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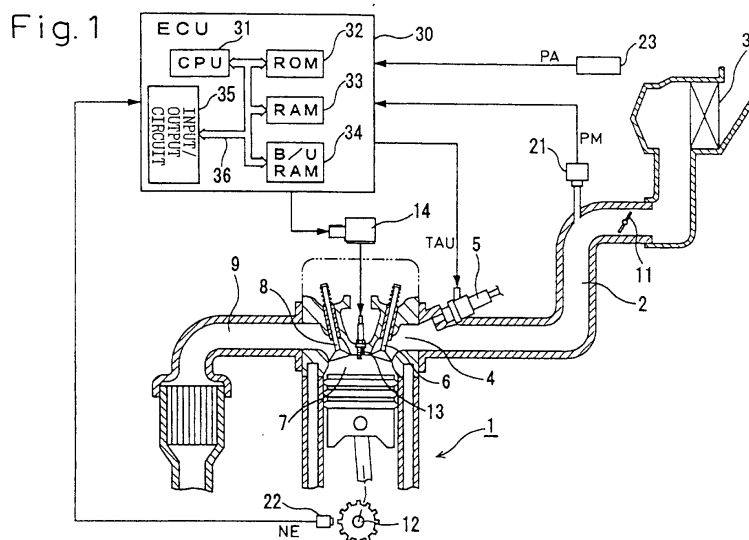
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(54) **CONTROLLER FOR INTERNAL COMBUSTION ENGINE**

(57) A final fuel injection amount TAU to be supplied to an engine 1 is calculated using as parameters a manifold pressure compensation value found by adding a difference between the atmospheric pressure PAbase at a base location detected by an atmospheric pressure sensor 23, that is, an atmospheric pressure difference, and a manifold pressure PM detected by a manifold pressure sensor 21 and an engine speed NE detected

by a crank angle sensor 22. By taking into consideration the change in atmospheric pressure with respect to a manifold pressure compensation value and reflecting it into the manifold pressure parameter, a suitable fuel injection amount can be supplied regardless of any change in atmospheric pressure, the operating state of the engine 1 is maintained well, and the drivability can be secured.



Description

TECHNICAL FIELD

[0001] The present invention relates to a control device for an internal combustion engine supplying a fuel injection amount corresponding to the manifold pressure of the internal combustion engine.

BACKGROUND ART

[0002] In the past, as a prior art relating to a control device of an internal combustion engine, there has been known the art disclosed in Japanese Unexamined Patent Publication (Kokai) No. 2-19626. In this, art is disclosed judging if the amount of increase of fuel is in the necessary region based on a manifold pressure compensated in accordance with a change of the atmospheric pressure and increasing the fuel injection amount in accordance with the result of judgement.

[0003] In general, when a vehicle travels from a low altitude to a high altitude and the atmospheric pressure falls, if finding the fuel injection amount and controlling the system to adjust it based on the manifold pressure and the engine speed of the engine in the same way as above, since the rise in the filling efficiency due to the fall in the exhaust pipe pressure is not considered, sometimes the air-fuel ratio shifts to the lean side and the drivability and starting property deteriorate.

[0004] Note that in the above art, the excess or shortage in the fuel injection amount due to a change in the atmospheric pressure is compensated by finding a compensation coefficient K from the map shown in FIG. 14 using a one-dimensional function based on the atmospheric pressure PA detected by an atmospheric pressure sensor etc. and this compensation coefficient K is multiplied with a basic fuel injection amount TP to calculate a final fuel injection amount TAU. Here, as shown in FIG. 15, when the atmospheric pressure PA changes, for example, the compensation amounts Δa , Δb , and Δc of the fuel injection amounts TAU (A, B, C) with respect to the manifold pressure PM of any three locations are not uniform (fixed ratios), so it is not possible to deal with them by one-dimensional compensation of the fuel injection amount TAU for changes in the atmospheric pressure PA. Therefore, there was the inconvenience that a suitable fuel injection amount TAU for the manifold pressure PM could not be obtained when the atmospheric pressure PA changed.

DISCLOSURE OF INVENTION

[0005] Therefore, the present invention was made to eliminate this inconvenience and has as its object the provision of an engine control device able to reflect changes in the atmospheric pressure in the manifold pressure of the engine and supply a suitable fuel injection amount.

[0006] According to the engine control device of one aspect of the present invention, the difference between a base atmospheric pressure and current atmospheric pressure calculated by an atmospheric pressure operating means is calculated as a change in atmospheric pressure by a change operating means based on a manifold pressure detected by a manifold pressure detecting means, the change in atmospheric pressure and an operation use manifold pressure for finding the fuel injection amount of the engine calculated by a manifold pressure operating means based on the manifold pressure detected by the manifold pressure detecting means are added to find a manifold pressure compensation value, and a fuel injection amount to be supplied to the engine is calculated by an injection amount operating means using as parameters the manifold pressure compensation value and engine speed detected by rotational speed detecting means. By taking into consideration the change in atmospheric pressure with respect to the manifold pressure compensation value and reflecting it in the manifold pressure parameter, a suitable fuel injection amount is supplied regardless of the change in atmospheric pressure, so the operating state of the engine is maintained well and the drivability is secured.

[0007] According to the engine control device of another aspect of the present invention, the difference between a base atmospheric pressure and current atmospheric pressure detected by an atmospheric pressure detecting means is calculated as a change in atmospheric pressure by a change operating means, the change in atmospheric pressure and an operation use manifold pressure for finding the fuel injection amount of the engine calculated by a manifold pressure operating means based on the manifold pressure detected by the manifold pressure detecting means are added to find a manifold pressure compensation value, and a fuel injection amount to be supplied to the engine is calculated by an injection amount operating means using as parameters the manifold pressure compensation value and engine speed detected by rotational speed detecting means. By taking into consideration the change in atmospheric pressure with respect to the manifold pressure compensation value and reflecting it into the manifold pressure parameter, the suitable fuel injection amount is supplied regardless of the change in atmospheric pressure, so the operating state of the engine is maintained well and the drivability is secured.

[0008] According to an engine control device of still another aspect of the present invention, an operation use manifold pressure for finding a fuel injection amount of an engine calculated by a manifold pressure operating means based on a manifold pressure detected by the manifold pressure detecting means is compensated by an atmospheric pressure calculated by an atmospheric pressure operating means and a predetermined atmospheric pressure and calculated as a manifold pressure compensation value by compensation value operating means, and a fuel injection amount to be supplied

plied to the engine is calculated by rotational speed detecting means using as parameters the manifold pressure compensation value and engine speed detected by the rotational speed detecting means. By taking into consideration the change in atmospheric pressure with respect to the manifold pressure compensation value and reflecting it into the manifold pressure parameter, the suitable fuel injection amount is supplied regardless of the change in atmospheric pressure, so the operating state of the engine is maintained well and the drivability is secured.

[0009] Below, the present invention will be more sufficiently understood from the attached drawings and the description of preferred embodiments of the invention.

BRIEF DESCRIPTION OF DRAWINGS

[0010]

FIG. 1 is a schematic view of the configuration showing an engine to which an engine control device according to a first embodiment of the present invention is applied and its peripheral equipment.

FIG. 2 is a flow chart of a processing routine for operating a fuel injection amount in a CPU in an ECU used in an engine control device according to the first embodiment of the present invention.

FIG. 3 is a map for explaining the calculation of a final fuel injection amount in the fuel injection amount operation routine of FIG. 2.

FIG. 4 is a schematic view of the configuration showing an engine to which an engine control device according to a second embodiment of the present invention is applied and its peripheral equipment.

FIG. 5 is a flow chart of a processing routine for detecting the atmospheric pressure and manifold pressure in a CPU in an ECU used in an engine control device according to the second embodiment of the present invention.

FIG. 6 is a flow chart of a processing routine for detecting atmospheric pressure in FIG. 5.

FIG. 7 is a flow chart of a processing routine for detecting manifold pressure in FIG. 5.

FIG. 8 is a flow chart of a processing routine for operating a fuel injection amount in a CPU in an ECU used in an engine control device according to the second embodiment of the present invention.

FIG. 9 is a flow chart of a first modification of a processing routine for operating a fuel injection amount in a CPU in an ECU used in an engine control device according to the second embodiment of the present invention.

FIG. 10 is a flow chart of a second modification of a processing routine for operating a fuel injection amount in a CPU in an ECU used in an engine control device according to the second embodiment of the present invention.

FIG. 11 is a flow chart of a third modification of a processing routine for operating a fuel injection amount in a CPU in an ECU used in an engine control device according to the second embodiment of the present invention.

FIG. 12 is a flow chart of a fourth modification of a processing routine for operating a fuel injection amount in a CPU in an ECU used in an engine control device according to the second embodiment of the present invention.

FIG. 13 is a map for calculating a compensation coefficient in FIG. 12.

FIG. 14 is a conventional map for calculating a compensation coefficient of a fuel injection amount due to a change in atmospheric pressure.

FIG. 15 is a conventional map showing the difference in compensation amounts of fuel injection amounts with respect to manifold pressure due to one-dimensional compensation with respect to a change in atmospheric pressure.

BEST MODE FOR CARRYING OUT THE INVENTION

[0011] Next, the present invention will be explained based on embodiments.

[0012] First, a first embodiment of the present invention will be explained. FIG. 1 is a schematic view of the configuration showing an engine to which an engine control device according to a first embodiment of the present invention is applied and its peripheral equipment.

[0013] In FIG. 1, reference numeral 1 is a single-cylinder water-cooled engine. Air from an air cleaner 3 is introduced into an intake passage 2 of the engine 1. In the middle of the intake passage 2 is provided a throttle valve 11 operating linked with operation of a not shown accelerator pedal etc. By the operation of the throttle valve 11, the amount of intake to the intake passage 2 (amount of intake air) is adjusted. At the same time as the amount of intake, fuel is injected and supplied to the engine 1 from an injector (fuel injector) provided in the intake passage 2 near the intake port 4. Further, an air-fuel mixture comprised of predetermined amounts of fuel and intake air is sucked into a fuel chamber 7 through an intake valve 6.

