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(54) **Electronic fuel injection control device**

Elektronische Kraftstoffeinspritzsteuervorrichtung

Dispositif électronique de commande d'injection de carburant

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- **PATENT ABSTRACTS OF JAPAN vol. 010, no. 122 (M-476), 7 May 1986 & JP 60 249633 A (HONDA GIKEN KOGYO KK), 10 December 1985**

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Description

[0001] The present invention relates to an electronic fuel injection device for an internal-combustion engine for a vehicle, and more particularly to an electronic fuel injection control device which can perform precise correction of a fuel injection amount according to atmospheric pressure even in a multiple throttle valve type internal-combustion engine by changing an atmospheric pressure correction coefficient for the fuel injection amount according to a load condition of the internal-combustion engine.

[0002] Japanese Patent Laid-open No. Hei 1-100335 has proposed a fuel injection device which can perform atmospheric pressure correction for a fuel injection amount without the use of an atmospheric pressure sensor. In the conventional fuel injection device, a reference value of variables in a given atmospheric condition is stored by using at least an engine speed as a parameter. Further, a signal corresponding to the parameter is input, and an output from air amount measuring means or limiting means is input. Further, atmospheric pressure correction computing means for computing an atmospheric pressure correction value in a given operational condition is provided, and a limited value of the variables is corrected with the atmospheric pressure correction value by the limiting means.

[0003] In a control device designed to compute a fuel injection amount according to an engine speed and an intake air amount, especially, an intake manifold vacuum, the fuel injection amount cannot sometimes be precisely corrected in the case where the fuel injection amount does not linearly change with the intake manifold vacuum corrected for computation in proportion to a decrease in atmospheric pressure at a highland. Particularly in a multiple throttle valve type internal-combustion engine, the linear relation between intake air amount and intake manifold vacuum is lost in a high-load condition of the engine. Therefore, if accurate atmospheric correction is not performed, a desired engine output cannot be obtained at a highland.

[0004] FIG. 19 is an illustration showing an example of the above-mentioned contents. In a single throttle valve type engine shown in FIG. 19(a), an intake manifold vacuum PB is detected by an intake manifold vacuum sensor, and an atmospheric pressure is detected by an atmospheric pressure sensor (not shown). As shown in FIG. 19(b), a PB correction value at a highland is calculated according to the ratio between a reference (lowland) atmospheric pressure and an actual atmospheric pressure (e.g., highland atmospheric pressure), and a fuel injection amount is set according to the PB correction value calculated above, thereby allowing substantially good atmospheric pressure correction.

[0005] However, in a multiple throttle valve type engine shown in FIG. 19(c), the linear relation between intake air amount and intake manifold vacuum PB is lost in a high-load condition of the engine. Accordingly, it is necessary to correct a fuel injection amount. Further, in a configuration that the load condition of the engine is detected according to intake manifold vacuum, and a fuel injection amount characteristic L in a low-load condition and a fuel injection amount characteristic H in a high-load condition are switched each other according to the detected load condition, there occurs a problem such that if a switching point between these characteristics L and H is not varied with variations in atmospheric pressure, a fuel amount demanded by the engine in running at a highland, for example, cannot be supplied.

[0006] US-A-5,095,877 discloses an electronic fuel injection control device in accordance with the preamble of claim 1. There, whether the engine is in a low load condition or a high load condition, is decided according to the intake manifold vacuum. EP 0 535 671A discloses a similar device, wherein the basic fuel amount is corrected by coefficients which are a function of the engine load and a function of atmospheric pressure, respectively.

[0007] It is accordingly an object of the present invention to provide an electronic fuel injection control device which can perform correction of a fuel injection amount according to atmospheric pressure with a high accuracy over the whole range from a low-load condition to a high-load condition.

[0008] According to the invention whether the engine is in the low-load condition or the high-load condition is decided according to the intake manifold vacuum, and a criterion of decision of the low-load condition or the high-load condition varies with a change in the atmospheric pressure.

[0009] A demanded fuel injection amount according to intake manifold vacuum in a low-load condition is different from that in a high-load condition. According to the present invention, the atmospheric pressure correction coefficients in the low-load condition and the high-load condition of the engine are provided, and the atmospheric pressure correction coefficient to be used is changed according to the load condition of the engine. Accordingly, atmospheric pressure correction for a fuel injection amount can be properly performed over the whole range from the low-load condition to the high-load condition.

