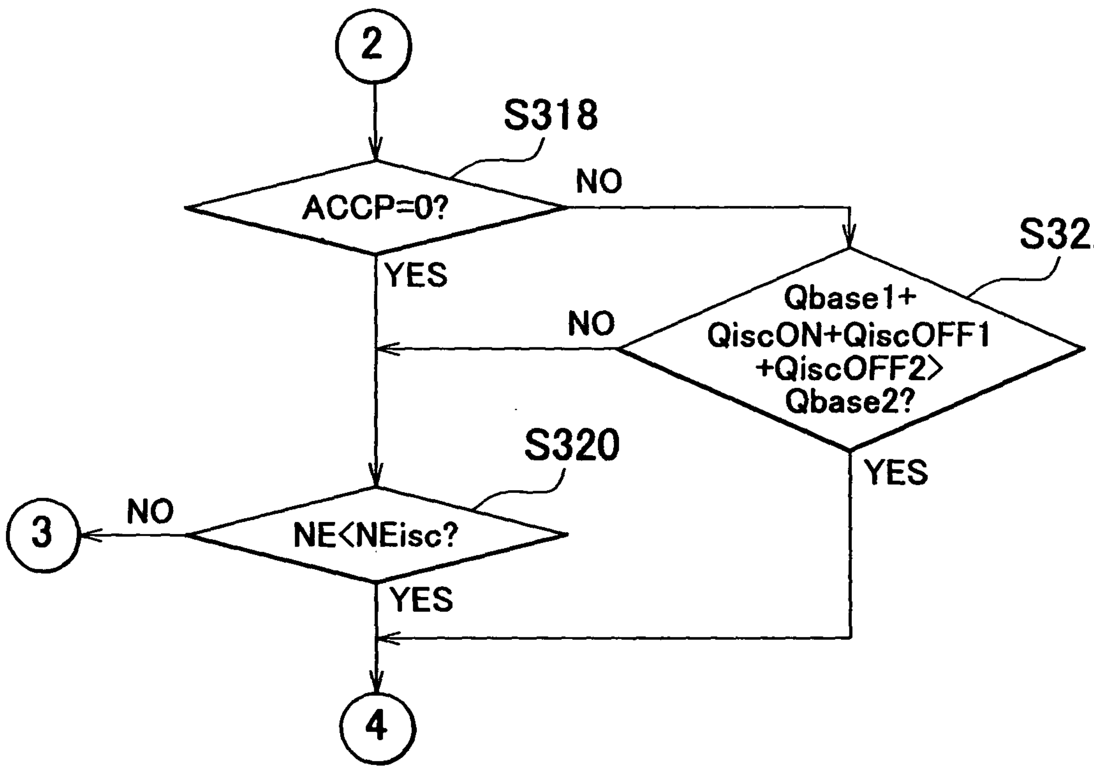

2
S318
ACCP=0?
NO
YES
S322
Qbase1+
QiscON+QiscOFF1
+QiscOFF2>
Qbase2?
NO
YES
S320
NO
3
NE<NEisc?
YES
4

FIG. 6

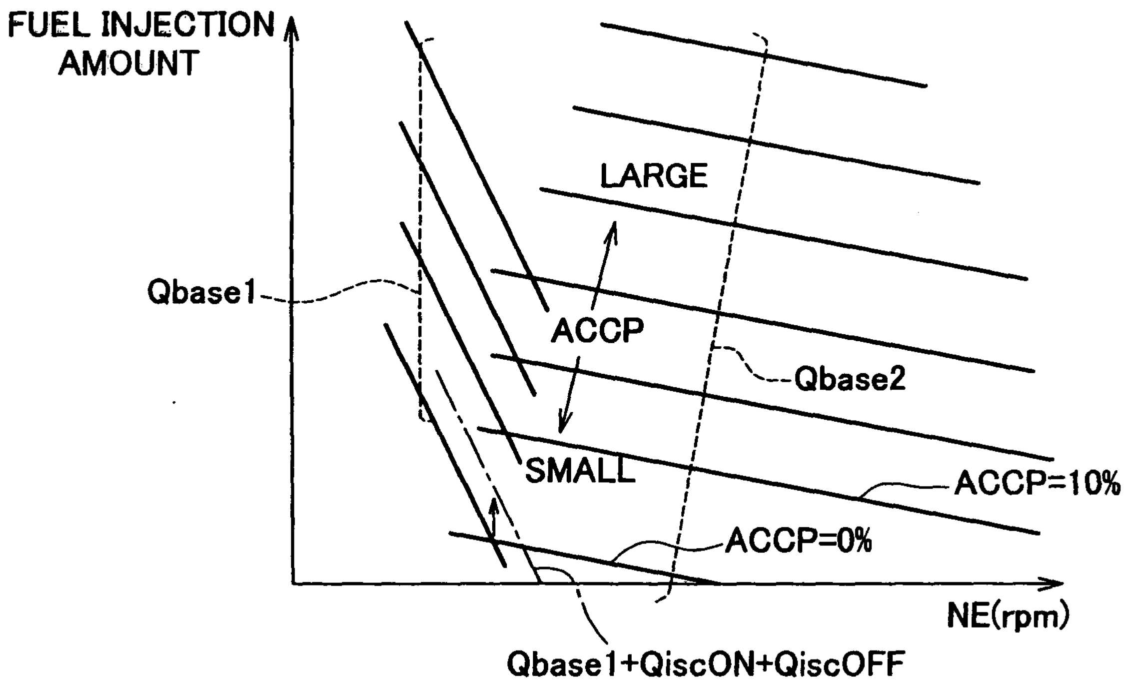
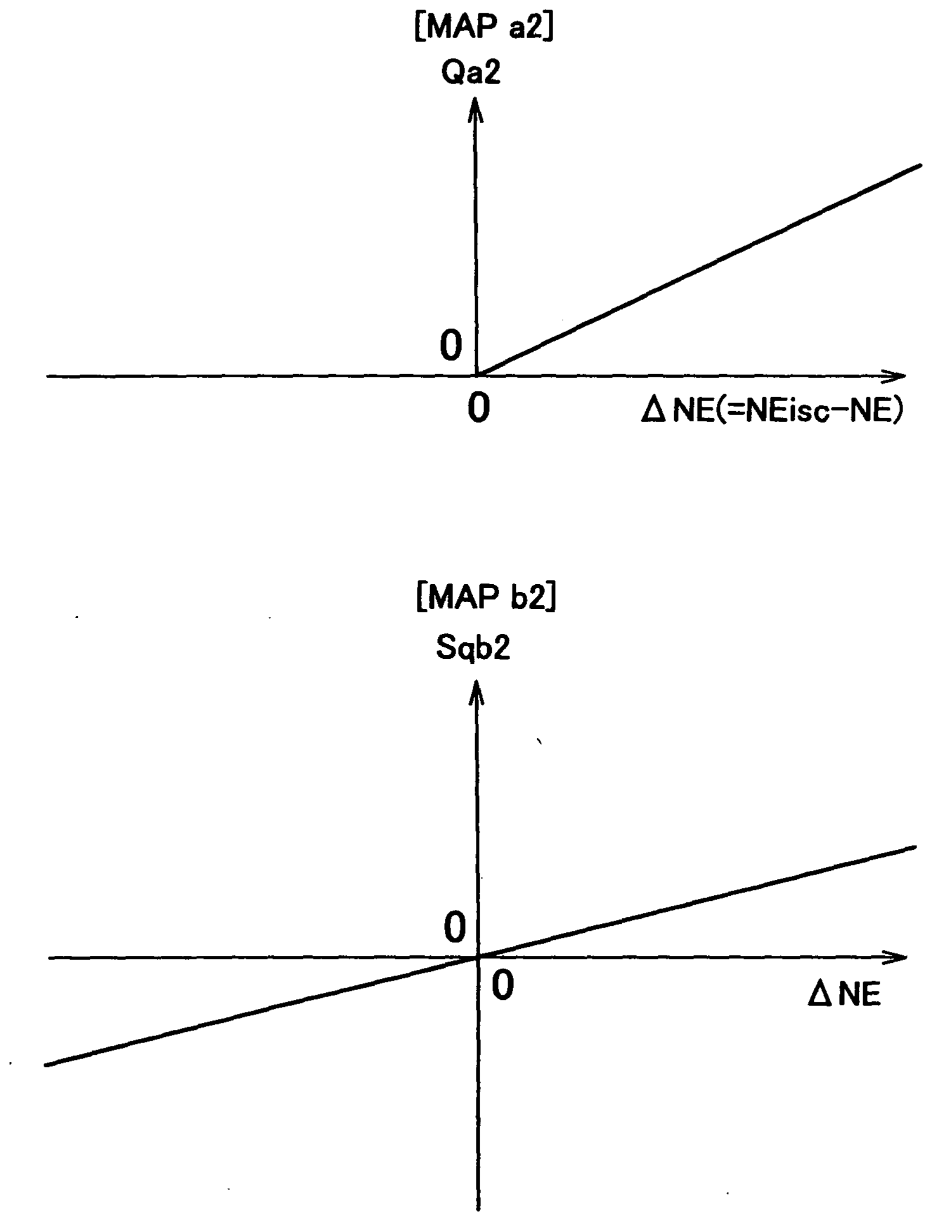