[0014] At the downstream side of the throttle valve 11 provided in the middle of the intake passage 2 is provided a manifold pressure sensor 21 for detecting a manifold pressure PM in the intake passage 2. A crank shaft 21 of the engine 1 is provided with a crank angle sensor 22 for detecting a crank angle (°CA) accompanying its rotation. An engine speed NE of the engine 1 is calculated in accordance with the crank angle detected by the crank angle sensor 22. An atmospheric pressure sensor 23 is provided for detecting the atmospheric pressure PA in the ambient environment of the engine 1.

[0015] A spark plug 13 is arranged facing the combustion chamber 7 of the engine 1. This spark plug 13

is supplied with a high voltage from an ignition coil/ignitor 14 based on an ignition command signal output from a later explained ECU (electronic control unit) in synchronization with a crank angle detected by the crank angle sensor 22 and ignites and burns the air-fuel mixture in the combustion chamber 7. In this way, the air-fuel mixture in the combustion chamber 7 is burned (expanded) and a drive force obtained. The exhaust gas after the combustion is led through the exhaust valve 8 from the exhaust manifold to the exhaust passage 9 and exhausted to the outside.

[0016] The ECU 30 is comprised as a logical operational circuit consisting of a CPU 31 serving as the central processing unit for executing various known types of processing, a ROM 32 for storing a control program, a RAM 33 for storing various data, a B/U (backup) RAM 34, an input/output circuit 35, a bus line 36 for connecting these, etc. This ECU 30 receives as input a manifold pressure PM from the manifold pressure sensor 21, the crank angle from the crank angle sensor 22, the atmospheric pressure PA from the atmospheric pressure sensor 23, etc. Based on the output signals from the ECU 30 based on these various information, the injector 5 is suitably controlled in fuel injection timing and fuel injection amount and the spark plug 13 and ignition coil/ignitor 14 etc. are suitably controlled in ignition timing.

[0017] Next, the processing routine for operation of the fuel injection amount in the CPU 31 in the ECU 30 used in the engine control device according to the first embodiment of the present invention will be explained based on the flow chart of FIG. 2. Note that this fuel injection amount operation routine is repeatedly executed by the CPU 31 every predetermined time interval.

[0018] In FIG. 2, first, at step S101, the engine speed NE of the engine 1 is read. Next, the routine proceeds to step S102, where the atmospheric pressure PA is read. Next, the routine proceeds to step S103, where the manifold pressure PM is read. Next, the routine proceeds to step S104, where the manifold pressure PMTP for basic fuel injection amount operation (hereinafter simply referred to as the "operation use manifold pressure") is calculated by the following formula (1) based on the manifold pressure PM read at step S103:

$$\text{PMTP} \leftarrow f(\text{PM}) \quad (1)$$

[0019] Next, the routine proceeds to step S105, where the difference between the atmospheric pressure PAbase at a base location, the atmospheric pressure 760 mmHg at a low altitude in this embodiment, and the atmospheric pressure PA at the current location read at step S102, that is, the change in atmospheric pressure $\Delta P_{\text{dev}} \{=(760-\text{PA})\}$, is added to the operation use manifold pressure PMTP calculated at step S104 to calculate a manifold pressure compensation value PMTP' for basic fuel injection amount operation (hereinafter referred to simply as the "manifold pressure compensation

value") by the following formula (2):

$$\text{PMTP}' \leftarrow (760-\text{PA})+\text{PMTP} \quad (2)$$

[0020] Next, the routine proceeds to step S106, where the final fuel injection amount TAU is calculated based on the manifold pressure compensation value PMTP' calculated at step S105 and the engine speed NE read at step S101, then the routine is ended.

[0021] Next, the calculation of the final fuel injection amount TAU using as parameters the manifold pressure compensation value PMTP' (mmHg) and engine speed NE (rpm) by the above fuel injection amount operation routine will be explained concretely with reference to the map of FIG. 3. Note that the control amount for a middle point in the map of FIG. 3 is found by interpolation of two points of the engine speed.

[0022] First, the map shown in FIG. 3A is used to calculate the fuel injection amount α at the time of a low altitude atmospheric pressure of 760 mmHg for when the read value of the manifold pressure PM is 200 mmHg and the read value of the engine speed NE is 1000 rpm. When the high altitude atmospheric pressure becomes 660 mmHg in the operating state of the engine 1, as shown in FIG. 3B, the read value of the manifold pressure PM ends up becoming 100 mmHg, so the fuel injection amount β is calculated based on the read value of the manifold pressure PM of 100 mmHg and the read value of the engine speed NE of 1000 rpm.

[0023] Therefore, at a high altitude atmospheric pressure of 660 mmHg, to maintain the operating state of the engine 1 of the time of the low altitude atmospheric pressure of 760 mmHg, as shown in FIG. 3C, the fuel injection amount γ is calculated from the manifold pressure compensation value PMTP' of 200 mmHg, obtained by adding the difference between the low altitude atmospheric pressure of 760 mmHg and high altitude atmospheric pressure of 660 mmHg, that is, the change in atmospheric pressure of 100 mmHg, to the high altitude manifold pressure 100 mmHg, and the engine speed NE of 1000 rpm. That is, the fuel injection amount γ at the time of the high altitude atmospheric pressure of 660 mmHg in the present embodiment is set equal to the fuel injection amount α at the time of the low altitude atmospheric pressure of 760 mmHg.

[0024] Due to this, the change in the manifold pressure PM is suitably compensated, and the final fuel injection amount TAU at the atmospheric pressure PA at the current location, that is, the high altitude atmospheric pressure of 660 mmHg, is calculated based on the atmospheric pressure PAbase at the base location, that is, the low altitude atmospheric pressure of 760 mmHg. Therefore, even when changing from the low altitude atmospheric pressure to the high altitude atmospheric pressure, the operating state of the engine 1 can be maintained well without being influenced by the change in atmospheric pressure and the drivability can be se-

cured.

[0025] In this way, the engine control device of the present embodiment is provided with the atmospheric pressure sensor 23 serving as the atmospheric pressure detecting means for detecting the atmospheric pressure PA; the manifold pressure sensor 21 serving as the manifold pressure detecting means for detecting the pressure of the intake air introduced into the intake passage 2 of the engine 1, that is, the manifold pressure PM; the manifold pressure operating means realized by the ECU 30 for calculating the operation use manifold pressure PMTP for calculating the fuel injection amount of the engine 1 based on the manifold pressure PM detected by the manifold pressure detecting sensor 21; the crank angle sensor 22 serving as the rotational speed detecting means for detecting the engine speed NE of the engine 1; the change operating means realized by the ECU 30 for calculating the difference between the atmospheric pressure P_{base} at the base location detected by the atmospheric pressure sensor 23 and the atmospheric pressure PA at the current location as the change in atmospheric pressure P_{Adev}; and the injection amount operating means realized by the ECU 30 for calculating the final fuel injection amount TAU to be supplied to the engine 1 using as parameters the manifold pressure compensation value PMTP' obtained by adding the change in atmospheric pressure P_{Adev} calculated by the change operating means to the operation use manifold pressure PMTP calculated by the manifold pressure operating means and the engine speed NE detected by the crank angle sensor 22.

[0026] That is, the final fuel injection amount TAU to be supplied to the engine 1 is calculated using as parameters the manifold pressure compensation value PMTP' found by adding the difference between the base atmospheric pressure P_{base} and the current atmospheric pressure PA detected by the atmospheric pressure sensor 23, that is, the change in atmospheric pressure P_{Adev}, and the operation use manifold pressure PMTP for calculating the fuel injection amount of the engine 1 based on the manifold pressure PM detected by the manifold pressure sensor 21 and the engine speed NE detected by the crank angle sensor 22. In this way, by taking into consideration the change in atmospheric pressure P_{Adev} with respect to the manifold pressure compensation value PMTP' and reflecting it into the manifold pressure parameter, it is possible to supply a suitable final fuel injection amount TAU regardless of the change in atmospheric pressure.

[0027] Note that in the above embodiment, the difference between the base atmospheric pressure P_{base} and the current atmospheric pressure PA is used as it is as the change in atmospheric pressure P_{Adev} for calculation of the fuel injection amount, but it is also possible to multiply for example 0.8 as a predetermined compensation coefficient based on compliance with the difference between the base atmospheric pressure P_{base} and atmospheric pressure PA at the current loca-

tion to obtain the change in atmospheric pressure P_{Adev}.

[0028] The change operating means realized by the ECU 30 of the engine control device multiplies a predetermined compensation coefficient with the difference to calculate the change in atmospheric pressure P_{Adev} and can expect actions and effects similar to the above embodiment.

[0029] Further, in the above embodiment, the difference between the base atmospheric pressure P_{base} and the current atmospheric pressure PA is used as it is as the change in atmospheric pressure P_{Adev} for calculation of the fuel injection amount, but it is also possible to multiply a predetermined compensation coefficient (1.0, 0.9, 0.8, ...) having as a parameter the manifold pressure PM (100, 200, 300,...) as the one-dimensional map based on compliance with the difference between the base atmospheric pressure P_{base} and atmospheric pressure PA at the current location to obtain the change in atmospheric pressure P_{Adev}.

[0030] The change operating means realized by the ECU 30 of the engine control device multiplies a predetermined compensation coefficient having the manifold pressure PM as a parameter with the difference to calculate the change in atmospheric pressure P_{Adev} and can expect actions and effects similar to the above embodiment.

[0031] Further, the above embodiment is configured provided with the atmospheric sensor 23 to detect the atmospheric pressure PA in the ambient environment of the engine 1, but it is also possible to calculate the atmospheric pressure PA based on the manifold pressure PM detected by the manifold pressure sensor 21 at a predetermined timing. In this case, the atmospheric pressure sensor 23 is not required.

[0032] This engine control device is provided with the manifold pressure sensor 21 serving as the manifold pressure detecting means for detecting the pressure of the intake air introduced into the intake passage 2 of the engine 1, that is, the manifold pressure PM; the manifold pressure operating means realized by the ECU 30 for calculating the operation use manifold pressure PMTP for calculating the fuel injection amount of the engine 1 based on the manifold pressure PM detected by the manifold pressure sensor 21; the atmospheric pressure operating means realized by the ECU 30 for calculating the atmospheric pressure PA based on the manifold pressure PM detected by the manifold pressure sensor 21; the crank angle sensor 22 serving as the rotational speed detecting means for detecting the engine speed NE of the engine 1; the change operating means realized by the ECU 30 for calculating the difference between the base atmospheric pressure P_{base} and the atmospheric pressure PA at the current location calculated by the atmospheric pressure operating means as the change in atmospheric pressure P_{Adev}; and the injection amount operating means realized by the ECU 30 for calculating the final fuel injection amount TAU to be

supplied to the engine 1 using as parameters the manifold pressure compensation value PMTP' obtained by adding the change in atmospheric pressure PAdev calculated by the change operating means to the operation use manifold pressure PMTP calculated by the manifold pressure operating means and the engine speed NE detected by the rotational speed detecting means. Similar actions and effects as the above embodiment can be expected.