[0010] Whether the engine is in the low-load condition or the high-load condition is decided according to intake manifold vacuum, and a criterion of this decision varies with a change in atmospheric pressure. Accordingly, a fuel injection amount can be properly corrected according to wide variations in atmospheric pressure from at a lowland to at a highland.

[0011] Particularly in a multiple throttle valve type engine, the linear relation between intake air amount and intake manifold vacuum is lost in a high-load condition, and it is therefore necessary to correct a fuel injection amount. According to the present invention, two kinds of atmospheric pressure correction coefficients different in characteristics according to engine load condition are

provided, and these coefficients are selectively used according to the load condition to thereby allow accurate atmospheric pressure correction.

[0012] Further, in deciding the low-load condition or the high-load condition according to intake manifold vacuum, the criterion of decision of either load condition is varied with variations in atmospheric pressure according to the present invention. Accordingly, even in running at a highland where atmospheric pressure is low, the load condition can be properly decided to allow proper atmospheric pressure correction.

[0013] A preferred embodiment of the present invention will be described with reference to the attached drawings, in which

FIG. 1 is an electric system diagram of an electronic fuel injection control device according to the present invention;

FIG. 2 is a perspective view showing the arrangement of essential components in a motorcycle including the electronic fuel injection control device according to the present invention;

FIG. 3 is a block diagram showing the general configuration of an electronic fuel injection control unit;

FIG. 4 is a functional block diagram showing the basic function of the electronic fuel injection control unit;

FIG. 5 is a flowchart showing the basic operation of the electronic fuel injection control unit;

FIG. 6 is a functional block diagram of atmospheric pressure correction coefficient setting means;

FIG. 7 is a graph showing an example of the contents of an atmospheric pressure correction coefficient table;

FIG. 8 is a flowchart showing the operation of the atmospheric pressure correction coefficient setting means;

FIG. 9 is a graph showing an example of an intake air temperature correction coefficient;

FIG. 10 is a graph showing an example of a cooling water temperature correction coefficient;

FIG. 11 is a block diagram showing a preferred embodiment of basic injection amount computing means and acceleration increase coefficient computing means;

FIG. 12 is a graph showing the operation of map designating means;

FIG. 13 is a flowchart showing the operation of acceleration correcting means;

FIG. 14 is a graph showing the relation between throttle opening and acceleration correction coefficient;

FIG. 15 is a flowchart showing the whole operation of the electronic fuel injection control device;

FIG. 16 is a flowchart showing a preferred embodiment of atmospheric pressure correction;

FIG. 17 is a graph showing an example of a starting atmospheric pressure correction coefficient;

FIG. 18 is a graph showing an example of a second atmospheric pressure correction coefficient and

FIG. 19 is an illustration showing problems in the prior art.

[0014] FIG. is an electric system diagram of an electronic fuel injection control device 1 according to the present invention, and FIG. 2 is a perspective view showing the arrangement of essential parts in a motorcycle including the electronic fuel injection control device 1.

[0015] The electronic fuel injection control device 1 includes an electronic fuel injection control unit 3 for controlling a timing of energization of each of four injectors (fuel injection valves) 2, for example, to control a fuel injection amount, and various sensors for detecting an operational condition of an engine 4. The engine 4 is of a V-shaped, four-cylinder, multiple throttle valve type.

[0016] A battery power source BAT is connected at its negative electrode to a vehicle body ground. When a combination switch (ignition switch) CSW becomes on, the supply voltage of the battery power source BAT is supplied through a fuse F1, the combination switch CSW, and a fuse F2 to a kill sensor KS, thereby making the kill sensor KS operative. The kill sensor KS has a tilt angle sensor, so that when the motorcycle is tilted beyond a predetermined angle, the kill sensor KS cuts off an exciting current flowing through a kill relay KR.