FUEL INJECTION AMOUNT
LARGE
Qbase1
ACCP
Qbase2
SMALL
ACCP=10%
ACCP=0%
NE(rpm)
Qbase1+QiscON+QiscOFF

FIG. 7



F I G . 8

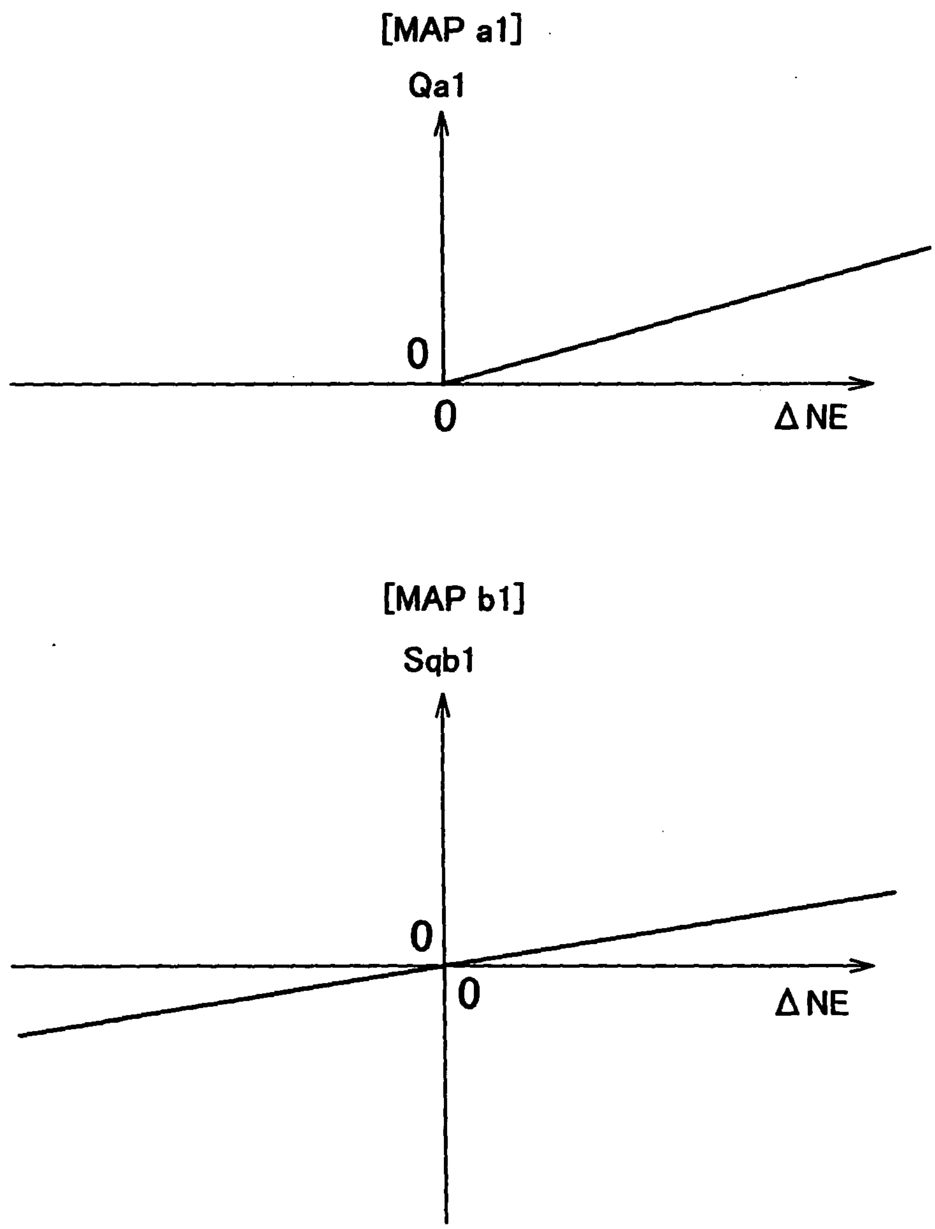
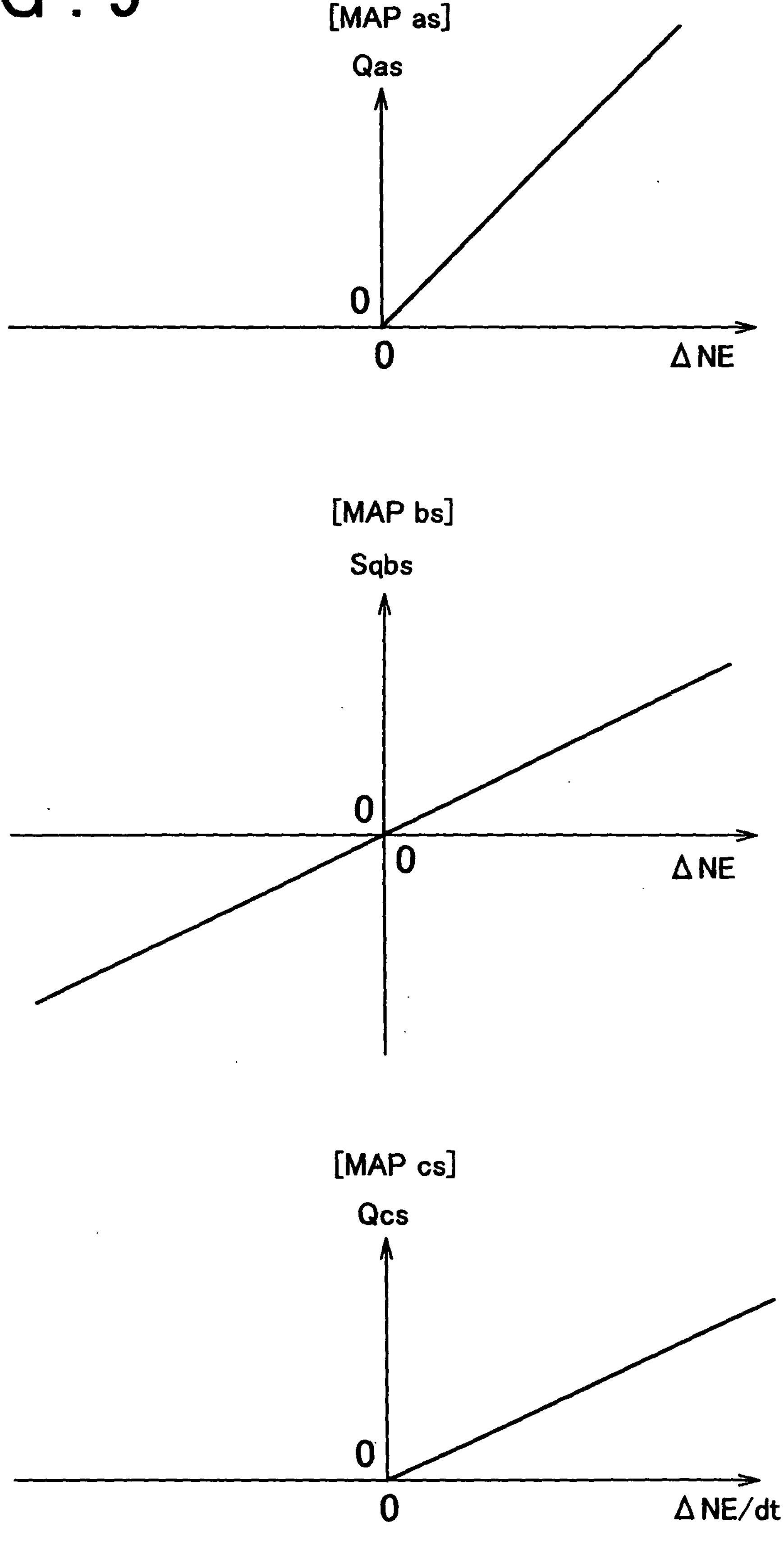
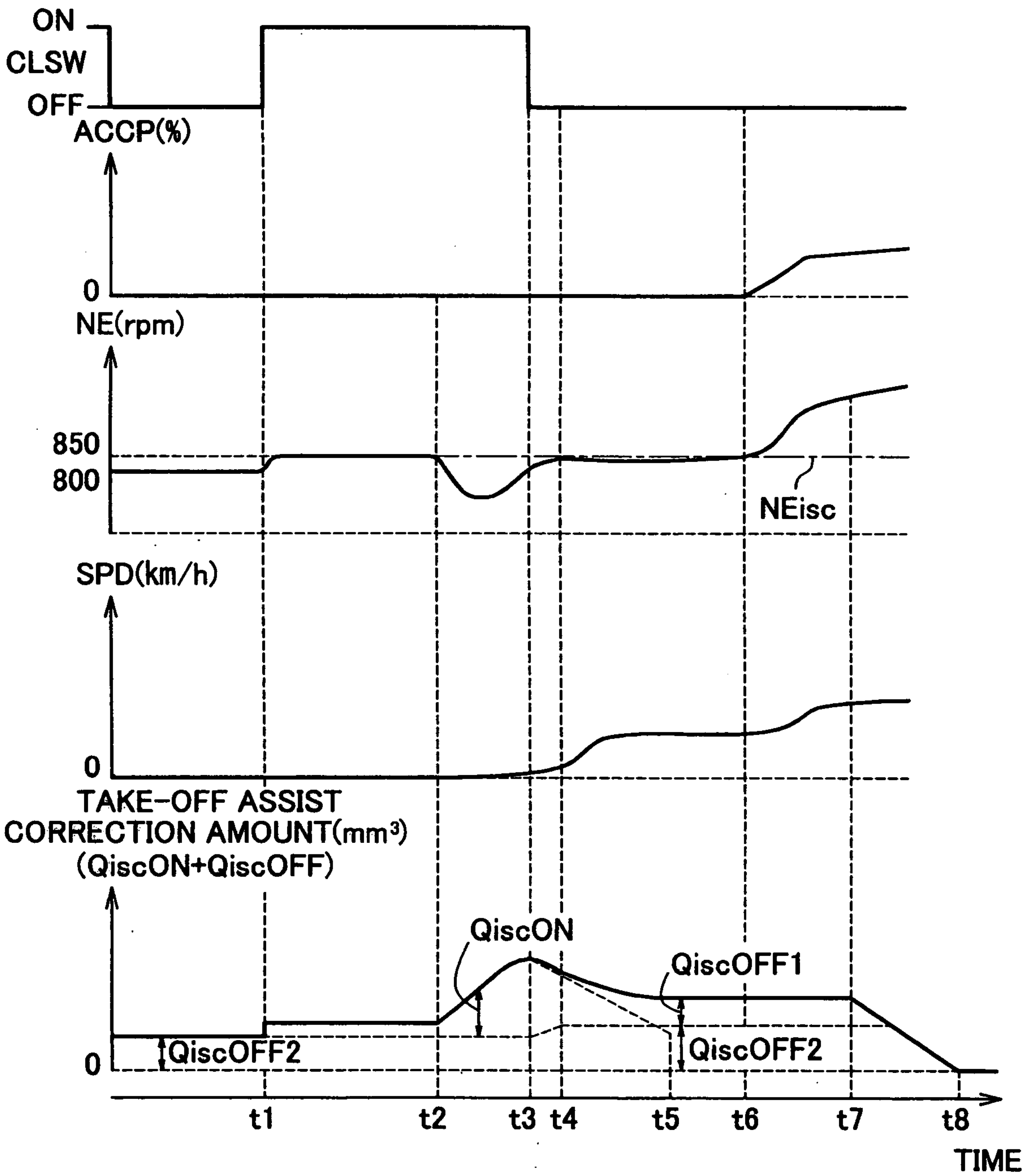