[0033] In the above embodiment, the explanation was made of the case of a change from the low altitude atmospheric pressure to the high altitude atmospheric pressure when using a low altitude as the reference, but when working the present invention, the change is not limited to this. A similar explanation may also be applied to a change from a high altitude atmospheric pressure to low altitude atmospheric pressure when using the high altitude as a reference. Note that in this case, the positive/negative sign of the difference between the base atmospheric pressure and atmospheric pressure at the current location merely becomes opposite.

[0034] Next, a second embodiment of the present invention will be explained. FIG. 4 is a schematic view of the configuration showing an engine to which an engine control device according to the second embodiment of the present invention is applied and its peripheral equipment. Only the atmospheric pressure sensor 23 for detecting the atmospheric pressure PA in the ambient environment of the engine 1 in FIG. 1 showing a schematic view of the configuration of the above first embodiment is removed. A detailed explanation will therefore be omitted.

[0035] Next, the processing routine for detecting the atmospheric pressure and manifold pressure in the CPU 31 in the ECU 30 used in the second embodiment of the present invention will be explained based on the flow charts of FIG. 5, FIG. 6, and FIG. 7. Note that the atmospheric pressure and manifold pressure detection routine is repeatedly executed by the CPU 31 every predetermined time interval.

[0036] In FIG. 5, first, at step S201, it is judged if there is an N signal interruption. This "N signal" is a signal output every 30° CA by the crank angle sensor 22 of the crank shaft 12 of the engine 1. When the judgement condition of step S201 does not stand, that is, there is no N signal interruption, the routine waits until there is an N signal interruption at step S201. It then proceeds to step S202, where "1" is added to the interruption number NNUM of the previous N signal, that is, the N signal interruption number NNUM is incremented by "+1". This N signal interruption number NNUM is a signal expressing crank angle positions "0" to "23" given for every 30° CA interval of the range of crank angle 720° CA comprised of four cycles (suction stroke → compression stroke → expansion (explosion) stroke → exhaust stroke) starting with the base crank angle position detected by the crank angle sensor 22 provided at the crank shaft 12 of the engine 1 as "0 (zero)".

[0037] Next, the routine proceeds to step S203, where it is judged if $Na \leq NNUM \leq Nb$. When the judgement condition of step S203 stands, that is, the N signal interruption number NNUM is between the preset constant Na and constant Nb, the routine proceeds to step S204, where it is judged that the timing is the atmospheric pressure detection timing and the later explained atmospheric pressure detection processing is executed. On the other hand, when the judgement condition of step S203 does not stand, that is, the N signal interruption number NNUM is not between the preset constant Na and constant Nb, the routine proceeds to step S205, where it is judged if $Nc \leq NNUM \leq Nd$. When the judgement condition of step S205 stands, that is, the N signal interruption number NNUM is between a preset constant Nc and constant Nd, the routine proceeds to step S206, where it is judged that the timing is the manifold pressure detection timing and the later explained manifold pressure detection processing is executed.

[0038] When the atmospheric pressure detection processing at step S204, the manifold pressure detection processing at step S206, or the judgement condition of step S205 does not stand, that is, the N signal interruption number NNUM is not between the preset constant Nc and constant Nd, the routine proceeds to step S207, where it is judged if the N signal interruption number NNUM is a preset constant Ne (= "23"). When the judgement condition of step S207 does not stand, that is, the N signal interruption number NNUM is not equal to a preset constant Ne, the routine returns to the above step S201, where similar processing is repeatedly executed. When the judgement condition of step S207 stands, that is, the N signal interruption number NNUM becomes equal to a preset constant Ne, the routine proceeds to step S208, where the N signal interruption number NNUM is cleared to "0", then the routine proceeds to the above step S201, where the same processing is repeatedly executed.

[0039] Next, the processing routine for detection of the atmospheric pressure will be explained with reference to FIG. 6.

[0040] In FIG. 6, first, at step S301, the manifold pressure PM is read. Next, the routine proceeds to step S302, where the manifold pressure PM read at step S301 is made the atmospheric pressure detection value PAi. That is, in the present embodiment, the pressure value based on the manifold pressure PM detected by the manifold pressure sensor 21 is used as the atmospheric pressure PA. Note that "i" is a number matching with the N signal interruption number NNUM. Next, the routine proceeds to step S303, where it is judged if "i" is equal to Nb. When the judgement condition of step S303 does not stand, that is, "i" is not equal to Nb, the atmospheric pressure detection value PAi from step S302 is stored, then the routine is ended.

[0041] On the other hand, when the judgement condition at step S303 stands, that is, "i" becomes equal to Nb, the routine proceeds to step S304, where the aver-

age value obtained by dividing the total $\sum PA_i$ of the atmospheric pressure detection values PA_i stored at step S302 by the number NPA is made the atmospheric pressure PA. Next, the routine proceeds to step S305, where all of the manifold pressure detection values PM_i are cleared to "0", then the routine is ended.

[0042] Next, the processing routine for detection of the manifold pressure will be explained with reference to FIG. 7.

[0043] In FIG. 7, first, at step S401, the manifold pressure PM is read. Next, the routine proceeds to step S402, where the manifold pressure PM read at step S401 is made the manifold pressure detection value PM_i . Note that "i" is a number matching with the N signal interruption number NNUM. Next, the routine proceeds to step S403, where it is judged if "i" is equal to Nd. When the judgement condition of step S403 does not stand, that is, "i" is not equal to Nd, the manifold pressure detection value PM_i from step S402 is stored, then the routine is ended.

[0044] On the other hand, when the judgement condition at step S403 stands, that is, "i" becomes equal to Nd, the routine proceeds to step S404, where the value according to the manifold pressure calculation function $f(PM_i)$ in which the manifold pressure detection value PM_i stored at step S402 is entered is made the manifold pressure calculation value PML. Note that the manifold pressure calculation value PML is treated simply as the "manifold pressure PM" in the subsequent flow charts. Next, the routine proceeds to step S405, where all of the manifold pressure detection values PM_i are cleared to "0", then the routine is ended.

[0045] Next, a processing routine for operation of the fuel injection amount in the CPU 31 in the ECU 30 used in the engine control device according to the second embodiment of the present invention will be explained based on the flow chart of FIG. 8. Note that this fuel injection amount operation routine is repeatedly executed by the CPU 31 every predetermined time interval.

[0046] In FIG. 8, first, at step S501, the engine speed NE of the engine 1 is read. Next, the routine proceeds to step S502, where the atmospheric pressure PA found by the above-mentioned atmospheric pressure detection routine is read. Next, the routine proceeds to step S503, where the manifold pressure PM found by the above manifold pressure detection routine is read. Next, the routine proceeds to step S504, where the operation use manifold pressure PMTP is calculated by the above formula (1) based on the manifold pressure PM read at step S503.

[0047] Next, the routine proceeds to step S505, where the value of the atmospheric pressure calculation function $f(PA)$ in which the atmospheric pressure PA read at step S502 is entered and the value of the atmospheric pressure calculation function $f(PA_0)$ in which the predetermined atmospheric pressure PA_0 is entered are multiplied with the operation use manifold pressure PMTP calculated at step S504 to calculate the manifold pres-

sure compensation value PMTP' by the following formula (3):

$$PMTP' \leftarrow PMTP \cdot f(PA) \cdot f(PA_0) \quad (3)$$

[0048] Next, the routine proceeds to step S506, where the final fuel injection amount TAU is calculated based on the manifold pressure compensation value PMTP' calculated at step S505 and the engine speed NE read at step S501 and the routine is ended. Note that the calculation of the final fuel injection amount TAU using as parameters the manifold pressure compensation value PMTP' (mmHg) and the engine speed NE (rpm) by the fuel injection amount operation routine is similar to that of the above embodiment, so the explanation will be omitted.

[0049] In this way, the engine control device of the present embodiment is provided with the manifold pressure sensor 21 serving as the manifold pressure detecting means for detecting the pressure of the intake air introduced into the intake passage 2 of the engine 1, that is, the manifold pressure PM; the manifold pressure operating means realized by the ECU 30 for calculating the operation use manifold pressure PMTP for calculating the fuel injection amount of the engine 1 based on the manifold pressure PM detected by the manifold pressure sensor 21; the atmospheric pressure operating means realized by the ECU 30 for calculating the atmospheric pressure PA based on the manifold pressure PM detected by the manifold pressure sensor 21; the crank angle sensor 22 serving as the rotational speed detecting means for detecting the engine speed NE of the engine 1; the compensation value operating means realized by the ECU 30 for compensating the operation use manifold pressure PMTP calculated by the manifold pressure operating means by the atmospheric pressure PA calculated by the atmospheric pressure operating means and the predetermined atmospheric pressure PA_0 and calculating the result as the manifold pressure compensation value PMTP'; and the injection amount operating means realized by the ECU 30 for calculating the final fuel injection amount TAU to be supplied to the engine 1 using as parameters the manifold pressure compensation value PMTP' obtained by the compensation value operating means and the engine speed NE detected by the crank angle sensor 22. Further, the manifold pressure compensation value PMTP' in the compensation value operating means realized by the ECU 30 of the engine control device of the present embodiment is calculated by multiplying the atmospheric pressure PA and predetermined atmospheric pressure PA_0 with the operation use manifold pressure PMTP.