[0017] When the combination switch CSW is on, a kill switch KSW interposed between the fuse F2 and the kill relay KR is on, and the tilt angle of the motorcycle is within the predetermined angle, an exciting current is supplied through the kill sensor KS to an exciting coil of the kill relay KR, so that the contacts of the kill relay KR becomes on and the supply voltage of the battery power source BAT is supplied to a power input terminal B+ of the electronic fuel injection control unit 3, a solenoid of each injector 2, and a variable intake solenoid valve 5. Accordingly, when the kill switch KSW is off, the vehicle cannot be operated. In this preferred embodiment, the supply voltage is supplied to the electronic fuel injection

control unit 3 through two kinds of fuses F3 and F4 having different breaking characteristics.

[0018] The electronic fuel injection control unit 3 includes a fuel pump driving circuit (not shown), so that an exciting current is supplied from an output terminal FPC of the fuel pump driving circuit to an exciting coil of a fuel cut relay FCR to close the contacts of the fuel cut relay FCR and thereby supply the supply voltage of the battery power source BAT to a fuel pump FP, thus operating the fuel pump FP. Accordingly, when the tilt angle of the vehicle exceeds the predetermined angle, the supply of power to the electronic fuel injection control unit 3 is stopped by the operation of the kill sensor KS, and simultaneously the supply of power to the fuel pump FP is also stopped by the operation of the kill sensor KS.

[0019] The electronic fuel injection control unit 3 further includes a variable intake valve driving circuit (not shown) to drive the variable intake solenoid valve 5 according to a drive signal 5a from an output terminal T5 of the variable intake valve driving circuit.

[0020] The electronic fuel injection control unit 3 further includes injector driving means (see reference numeral 52 shown in FIG. 3) to control fuel injection from each injector 2 according to an injector drive signal output from a terminal T2n of the injector driving means.

[0021] The electronic fuel injection control unit 3 further includes a reference power supply (not shown) with a common negative potential VR-, for supplying two reference voltages VR1 and VR2. The first reference voltage VR1 is supplied to an atmospheric pressure sensor S1, a rear intake manifold vacuum sensor S2, and a front intake manifold vacuum sensor S3, thereby obtaining voltage signals VPA, VPBR, and VPBF respectively corresponding to an atmospheric pressure, rear intake manifold vacuum, and front intake manifold vacuum.

[0022] The first reference voltage VR1 is further supplied through an intake air temperature detection reference resistor (not shown) provided in the electronic fuel injection control unit 3 to an intake air temperature sensor S4, thereby obtaining a voltage signal VTa corresponding to an intake air temperature according to a divided voltage between the reference resistor and a heat-sensitive resistor element in the intake air temperature sensor S4. The intake air temperature sensor S4 is located in an air cleaner provided in the vicinity of the engine.

[0023] The first reference voltage VR1 is further supplied through a water temperature detection reference resistor provided in the electronic fuel injection control unit 3 to a water temperature sensor S5, thereby obtaining a voltage signal VTw corresponding to an engine cooling water temperature according to a divided voltage between the reference resistor and a heat-sensitive resistor element in the water temperature sensor S5.

[0024] Inside each intake passage extending from the air cleaner to the corresponding cylinder of the engine 4, a throttle valve SV is provided and each injector 2 is located in the vicinity of the corresponding throttle valve SV. A throttle opening sensor S6 for detecting a throttle opening θ TH is connected to a rotating shaft of the throttle valve SV. The second reference voltage VR2 is supplied to the throttle opening sensor S6 to obtain a voltage signal V θ TH corresponding to the throttle opening.

[0025] The second reference voltage VR2 is further supplied to an idle mixture adjuster 6, so that divided voltages obtained by variable resistors 6a to 6d in the idle mixture adjuster 6 respectively provided for the four cylinders are respectively supplied to idle injection amount adjustment input terminals ID1 to ID4 of the electronic fuel injection control unit 3. The electronic fuel injection control unit 3 decides a fuel injection amount at idling for each cylinder according to each voltage supplied from the idle mixture adjuster 6.

[0026] The electronic fuel injection control unit 3 has a terminal T8 for inputting an intake valve opening/closing timing pulse 8a output from a cam pulse generator 8 cooperating with a cam pulser rotor 7, thereby detecting a fuel injection timing. The electronic fuel injection control unit 3 further has a terminal T10 for inputting a crank rotation pulse signal 10a output from a crank pulse generator 10 cooperating with a crank pulser rotor 9, thereby computing an engine speed. The control unit 3 further has a terminal DG which is a ground terminal for a digital signal system.