FIG. 9



F I G . 10


ON
CLSW
OFF
ACCP(%)
0
NE(rpm)
850
800
NEisc
SPD(km/h)
0
TAKE-OFF ASSIST
CORRECTION AMOUNT(mm³)
(QiscON+QiscOFF)
QiscON
QiscOFF1
QiscOFF2
QiscOFF2
0
t1
t2
t3
t4
t5
t6
t7
t8
TIME

F I G . 11

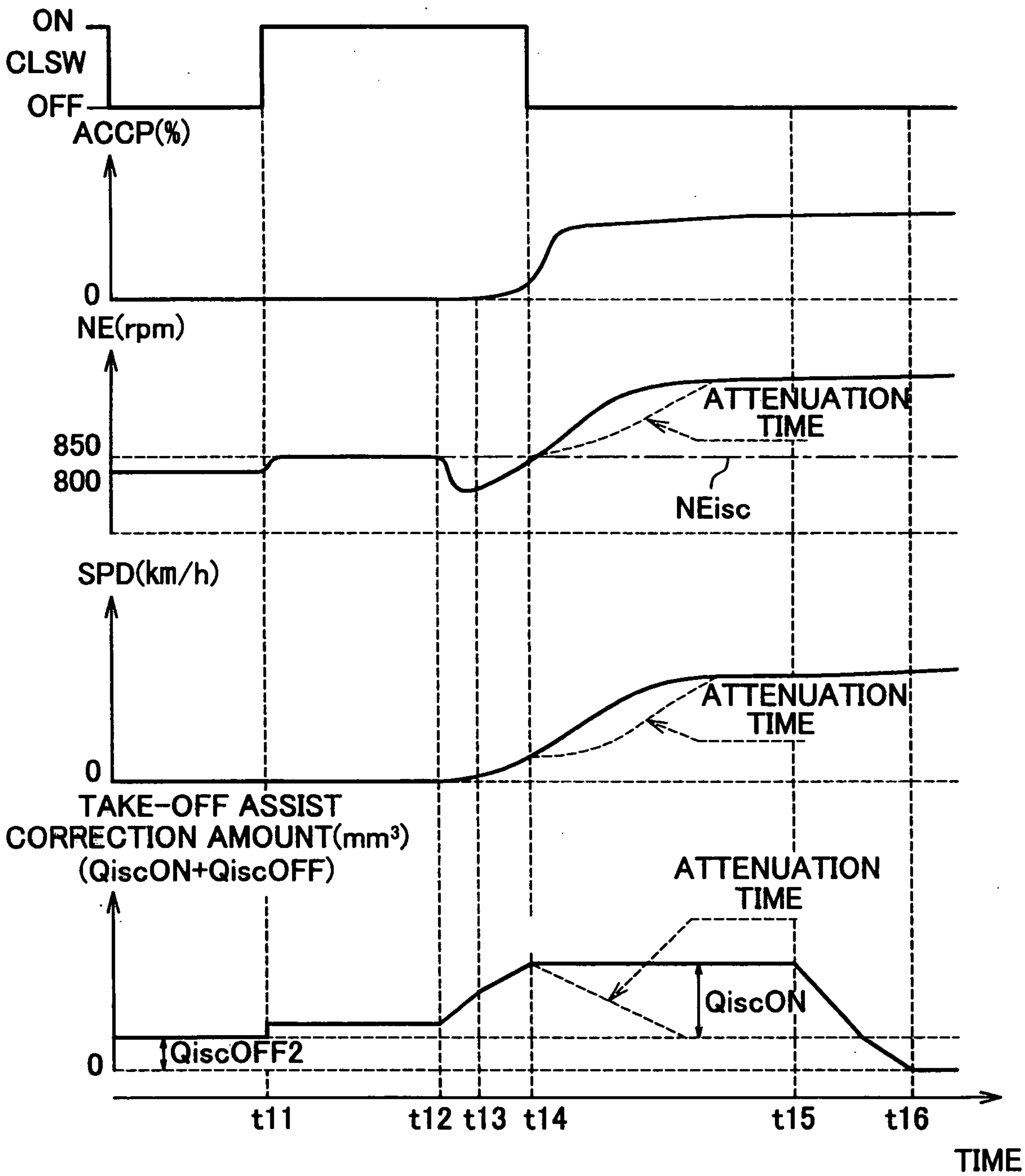

ON
CLSW
OFF
ACCP(%)
0
NE(rpm)
850
800
ATTENUATION TIME
NEisc
SPD(km/h)
0
ATTENUATION TIME
TAKE-OFF ASSIST CORRECTION AMOUNT(mm³)
(QiscON+QiscOFF)
ATTENUATION TIME
QiscON
QiscOFF2
0
t11
t12
t13
t14
t15
t16
TIME