[0050] That is, the operation use manifold pressure value PMTP for calculating the fuel injection amount of the engine 1 based on the manifold pressure PM detected by the manifold pressure sensor 21 is compensated

by the atmospheric pressure PA calculated based on the manifold pressure PM and the predetermined atmospheric pressure PA0, and the final fuel injection amount TAU to be supplied to the engine 1 is calculated using as parameters the manifold pressure compensation value PMTP' and the engine speed NE detected by the crank angle sensor 22. By taking into consideration the change in atmospheric pressure with respect to the manifold pressure compensation value PMTP' and reflecting this into the manifold pressure parameter, it is possible to calculate the optimal manifold pressure compensation value regardless of the change in atmospheric pressure and supply a suitable final fuel injection amount TAU by this manifold pressure compensation value.

[0051] Next, a first modification of the processing routine for operation of the fuel injection amount in the CPU 31 in the ECU 30 used in the engine control device according to the second embodiment of the present invention will be explained based on the flow chart of FIG. 9. Note that this fuel injection amount operation routine is repeatedly executed by the CPU 31 every predetermined time interval.

[0052] In FIG. 9, step S601 to step S604 correspond to step S501 to step S504 in the above embodiment, so a detailed description will be omitted. Here, at step S605, the value obtained by dividing the predetermined atmospheric pressure PA0 by the atmospheric pressure PA read at step S602 is multiplied with the operation use manifold pressure PMTP calculated at step S604 to calculate the manifold pressure compensation value PMTP' by the following formula (4):

$$\text{PMTP}' \leftarrow \text{PMTP} \cdot (\text{PA0}/\text{PA}) \quad (4)$$

[0053] Next, the routine proceeds to step S606, where the final fuel injection amount TAU is calculated based on the manifold pressure compensation value PMTP' calculated at step S605 and the engine speed NE read at step S601 and the routine is ended. Note that the calculation of the final fuel injection amount TAU using as parameters the manifold pressure compensation value PMTP' (mmHg) and the engine speed NE (rpm) by the fuel injection amount operation routine is similar to that of the above embodiment, so the explanation will be omitted.

[0054] In this way, the operation use manifold pressure compensation value PMTP' in the compensation value operating means realized by the ECU 30 of the engine control device of the present modification is calculated by multiplying a value obtained by dividing a predetermined atmospheric pressure PA0 by the atmospheric pressure PA with the operation use manifold pressure PMTP. That is, by taking into consideration the change in atmospheric pressure with respect to the manifold pressure compensation value PMTP' and reflecting this into the manifold pressure parameter, it is

possible to calculate the optimal manifold pressure compensation value PMTP' for setting the final fuel injection amount TAU regardless of the change in atmospheric pressure.

[0055] Next, a second modification of the processing routine for operation of the fuel injection amount in the CPU 31 in the ECU 30 used in the engine control device according to the second embodiment of the present invention will be explained based on the flow chart of FIG. 10. Note that this fuel injection amount operation routine is repeatedly executed by the CPU 31 every predetermined time interval.

[0056] In FIG. 10, step S701 to step S704 correspond to step S501 to step S504 in the above embodiment, so a detailed description will be omitted. Here, at step S705, the value obtained by dividing the predetermined atmospheric pressure PA0 multiplied with a predetermined compensation coefficient δ by the atmospheric pressure PA read at step S702 is multiplied with the operation use manifold pressure PMTP calculated at step S704 to calculate the manifold pressure compensation value PMTP' by the following formula (5):

$$\text{PMTP}' \leftarrow \text{PMTP} \cdot \{\delta(\text{PA0})/\text{PA}\} \quad (5)$$

[0057] Next, the routine proceeds to step S706, where the final fuel injection amount TAU is calculated based on the manifold pressure compensation value PMTP' calculated at step S705 and the engine speed NE read at step S701 and the routine is ended. Note that the calculation of the final fuel injection amount TAU using as parameters the manifold pressure compensation value PMTP' (mmHg) and the engine speed NE (rpm) by the fuel injection amount operation routine is similar to that of the above embodiment, so the explanation will be omitted.

[0058] In this way, the manifold pressure compensation value PMTP' in the compensation value operating means realized by the ECU 30 of the engine control device of the present modification is calculated by multiplying a value obtained by dividing a predetermined atmospheric pressure PA0 multiplied with a predetermined compensation coefficient δ by the atmospheric pressure PA with the operation use manifold pressure PMTP. That is, by taking into consideration the change in atmospheric pressure with respect to the manifold pressure compensation value PMTP' and reflecting this into the manifold pressure parameter, it is possible to calculate the optimal manifold pressure compensation value PMTP' for setting the final fuel injection amount TAU regardless of the change in atmospheric pressure.

[0059] Next, a third modification of the processing routine for operation of the fuel injection amount in the CPU 31 in the ECU 30 used in the engine control device according to the second embodiment of the present invention will be explained based on the flow chart of FIG. 11. Note that this fuel injection amount operation routine

is repeatedly executed by the CPU 31 every predetermined time interval.

[0060] In FIG. 11, step S801 to step S804 correspond to step S501 to step S504 in the above embodiment, so a detailed description will be omitted. Here, at step S805, the value obtained by multiplying a predetermined compensation coefficient ε with the difference between the predetermined atmospheric pressure PAO and the atmospheric pressure PA read at step S802 is added to the operation use manifold pressure PMTP calculated at step S804 to calculate the manifold pressure compensation value PMTP' by the following formula (6):

$$\text{PMTP}' \leftarrow \text{PMTP} + \varepsilon(\text{PAO} - \text{PA}) \quad (6)$$

[0061] Next, the routine proceeds to step S806, where the final fuel injection amount TAU is calculated based on the manifold pressure compensation value PMTP' calculated at step S805 and the engine speed NE read at step S801 and the routine is ended. Note that the calculation of the final fuel injection amount TAU using as parameters the manifold pressure compensation value PMTP' (mmHg) and the engine speed NE (rpm) by the fuel injection amount operation routine is similar to that of the above embodiment, so the explanation will be omitted.

[0062] In this way, the manifold pressure compensation value PMTP' in the compensation value operating means realized by the ECU 30 of the engine control device of the present modification is calculated by adding a value obtained by multiplying a predetermined compensation coefficient ε with the difference between the predetermined atmospheric pressure PAO and atmospheric pressure PA to the operation use manifold pressure PMTP. That is, by taking into consideration the change in atmospheric pressure with respect to the manifold pressure compensation value PMTP' and reflecting this into the manifold pressure parameter, it is possible to calculate the optimal manifold pressure compensation value PMTP' for setting the final fuel injection amount TAU regardless of the change in atmospheric pressure.

[0063] Next, a fourth modification of the processing routine for operation of the fuel injection amount in the CPU 31 in the ECU 30 used in the engine control device according to the second embodiment of the present invention will be explained with reference to FIG. 13 based on the flow chart of FIG. 12. Here, FIG. 13 is a map for calculating by interpolation the predetermined compensation coefficient ζ from the operation use manifold pressure PMTP and engine speed NE. Note that this fuel injection amount operation routine is repeatedly executed by the CPU 31 every predetermined time interval.

[0064] In FIG. 12, step S901 to step S904 correspond to step S501 to step S504 in the above embodiment, so

a detailed description will be omitted. Here, at step S905, the map shown in FIG. 13 is used for calculation of a predetermined compensation coefficient ζ from the operation use manifold pressure PMTP and engine speed NE by known four-point interpolation. Next, the routine proceeds to step S906, where the value obtained by multiplying a predetermined compensation coefficient ζ calculated at step S905 with the difference between the predetermined atmospheric pressure PAO and the atmospheric pressure PA read at step S902 is added to the operation use manifold pressure PMTP calculated at step S904 to calculate the manifold pressure compensation value PMTP' by the following formula (7):

$$\text{PMTP}' \leftarrow \text{PMTP} + \zeta(\text{PAO} - \text{PA}) \quad (7)$$

[0065] Next, the routine proceeds to step S907, where the final fuel injection amount TAU is calculated based on the manifold pressure compensating value PMTP' calculated at step S906 and the engine speed NE read at step S901 and the routine is ended. Note that the calculation of the final fuel injection amount TAU using as parameters the manifold pressure compensation value PMTP' (mmHg) and the engine speed NE (rpm) by the fuel injection amount operation routine is similar to that of the above embodiment, so the explanation will be omitted.

[0066] In this way, the manifold pressure compensation value PMTP' in the compensation value operating means realized by the ECU 30 of the engine control device of the present modification is calculated by adding a value obtained by multiplying a predetermined compensation coefficient ζ with the difference between the predetermined atmospheric pressure PAO and atmospheric pressure PA to the operation use manifold pressure PMTP. Further, the predetermined compensation coefficient ζ of the present modification is calculated using as parameters the operation use manifold pressure PMTP and engine speed NE. That is, by calculating the optimal compensation coefficient ζ regardless of the change in atmospheric pressure, taking into consideration the change in atmospheric pressure with respect to the manifold pressure compensation value PMTP', and reflecting this into the manifold pressure parameter, it is possible to calculate the optimal manifold pressure compensation value PMTP' for setting the final fuel injection amount TAU regardless of the change in atmospheric pressure.

[0067] Note that while the present invention has been described in detail based on specific embodiments, a person skilled in the art could make various modifications, changes, etc. within the claims and idea of the present invention.

Claims

1. An engine control device provided with:

manifold pressure detecting means for detecting pressure of intake air introduced into an intake passage of an engine, that is, manifold pressure; 5
 manifold pressure operating means for calculating operation use manifold pressure for calculating a fuel injection amount of an engine based on manifold pressure detected by said manifold pressure detecting means; 10
 atmospheric pressure operating means for calculating an atmospheric pressure based on a manifold pressure detected by said manifold pressure detecting means; 15
 rotational speed detecting means for detecting an engine speed of said engine; 20
 change operating means for calculating the difference between a base atmospheric pressure and a current atmospheric pressure calculated by said atmospheric pressure operating means as the change in atmospheric pressure; and 25
 injection amount operating means for calculating a fuel injection amount to be supplied to said engine using as parameters a manifold pressure compensation value obtained by adding the change in atmospheric pressure calculated by said change operating means to said operation use manifold pressure calculated by said manifold pressure operating means and the engine speed detected by said rotational speed detecting means. 30
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2. An engine control device provided with:

atmospheric pressure detecting means for detecting an atmospheric pressure; 40
 manifold pressure detecting means for detecting pressure of intake air introduced into an intake passage of an engine, that is, manifold pressure; 45
 manifold pressure operating means for calculating an operation use manifold pressure for calculating a fuel injection amount of said engine based on a manifold pressure detected by said manifold pressure detecting means; 50
 rotational speed detecting means for detecting an engine speed of said engine; 55
 change operating means for calculating the difference between a base atmospheric pressure and a current atmospheric pressure detected by said atmospheric pressure detecting means as the change in atmospheric pressure; and
 injection amount operating means for calculating a fuel injection amount to be supplied to said engine using as parameters a manifold pres-

sure compensation value obtained by adding the change in atmospheric pressure calculated by said change operating means to said operation use manifold pressure calculated by said manifold pressure operating means and the engine speed detected by said rotational speed detecting means.