[0027] The electronic fuel injection control unit 3 computes an engine speed according to the crank rotation pulse signal 10a, and generates a tachometer driving signal 11a according to the engine speed computed above to drive a tachometer 11. The electronic fuel injection control unit 3 generates a water temperature gauge driving signal 12a according to a detection output from the water temperature sensor S5 to drive a water temperature gauge 12. Further, the electronic fuel injection control unit 3 generates a display control signal 13a to control the display of an indicator 13.

[0028] In this preferred embodiment, when the combination switch CSW is on, the supply voltage of the battery power source BAT is supplied through a fuse F5 to a speed sensor 14, and a speedometer 16 provided at a meter portion 15 is directly driven by a speed detection signal 14a from the speed sensor 14. Accordingly, as far as the combination switch CSW is on, the indication of vehicle speeds by the speedometer 16 can be made even if the electronic fuel injection control unit 3 is not powered.

[0029] FIG. 3 is a block diagram showing the whole configuration of the electronic fuel injection control unit 3.

[0030] The electronic fuel injection control unit 3 is configured by using a microcomputer system, and includes various correction coefficients setting means 20, basic injection amount computing means 30, acceleration increase coefficient computing means 40, fuel injection amount setting means 51, injector driving means 52, AID converter 53, average vacuum computing means 54, engine speed computing means 55, and map

designating means 56.

[0031] The A/D converter 53 converts the voltage signals VPA, VPBR, VPBF, VTa, VTw, and V θ TH respectively corresponding to an atmospheric pressure, intake manifold vacuum (rear), intake manifold vacuum (front), intake air temperature, cooling water temperature, and throttle opening detected by the sensors S1 to S6 into corresponding digital data PA, PBR, PBF, Ta, Tw, and θTH.

[0032] The average vacuum computing means 54 computes an average vacuum PBH of the rear and front intake manifold vacuums PBR and PBF, and supplies the average vacuum PBH to the basic injection amount computing means 30 and the acceleration increase coefficient computing means 40.

[0033] The engine speed computing means 55 computes an engine speed according to a pulse period of the crank rotation pulse signal 10a to output engine speed data (which will be hereinafter referred to simply as engine speed).

[0034] FIG. 4 is a functional block diagram showing the basic function of the electronic fuel injection control unit 3.

[0035] Also shown in FIG. 3, the electronic fuel injection control unit 3 includes the various correction coefficients setting means 20 for generating various correction coefficients Kpa, Kta, and Ktw; the basic injection amount computing means 30 for computing a basic injection amount Ti; the acceleration increase coefficient computing means 40 for computing an acceleration increase coefficient Kacc; the fuel injection amount setting means 51 for generating a fuel injection amount Tout obtained by multiplying the basic injection amount Ti and the acceleration increase coefficient Kacc; and the injector driving means 52 for controlling an energization time (or energization duty) of each injector 2 according to the fuel injection amount Tout.

[0036] The various correction coefficients setting means 20 includes atmospheric pressure correction coefficient setting means 21 for setting the atmospheric pressure correction coefficient Kpa according to the atmospheric pressure PA; intake air temperature correction coefficient setting means 22 for setting the intake air temperature correction coefficient Kta according to the intake air temperature Ta; and cooling water temperature correction coefficient setting means 23 for setting the cooling water temperature correction coefficient Ktw according to the cooling water temperature Tw.

[0037] The basic injection amount computing means 30 includes basic injection amount setting means 31 having a preliminarily registered injection amount map or injection amount operation equation, etc., for generating a basic injection amount Tim under normal operational conditions (e.g., at 1 atmospheric pressure, a predetermined intake air temperature, and a predetermined cooling water temperature); basic injection amount correcting means 32 for generating the basic injection amount Ti fit for present operational conditions by multiplying the basic injection amount Tim and a total correction coefficient Ktotal; and basic injection amount correction coefficient setting means 33 for generating the total correction coefficient Ktotal obtained by multiplying the atmospheric pressure correction coefficient Kpa, the intake air temperature correction coefficient Kta, and the cooling water temperature correction coefficient Ktw respectively output from the atmospheric pressure correction coefficient setting means 21, the intake air temperature correction coefficient setting means 22, and the cooling water temperature correction coefficient setting means 23.