FIG. 12

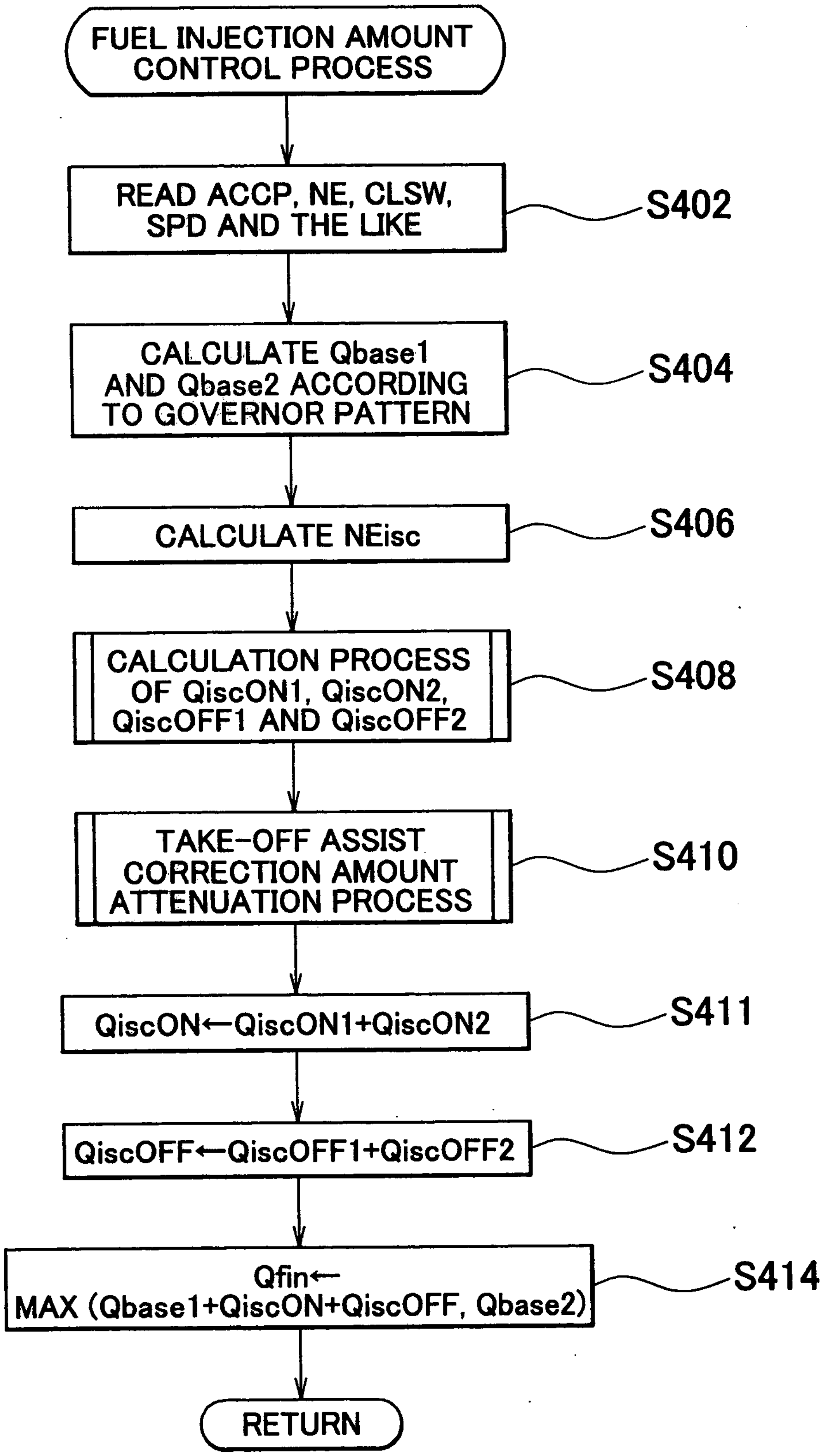
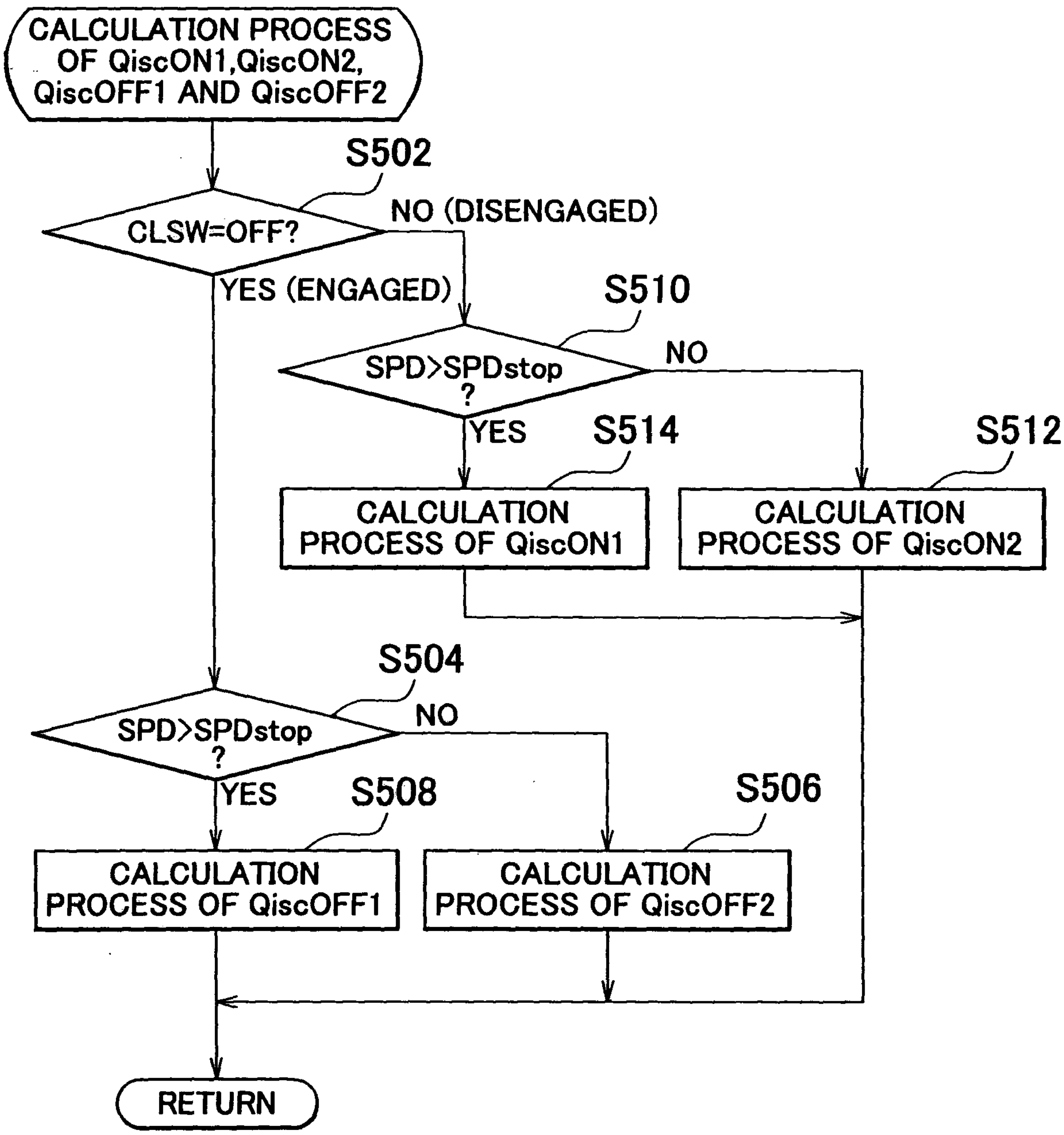