3. An engine control device as set forth in claim 1 or 2, wherein said change operating means multiplies a predetermined compensation coefficient with said difference to calculate said change in atmospheric pressure

4. An engine control device as set forth in claim 1 or 2, wherein said change operating means multiplies a predetermined compensation coefficient using a manifold pressure as a parameter with said difference to calculate said change in atmospheric pressure.

5. An engine control device provided with:

manifold pressure detecting means for detecting a pressure of intake air introduced into an intake passage of an engine, that is, a manifold pressure;
 manifold pressure operating means for calculating an operation use manifold pressure for calculating a fuel injection amount of an engine based on a manifold pressure detected by said manifold pressure detecting means;
 atmospheric pressure operating means for calculating an atmospheric pressure based on a manifold pressure detected by said manifold pressure detecting means;
 rotational speed detecting means for detecting an engine speed of said engine;
 compensation value operating means for compensating the operation use manifold pressure calculated by said manifold pressure operating means by the atmospheric pressure calculated by said atmospheric pressure operating means and a predetermined atmospheric pressure to calculate a manifold pressure compensation value; and
 injection amount operating means for calculating a fuel injection amount to be supplied to said engine using as parameters the manifold pressure compensation value calculated by said compensation value operating means and the engine speed detected by said rotational speed detecting means.

6. An engine control device as set forth in claim 5, wherein said manifold pressure compensation value in said compensation value operating means is calculated by multiplying the compensation value

using as a parameter the atmospheric pressure calculated by said atmospheric pressure operating means and said compensation value based on a predetermined atmospheric pressure with said operation use manifold pressure.

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7. An engine control device as set forth in claim 5, wherein said manifold pressure compensation value in said compensation value operating means is calculated by multiplying a value obtained by dividing said predetermined atmospheric pressure by an atmospheric pressure calculated by said atmospheric pressure operating means with said operation use manifold pressure.

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8. An engine control device as set forth in claim 5, wherein said manifold pressure compensation value in said compensation value operating means is calculated by multiplying a value obtained by dividing said predetermined atmospheric pressure multiplied with a predetermined compensation coefficient by the atmospheric pressure calculated by said atmospheric pressure operating means with said operation use manifold pressure.

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9. An engine control device as set forth in claim 5, wherein said manifold pressure compensation value in said compensation value operating means is calculated by adding a value obtained by multiplying a predetermined compensation coefficient with a difference between said predetermined atmospheric pressure and the atmospheric pressure calculated by said atmospheric pressure operating means to said operation use manifold pressure.

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10. An engine control device as set forth in claim 8 or 9, wherein said predetermined compensation coefficient is calculated using as parameters said operation use manifold pressure and said engine speed.

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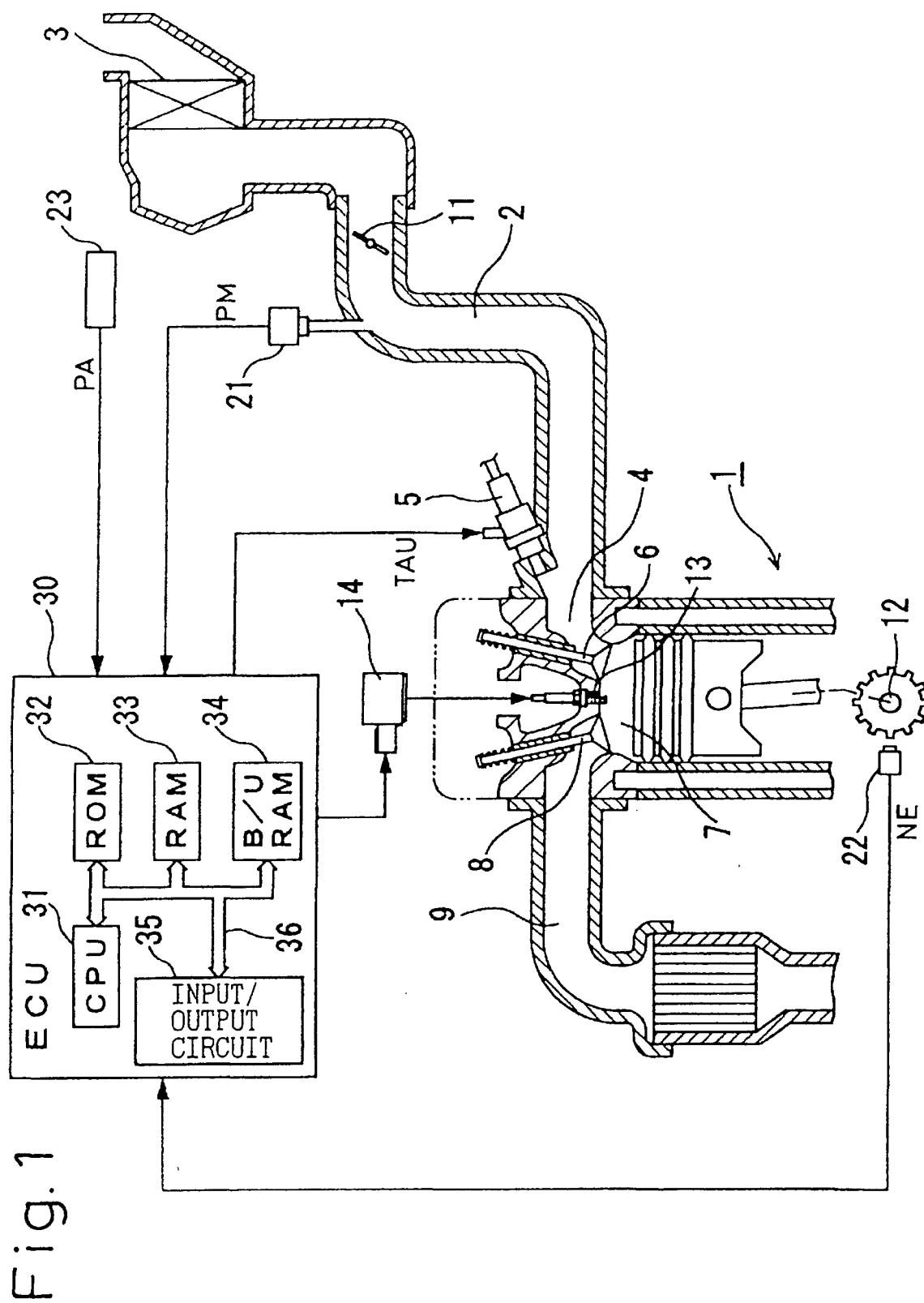


Fig.2

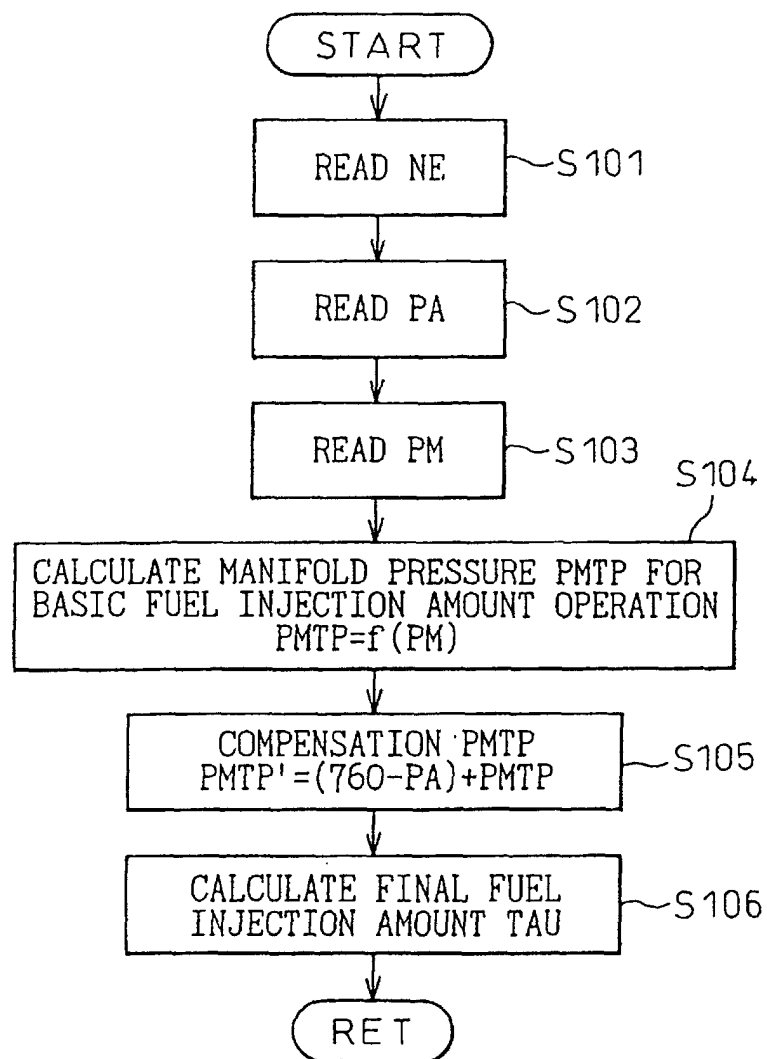


Fig.3A LOW ALTITUDE ATMOSPHERIC PRESSURE (760mmHg)

MANIFOLD PRESSURE PM [mmHg]	100	200	300
ENGINE SPEED NE [rpm]			
1000		α	
2000			
3000			

Fig.3B HIGH ALTITUDE ATMOSPHERIC PRESSURE (660mmHg)

MANIFOLD PRESSURE PM [mmHg]	100	200	300
ENGINE SPEED NE [rpm]			
1000	β	$\Leftarrow \alpha$	
2000			
3000			