[0038] FIG. 5 is a flowchart showing the basic operation of the electronic fuel injection control unit 3. The process of computing the fuel injection amount Tout is started by interruption according to the crank rotation pulse signal 10a. In step P1, the atmospheric pressure correction coefficient Kpa is calculated. In step P2, the intake air temperature correction coefficient Kta is calculated. In step P3, the cooling water temperature correction coefficient Ktw is calculated. In step P4, the correction coefficients Kpa, Kta, and Ktw are multiplied together to give the total correction coefficient Ktotal. In step P5, the basic injection amount Tim is set. In step P6, the basic injection amount Tim and the total correction coefficient Ktotal are multiplied together to give the corrected basic injection amount Ti. In step P7, the acceleration increase coefficient Kacc is calculated. In step P8, the corrected basic injection amount Ti and the acceleration increase coefficient Kacc are multiplied together to give the fuel injection amount Tout.

[0039] FIG. 6 is a functional block diagram of the atmospheric pressure correction coefficient setting means 21.

[0040] The atmospheric pressure correction coefficient setting means 21 includes two kinds of atmospheric pressure correction coefficient tables 21a and 21b for a low-load condition and a high-load condition; applicable table selecting means 21c; load condition deciding means 21d for deciding whether the operational condition of the engine is a low-load condition or a high-load condition; and load condition decision threshold computing means 21e for computing a decision threshold for the load condition.

[0041] FIG. 7 is a graph showing an example of the contents of each atmospheric pressure correction coefficient table.

[0042] An atmospheric pressure correction coefficient KpaL for a low-load condition is stored in the low-load atmospheric pressure correction coefficient table 21a, and an atmospheric pressure correction coefficient KpaH for a high-load condition is stored in the high-load atmospheric pressure correction coefficient table 21b. The horizontal axis in the graph represents atmospheric pressure PA with a unit of mmHg (mercury column height). At atmospheric pressures not less than 760 mmHg, both the correction coefficients KpaL and KpaH are set to 1.0. The low-load atmospheric pressure cor-

rection coefficient KpaL gently increases up to about 1.2 at the maximum with a decrease in atmospheric pressure. The high-load atmospheric pressure correction coefficient KpaH increases up to about 1.8 at the maximum with a decrease in atmospheric pressure.

[0043] The load condition deciding means 21d decides whether the engine is in a high-load condition or a low-load condition according to an intake manifold vacuum, and the applicable table selecting means 21c generates an applicable one of the atmospheric pressure correction coefficients KpaL and KpaH as the atmospheric pressure correction coefficient Kpa according to a decision output (low load/high load) 21f generated from the load condition deciding means 21d.

[0044] Even when the engine load condition is constant, the intake manifold vacuum varies with variations in atmospheric pressure. To cope with this fact, this preferred embodiment has a configuration that the intake manifold vacuum (load condition decision threshold) PBsud as a criterion of decision of a high-load condition or a low-load condition is made variable with variations in atmospheric pressure. To this end, the load condition decision threshold computing means 21e performs the following operation according to the atmospheric pressure PA, and supplies the load condition decision threshold PBsud obtained by this operation to the load condition deciding means 21d.

$$PBsud = (PA/760) \times PBsud0$$

PBsud:	Load condition decision threshold
PA:	Atmospheric pressure
PBsud0:	Load condition decision threshold (e.g., 608 mmHg) at an atmospheric pressure of 760 mmHg

[0045] FIG. 8 is a flowchart showing the operation of the atmospheric pressure correction coefficient setting means 21.

[0046] In step P11, the atmospheric pressure - low-load atmospheric pressure correction coefficient (PA - KpaL) table is referred to, and a correction coefficient KpaL corresponding to an atmospheric pressure detected by the atmospheric pressure sensor S1 is calculated. As shown in FIG. 7, four correction coefficients KpaL corresponding to four atmospheric pressures (e.g., 480, 580, 670, and 760 mmHg) are preliminarily stored in the table, and any correction coefficient KpaL corresponding to any atmospheric pressure between any two of the above four points is calculated by interpolation. Similarly, the high-load atmospheric pressure correction coefficient KpaH is calculated.