FUEL INJECTION AMOUNT CONTROL PROCESS
READ ACCP, NE, CLSW, SPD AND THE LIKE
S402
CALCULATE Qbase1 AND Qbase2 ACCORDING TO GOVERNOR PATTERN
S404
CALCULATE NEisc
S406
CALCULATION PROCESS OF QiscON1, QiscON2, QiscOFF1 AND QiscOFF2
S408
TAKE-OFF ASSIST CORRECTION AMOUNT ATTENUATION PROCESS
S410
QiscON←QiscON1+QiscON2
S411
QiscOFF←QiscOFF1+QiscOFF2
S412
Qfin← MAX (Qbase1+QiscON+QiscOFF, Qbase2)
S414
RETURN

FIG. 13


CALCULATION PROCESS OF QiscON1,QiscON2, QiscOFF1 AND QiscOFF2
S502
CLSW=OFF?
NO (DISENGAGED)
YES (ENGAGED)
S510
SPD>SPDstop ?
NO
YES
S514
S512
CALCULATION PROCESS OF QiscON1
CALCULATION PROCESS OF QiscON2
S504
SPD>SPDstop ?
NO
YES
S508
S506
CALCULATION PROCESS OF QiscOFF1
CALCULATION PROCESS OF QiscOFF2
RETURN

F I G . 14

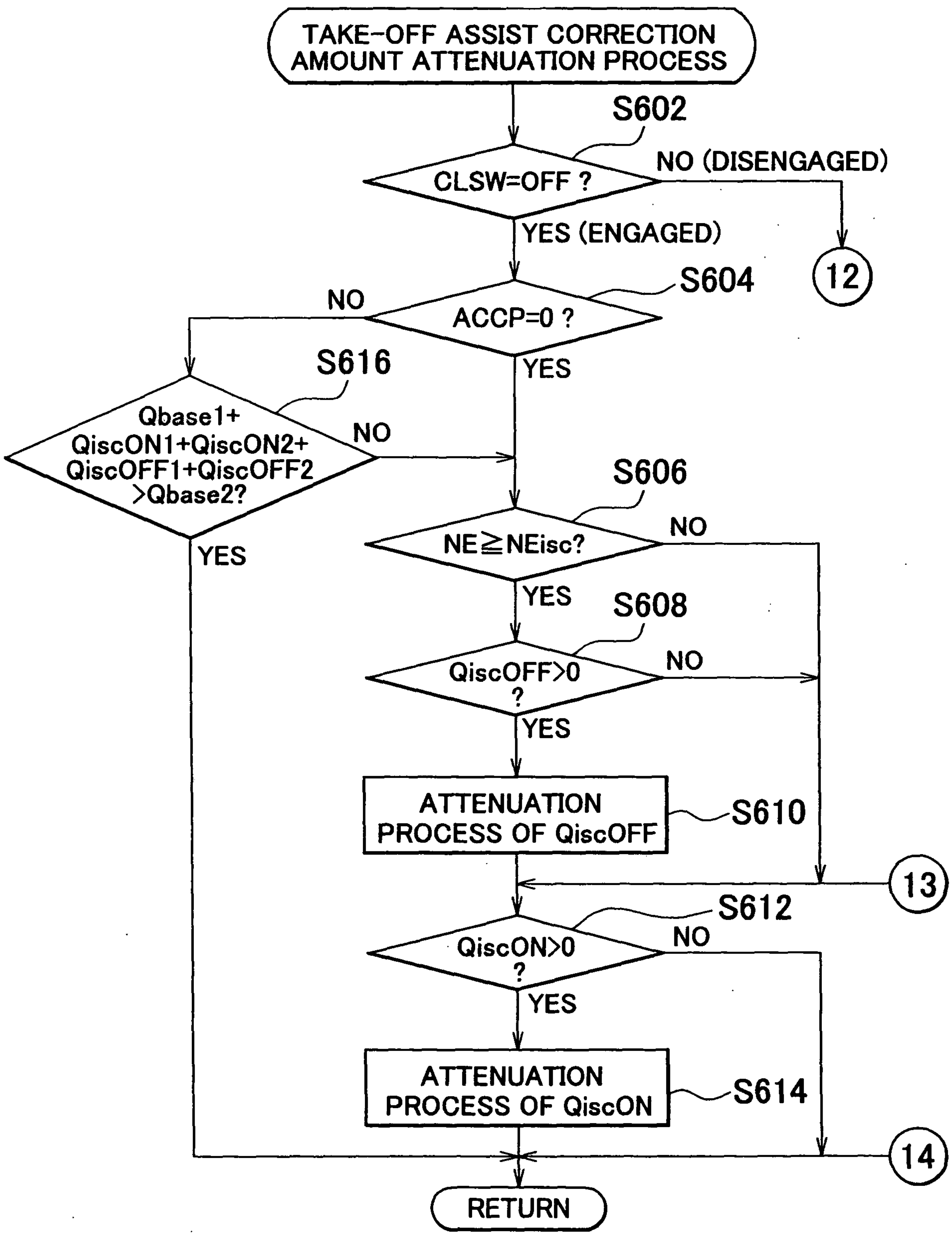

TAKE-OFF ASSIST CORRECTION AMOUNT ATTENUATION PROCESS
S602
CLSW=OFF ?
NO (DISENGAGED)
YES (ENGAGED)
12
S604
NO
ACCP=0 ?
YES
S616
Qbase1+ QiscON1+QiscON2+ QiscOFF1+QiscOFF2 >Qbase2?
NO
YES
S606
NE≧NEisc?
NO
YES
S608
QiscOFF>0 ?
NO
YES
ATTENUATION PROCESS OF QiscOFF
S610
13
S612
QiscON>0 ?
NO
YES
ATTENUATION PROCESS OF QiscON
S614
14
RETURN