Fig.3C HIGH ALTITUDE ATMOSPHERIC PRESSURE (660mmHg)

MANIFOLD
PRESSURE
COMPENSATION
VALUE PMTP'
[mmHg]

MANIFOLD PRESSURE COMPENSATION VALUE PMTP' [mmHg]	100	200	300
ENGINE SPEED NE [rpm]			
1000	β	$\Rightarrow \gamma$	
2000			
3000			

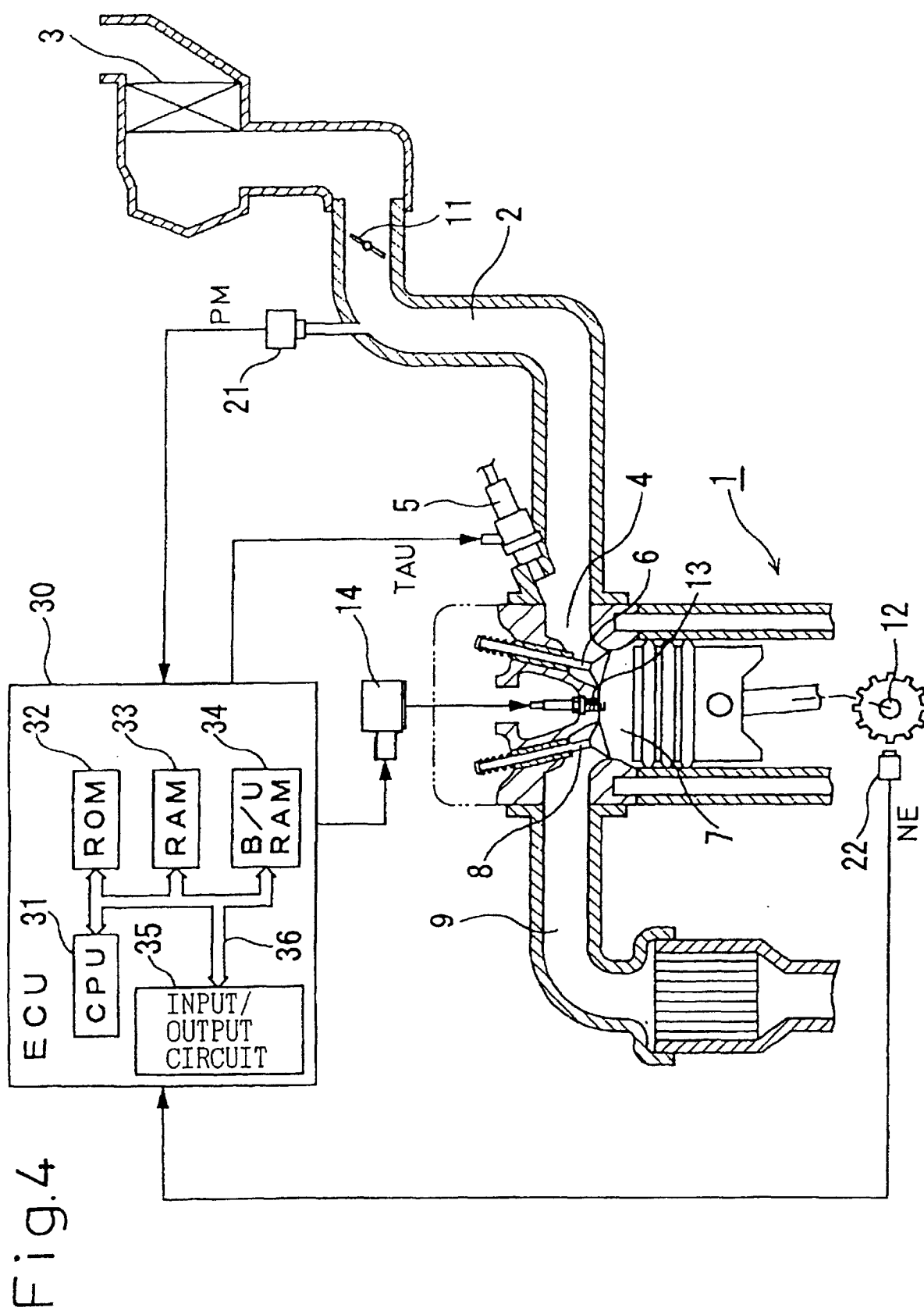


Fig.5

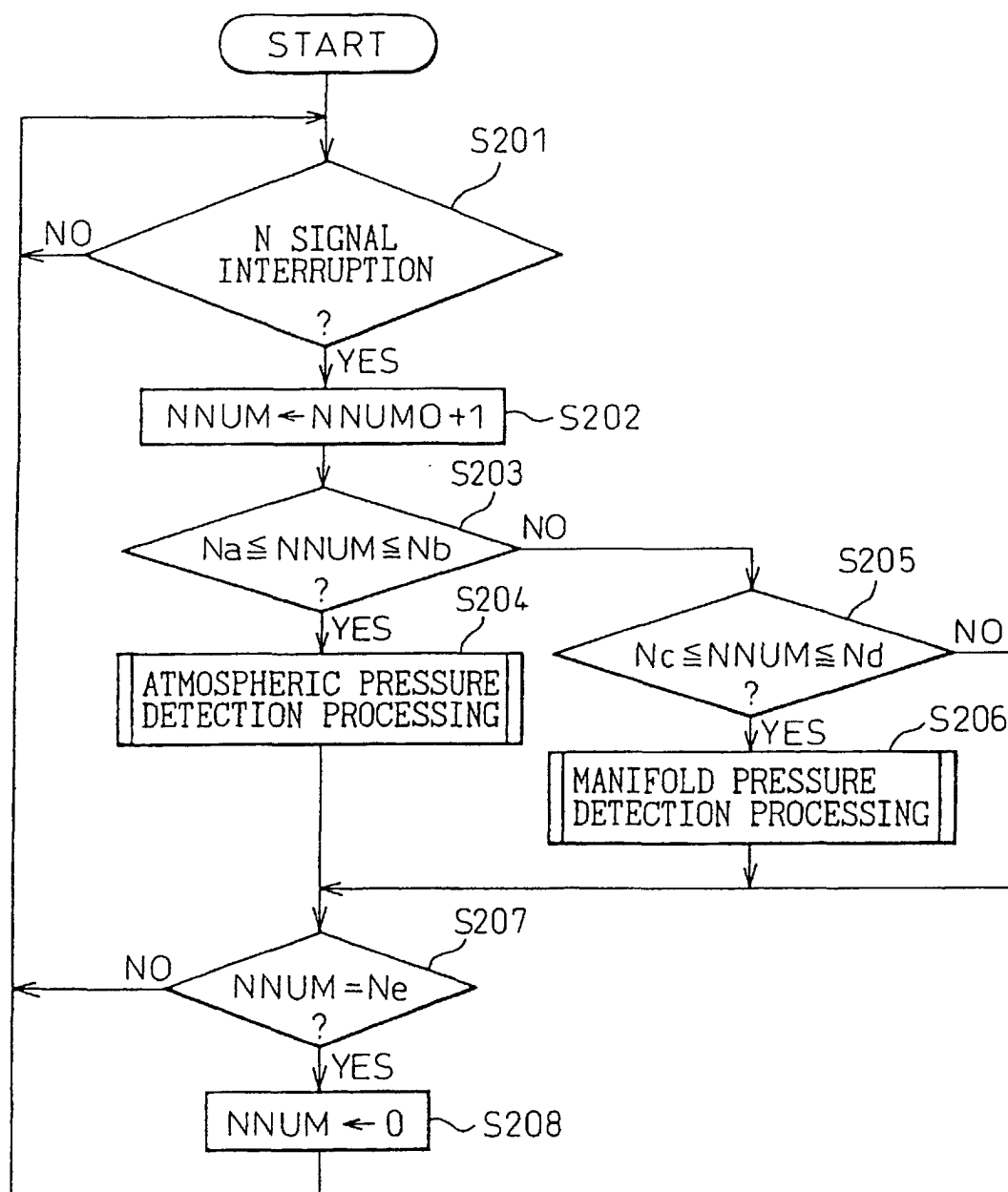


Fig.6

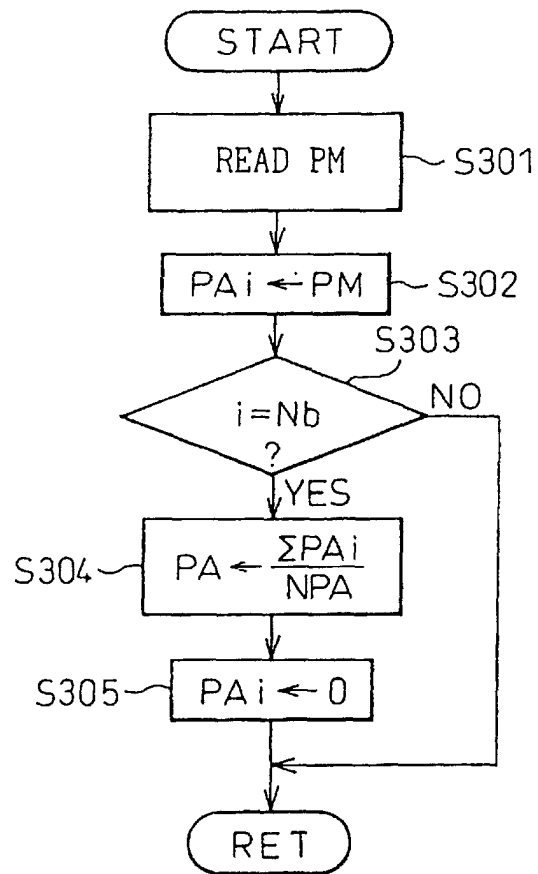


Fig.7

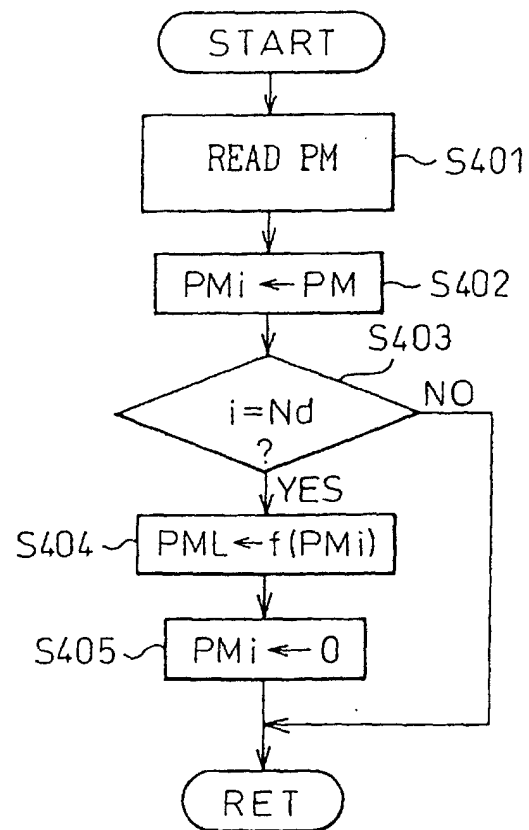


Fig.8

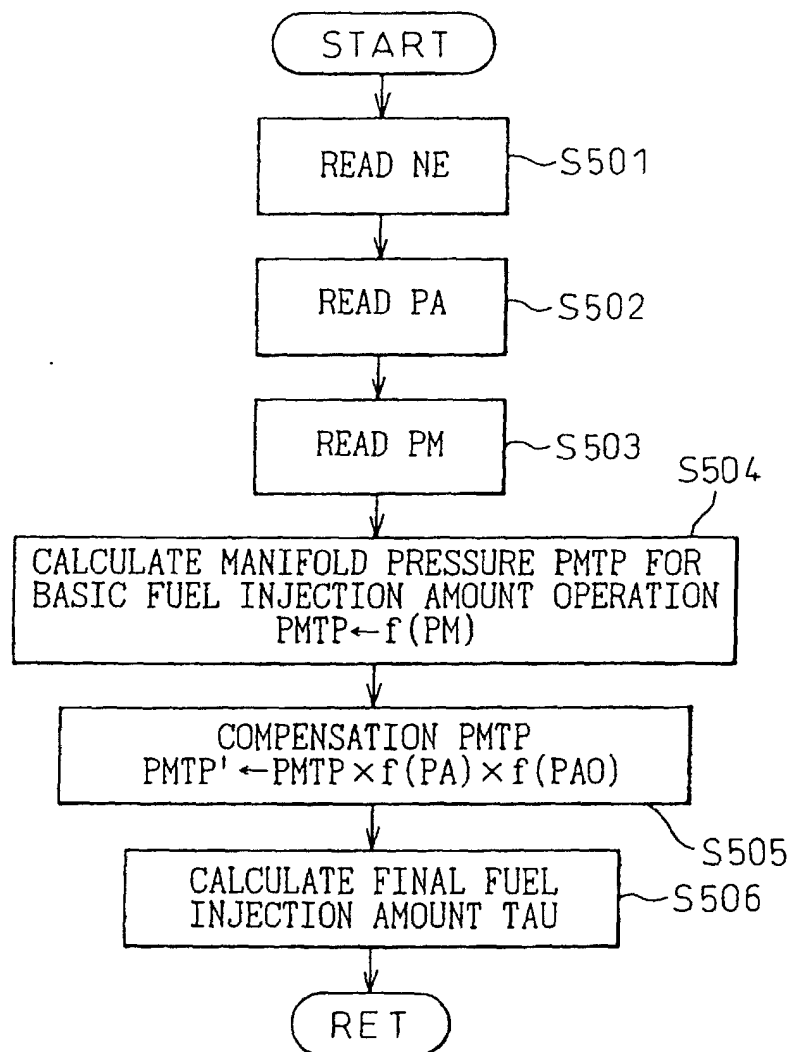


Fig.9

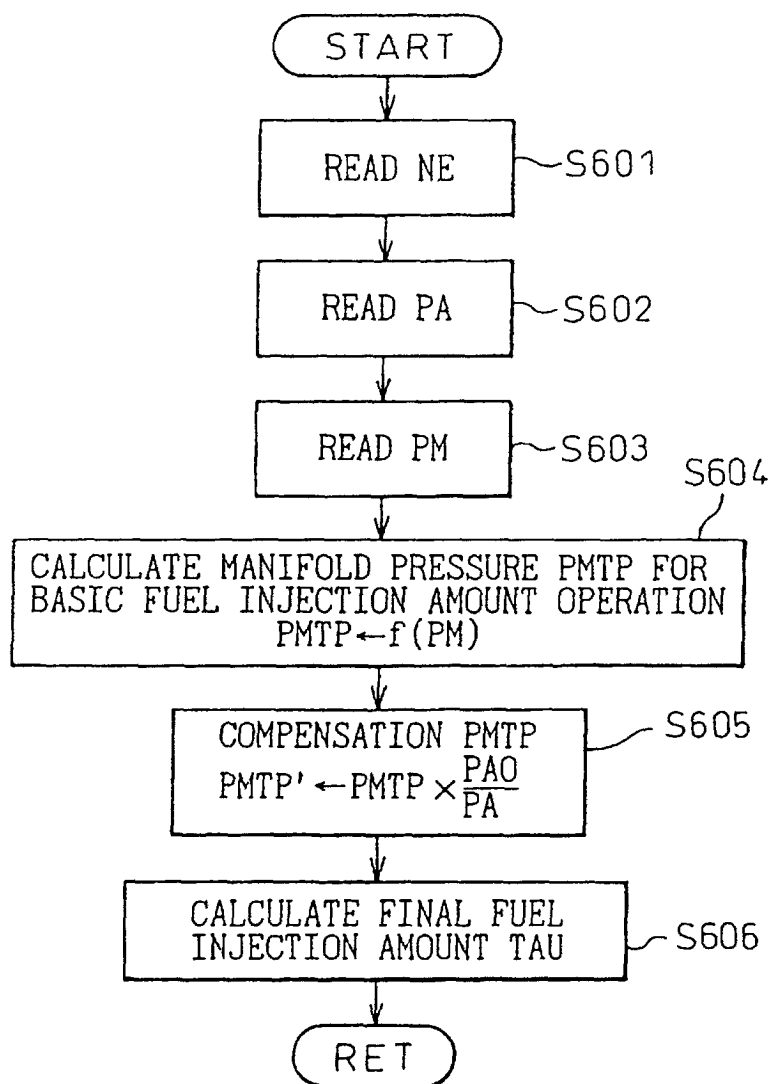


Fig. 10

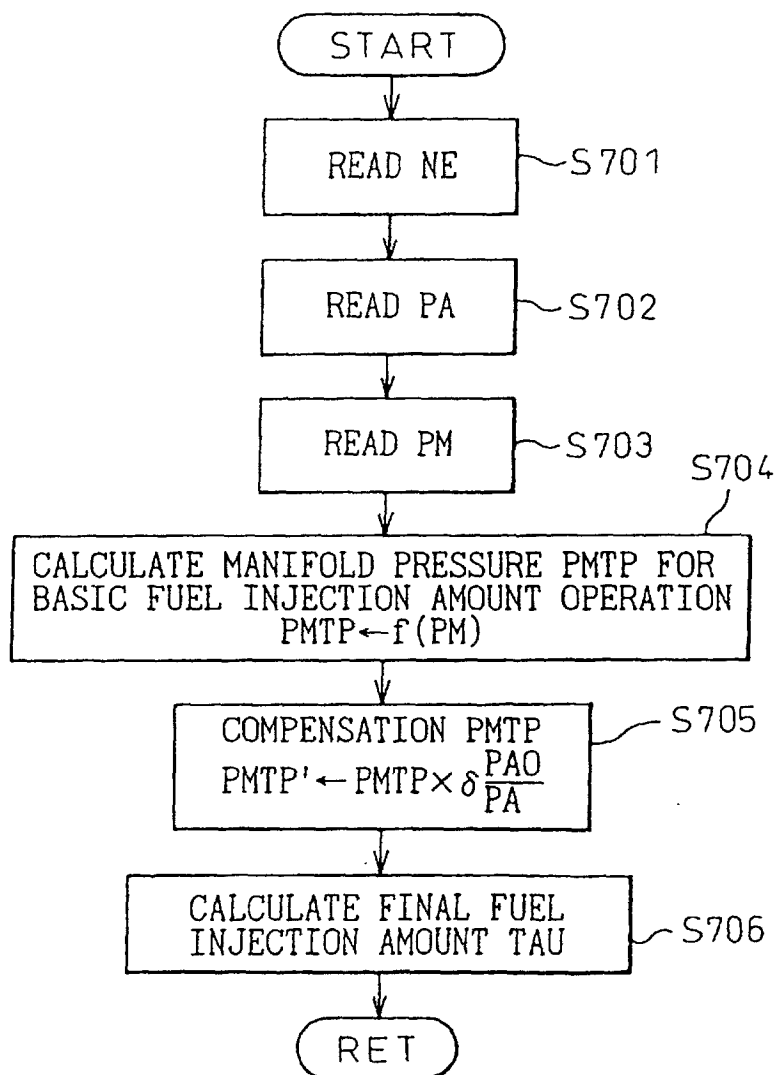


Fig. 11

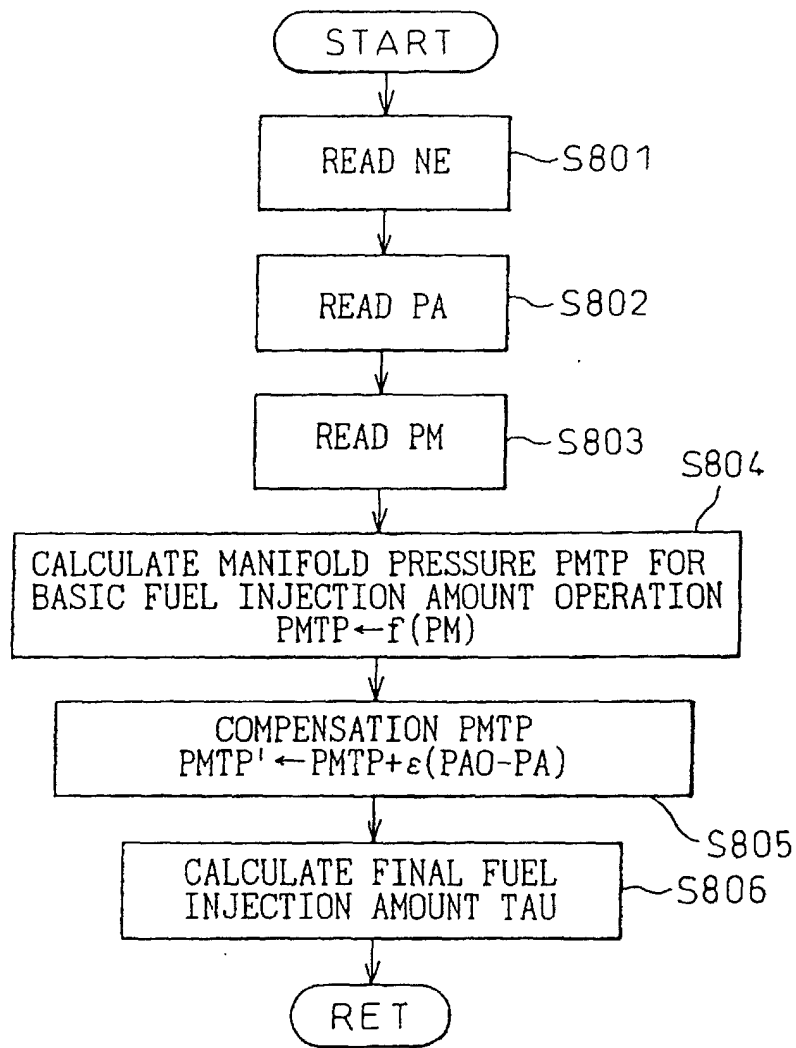


Fig.12

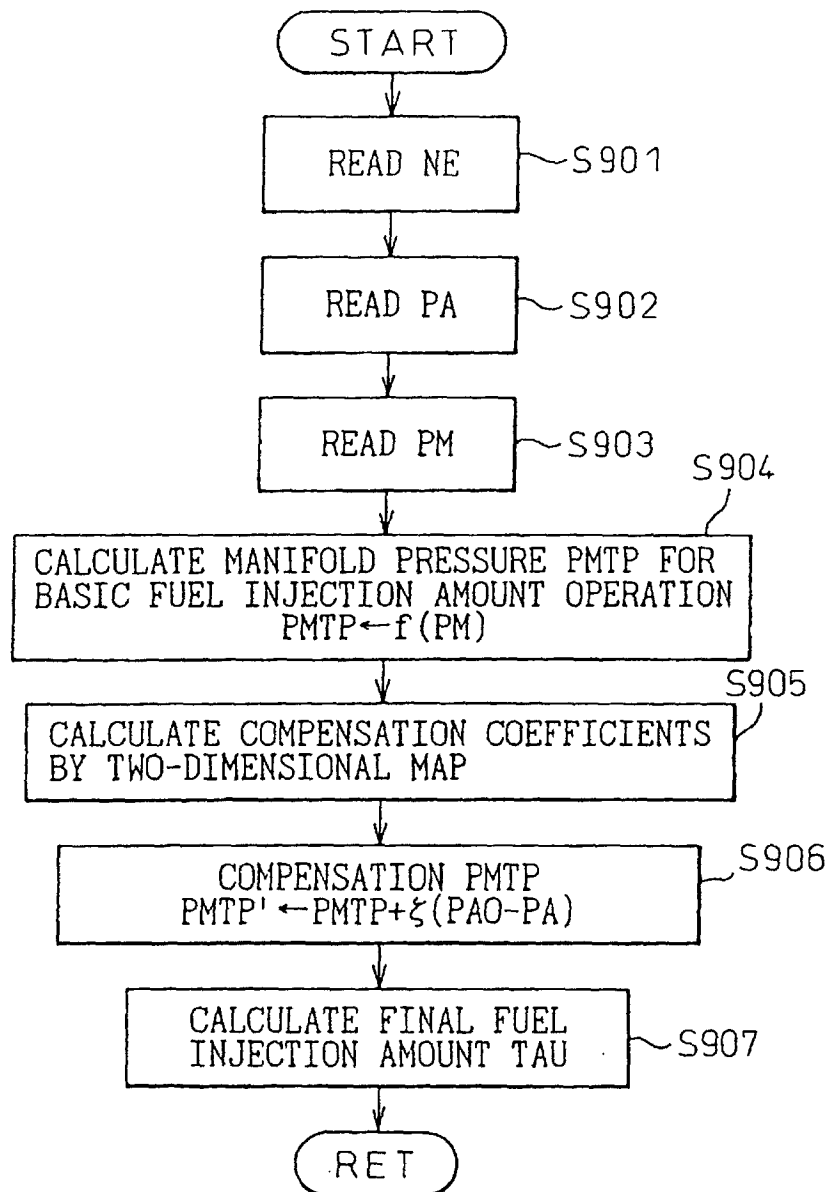


Fig.13

	P M T P				
N E	ξ_{11}	ξ_{12}	ξ_{13}	$\cdot \cdot \cdot \cdot \cdot$	ξ_{1n}
	ξ_{21}				ξ_{2n}
	ξ_{31}				ξ_{3n}
	ξ_{41}				$\cdot$
	$\cdot$				$\cdot$
	$\cdot$				$\cdot$
	$\cdot$				$\cdot$
	ξ_{m1}				ξ_{mn}

Fig. 14

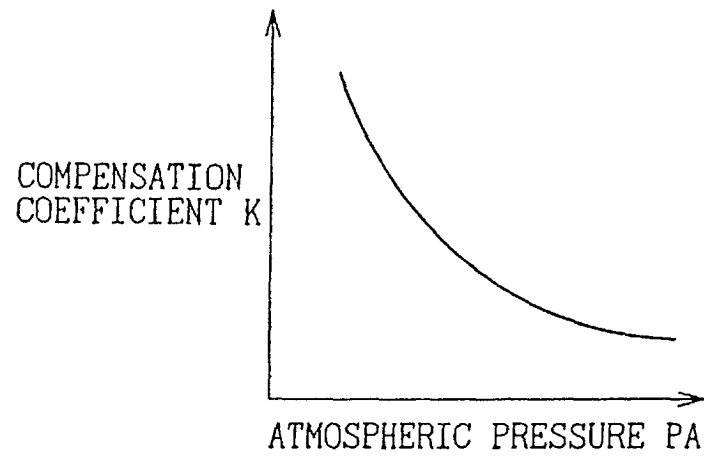
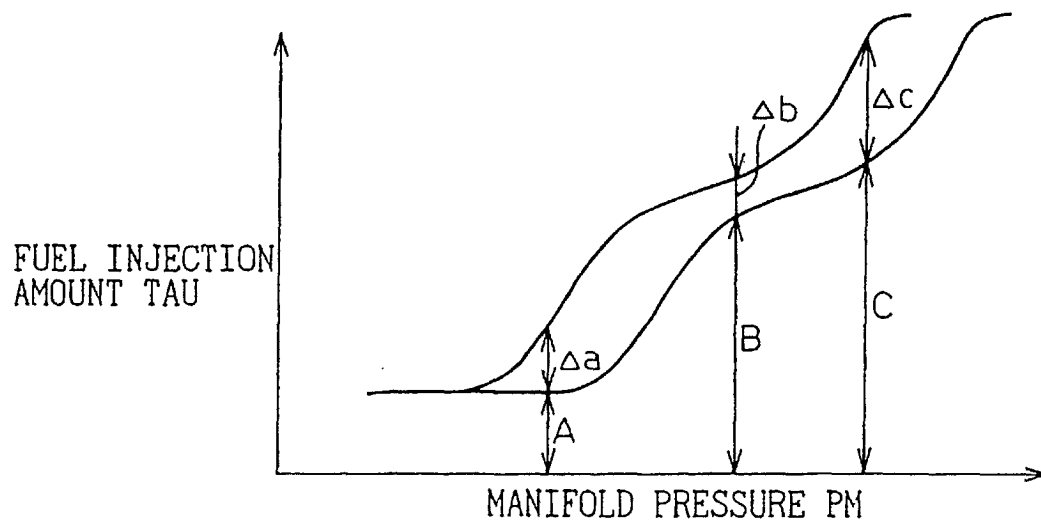


Fig. 15