[0047] In step P13, the load condition decision threshold PBsud corresponding to the present atmospheric pressure PA is calculated. In step P14, the intake manifold vacuum PB and the load condition decision threshold PBsud are compared with each other. If the intake manifold vacuum PB is not less than the load condition decision threshold PBsud, it is decided that the engine is in a high-load condition, and in step P15, the high-load atmospheric pressure correction coefficient KpaH is set to the atmospheric pressure correction coefficient Kpa. If the intake manifold vacuum PB is less than the load condition decision threshold PBsud, it is decided that the engine is in a low-load condition, and in step P16, the low-load atmospheric pressure correction coefficient KpaL is set to the atmospheric pressure correction coefficient Kpa. Alternatively, the decision of the load condition may be made in advance, and the calculation of the atmospheric pressure correction coefficient may be made according to the load condition decided above.

[0048] FIG. 9 is a graph showing an example of the intake air temperature correction coefficient Kta. The intake air temperature correction coefficient Kta also has characteristics different according to the load condition of the engine.

[0049] FIG. 10 is a graph showing an example of the cooling water temperature correction coefficient Ktw. The cooling water temperature correction coefficient Ktw also has characteristics different according to the load condition of the engine.

[0050] FIG. 11 is a block diagram showing the configuration of the basic injection amount computing means 30 and the acceleration increase coefficient computing means 40.

[0051] The basic injection amount setting means 31 for generating the basic injection amount Tim includes two kinds of injection amount maps (tables) 31a and 31b, and basic injection amount map selecting means 31c for selecting/switching the map to be used according to a usable map command 56a supplied from the map designating means 56. While the basic injection amount map selecting means 31c is so configured as to select an output from either the injection amount map 31a or the injection amount map 31b as shown, the selecting means 31c may be so configured as to switch between the maps to be searched.

[0052] The relation between the average intake manifold vacuum PBH, the engine speed NE, and the basic injection amount Tim is preliminarily registered in the intake manifold vacuum - injection amount map 31a. On the other hand, the relation between the throttle opening θ TH, the engine speed NE, and the basic injection amount Tim is preliminarily registered in the throttle opening - injection amount map 31b. The basic injection amount Tim registered in each of the injection amount maps 31a and 31b is an injection amount at a predetermined atmospheric pressure, a predetermined intake air temperature, and a predetermined cooling water temperature.

[0053] FIG. 12 is a graph showing the operation of the map designating means 56.

[0054] When the throttle opening θ TH is relatively large, the map designating means 56 generated a com-

mand 56a demanding the use of the map according to the throttle opening, whereas when the throttle opening θTH is relatively small, the map designating means 56 generates a command 56a demanding the use of the map according to the intake manifold vacuum. When the throttle opening θ TH is large, the intake manifold vacuum is substantially approximate to the atmospheric pressure, and a change in the intake manifold vacuum is small. Therefore, in such a region, the injection amount is obtained by using the throttle opening θ TH as a parameter. In another region where a change in the intake manifold vacuum is remarkable, the injection amount is obtained by using the intake manifold vacuum as a parameter. Thus, a suitable injection amount can be obtained over a wide range of operational condition.

[0055] As shown in FIG. 11, the acceleration increase coefficient computing means 40 includes throttle change amount computing means 41; acceleration condition deciding means 42; two kinds of increase coefficient maps (tables) 43a and 43b; increase coefficient map selecting means 43c for selecting either the increase coefficient map 43a or 43b to be used according to the usable map command 56a supplied from the map designating means 56; acceleration correcting means 44 for correcting an acceleration increase coefficient KAM obtained by searching the map 43a or 43b, according to an engine operational condition; and stepped correcting means 45.

[0056] The throttle change amount computing means 41 computes a change amount (change rate) of throttle opening per given unit time to generate a throttle opening change amount (change rate) data (which will be hereinafter referred to simply as throttle opening change amount) Δ θ TH.

[0057] The acceleration condition deciding means 42 decides whether or not the vehicle is in an accelerated condition according to the engine speed NE, the throttle opening θTH, and the throttle opening change amount Δ θTH to generate an acceleration increase command 42a demanding the increase of fuel injection amount and also generate acceleration continuation/termination condition decision information 42b indicating whether acceleration is continued or acceleration has been terminated.