FIG. 15

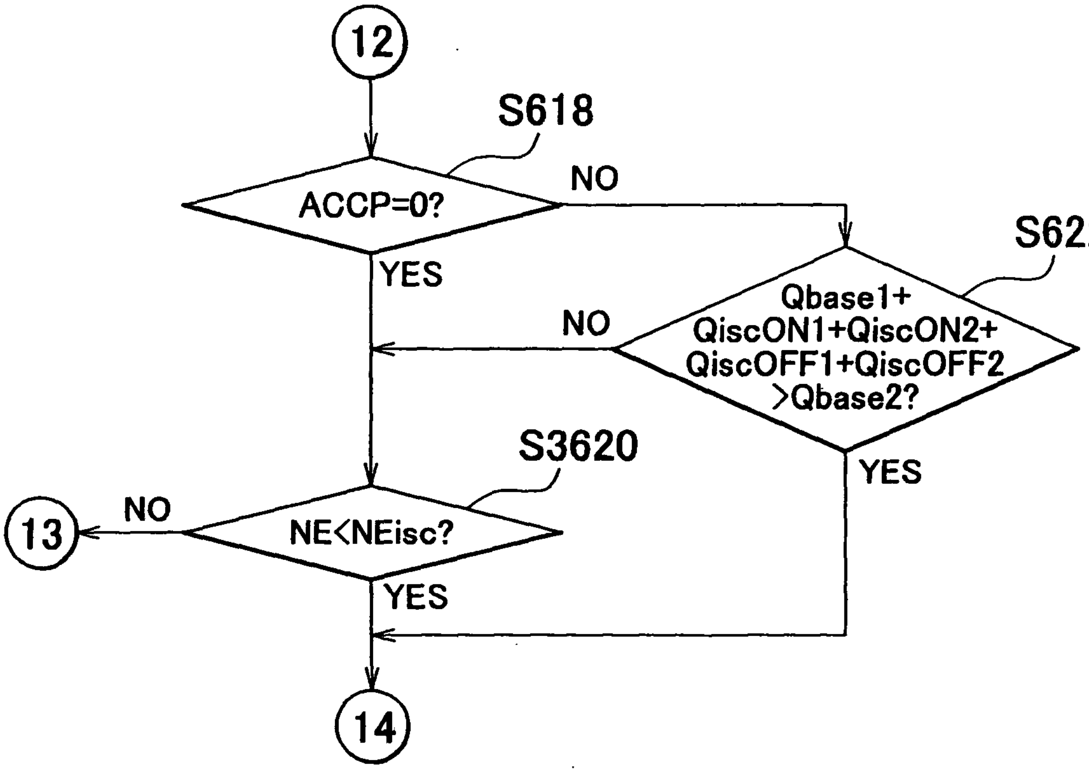

12
S618
ACCP=0?
NO
YES
S622
Qbase1+
QiscON1+QiscON2+
QiscOFF1+QiscOFF2
>Qbase2?
NO
YES
S3620
NE<NEisc?
NO
13
YES
14

FIG. 16

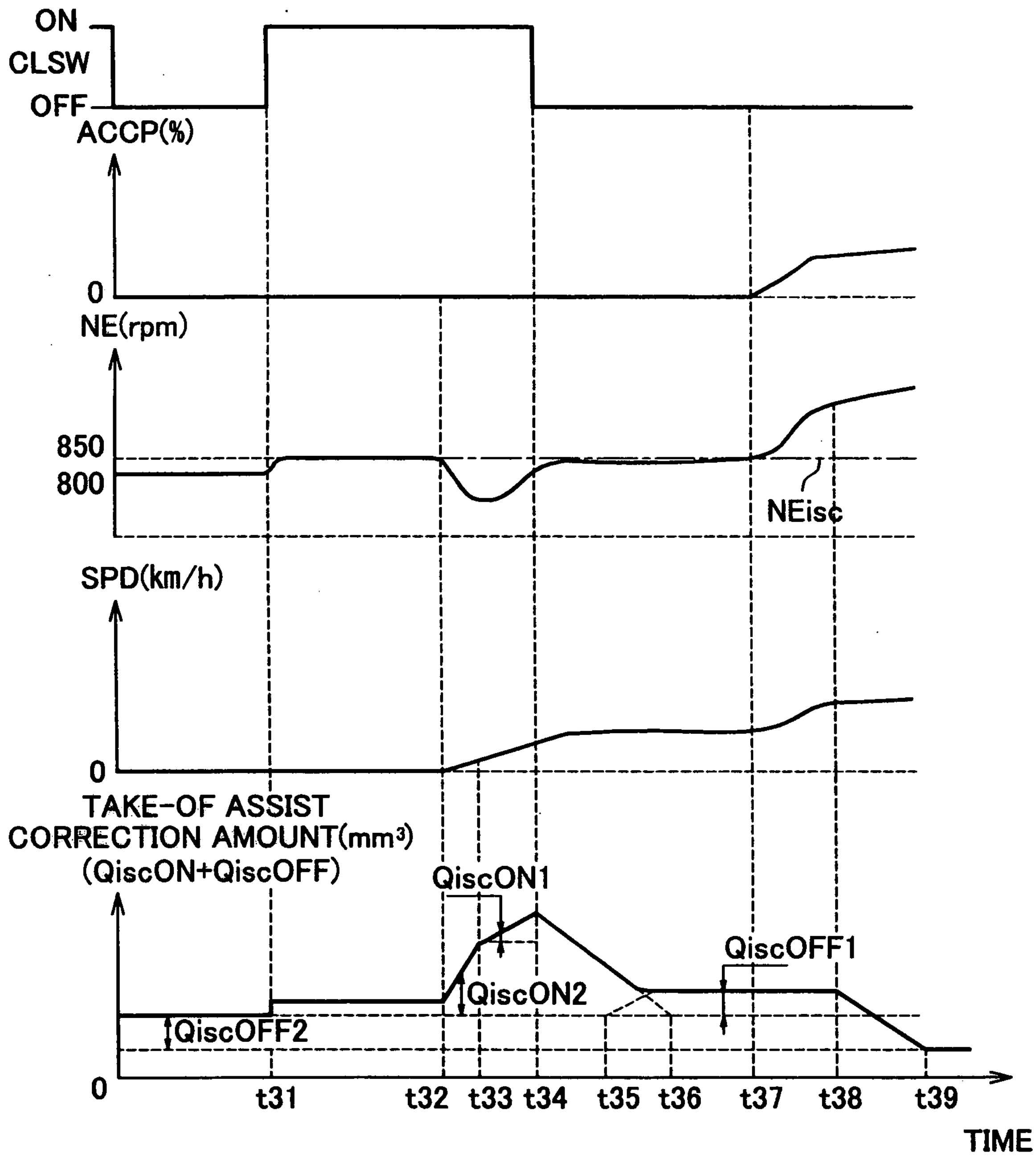
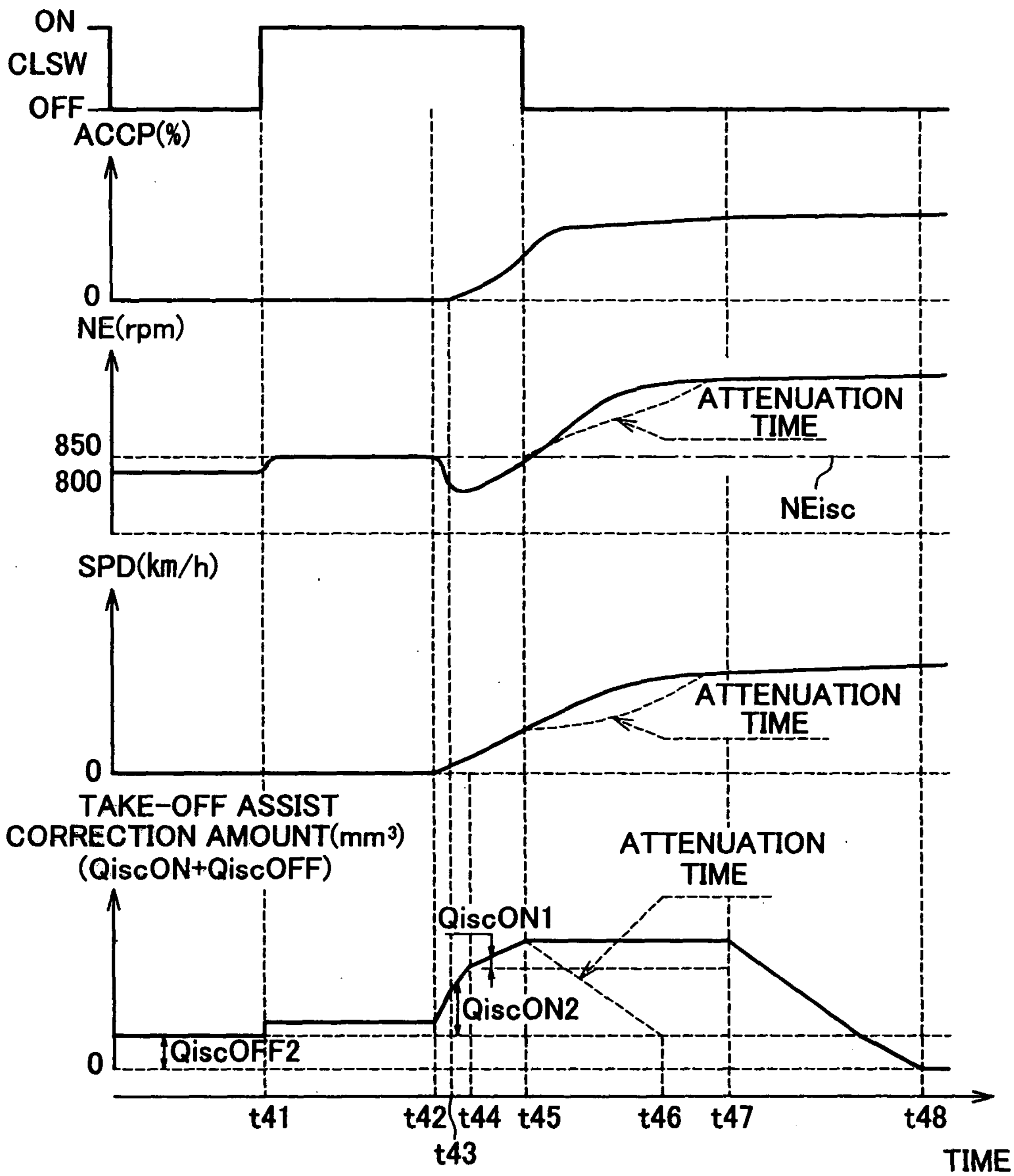

ON
CLSW
OFF
ACCP(%)
0
NE(rpm)
850
800
NEisc
SPD(km/h)
0
TAKE-OF ASSIST
CORRECTION AMOUNT(mm³)
(QiscON+QiscOFF)
QiscON1
QiscON2
QiscOFF1
QiscOFF2
0
t31
t32
t33
t34
t35
t36
t37
t38
t39
TIME

FIG. 17


ON
CLSW
OFF
ACCP(%)
0
NE(rpm)
850
800
ATTENUATION TIME
NEisc
SPD(km/h)
0
ATTENUATION TIME
TAKE-OFF ASSIST CORRECTION AMOUNT(mm3) (QiscON+QiscOFF)
ATTENUATION TIME
QiscON1
QiscON2
QiscOFF2
0
t41
t42
t43
t44
t45
t46
t47
t48
TIME

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 04 00 5154

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X	EP 0 742 362 A (ISUZU MOTORS LTD) 13 November 1996 (1996-11-13) * column 6, line 30 - column 7, line 30 * * figures 1,6,7 *	1,2	
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F02D
B69K
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
MUNICH	10 May 2004	De Vita, D

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