List of reference number

- 1...internal combustion engine
- 21...manifold pressure sensor
- 22...crank angle sensor
- 23...atmospheric pressure sensor
- 30...ECU(electronic control unit)

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP02/10107

A. CLASSIFICATION OF SUBJECT MATTER Int.Cl ⁷ F02D41/04, F02D45/00		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) Int.Cl ⁷ F02D41/04, F02D45/00		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2002 Kokai Jitsuyo Shinan Koho 1971-2002 Toroku Jitsuyo Shinan Koho 1994-2002		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 02-019626 A (Toyota Motor Corp.), 23 January, 1990 (23.01.90), Full text; Fig. 5 (Family: none)	1-10
Y	JP 2000-297688 A (Toyota Motor Corp.), 24 October, 2000 (24.10.00), Column 13, line 28 to column 15, line 2; Figs. 3, 8, 9 & WO 00/42306 A & EP 1143130 A	1-10
Y	JP 2000-213401 A (Denso Corp.), 02 August, 2000 (02.08.00), Full text; all drawings (Family: none)	1, 3-10
☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.		
* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier document but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family		
Date of the actual completion of the international search 06 December, 2002 (06.12.02)		Date of mailing of the international search report 24 December, 2002 (24.12.02)
Name and mailing address of the ISA/ Japanese Patent Office		Authorized officer
Facsimile No.		Telephone No.

Form PCT/ISA/210 (second sheet) (July 1998)

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP02/10107

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5715796 A (SUZUKI et al.), 10 February, 1998 (10.02.98), Column 33, lines 8 to 16; Fig. 36 & JP 08-232714 A & US 5839415 A	4, 10
Y	US 6109244 A (YAMAMOTO et al.), 29 August, 2000 (29.08.00), Column 13, line 41 to column 14, line 18; Fig. 11 & JP 11-200918 A & DE 19852755 A	6
Y	US 4881509 A (OHASHI et al.), 21 November, 1989 (21.11.89), Column 7, lines 12 to 22; Fig. 2 & JP 01-053030 A	7, 8

Form PCT/ISA/210 (continuation of second sheet) (July 1998)