[0058] The acceleration condition deciding means 42 stops the output of the acceleration increase command 42a when the engine is inoperative, when the engine speed NE is greatly high (e.g., at not less than 10000 rpm), or when the throttle opening θ TH is not relatively large (e.g., at less than 15 degrees).

[0059] The acceleration condition deciding means 42 decides that the vehicle is in an accelerated condition to generate the decision signal 42b indicative of the accelerated condition when the engine speed is in a predetermined range (e.g., at less than 10000 rpm), when the throttle opening θTH is in a predetermined range (e.g., from not less than 15 degrees to less than the full opening), and when the throttle opening change amount Δ θ TH is relatively large (e.g., several degrees per 10 to 20 milliseconds).

[0060] In contrast, the acceleration condition deciding means 42 decides that the acceleration has been terminated when the throttle opening θTH becomes near to the full opening (e.g., at about 85 degrees) after the accelerated condition, or when the throttle opening change amount Δ θ TH becomes relatively small (e.g., less than several degrees per 10 to 20 milliseconds) after the accelerated condition.

[0061] The relation between the engine speed NE, the intake manifold vacuum PB, the acceleration increase coefficient, and the number of injections for acceleration increase correction (which number will be hereinafter referred to as acceleration increase injections number) is preliminarily registered in the intake manifold vacuum - increase coefficient map 43a. Further, the relation between the engine speed NE, the throttle opening θTH, the acceleration increase coefficient, and the acceleration increase injections number is preliminarily registered in the throttle opening - increase coefficient map 43b. Since the acceleration increase coefficient is set according to the engine speed NE, acceleration increase correction according to engine speed can be performed even at acceleration from a low engine speed or from a medium/high engine speed. Accordingly, as compared with the case where an increase amount of fuel to be injected at acceleration is set regardless of engine speed, a more proper increase amount can be set according to the present invention.

[0062] The acceleration correcting means 44 computes a corrected acceleration increase coefficient KAH by multiplying an acceleration correction coefficient KH set according to the throttle opening θTH and an acceleration increase coefficient KAH obtained by the search of the map 43a or 43b, and then supplies the corrected acceleration increase coefficient KAH to the stepped correcting means 45 when the engine speed NE is medium and the throttle opening θ TH is in a predetermined range.

[0063] FIG. 13 is a flowchart showing the operation of the acceleration correcting means 44, and FIG. 14 is a graph showing the relation between the throttle opening θ TH and the acceleration correction coefficient KH.

[0064] When the engine speed NE is in a predetermined medium speed range (e.g., 4800 to 10000 rpm) (P21), and when the throttle opening θ TH is in a predetermined angle range (e.g., greater than an opening angle at idling to less than a full opening angle) (P22), the acceleration correcting means 44 searches the map storing the relation between the throttle opening θ TH and the acceleration correction coefficient KH shown in FIG. 14 (P23). Further, as far as the number of injections for acceleration increase correction is not zero (P24), the acceleration correcting means 44 generates the corrected acceleration increase coefficient KAH obtained by multiplying the acceleration correction coefficient KH and the increase coefficient KAM obtained by the map

search (P25).

[0065] When the engine speed NE and the throttle opening θ TH do not satisfy the above-mentioned correction conditions, the correction coefficient KAH is set to 1.0 (P26), so that the acceleration increase coefficient KAM obtained by the map search is output without any change as the corrected acceleration increase coefficient KAH (P25).

[0066] As shown in FIG. 14, the correction coefficient KH is set by multiplying by 1.05 the increase coefficient KAM obtained by the map search over 10-90% of the entire range of the throttle opening θTH. Therefore, the fuel injection amount at acceleration is increased in this predetermined throttle opening range except a region where the throttle opening θTH is greatly small and a region where the throttle opening θTH is almost full, thereby improving acceleration performance.

[0067] The stepped correcting means 45 corrects the corrected acceleration increase coefficient KAH, so as to prevent a rapid change in fuel injection amount to be actually increased, and supplies an acceleration increase coefficient KACC to the fuel injection amount setting means 51 using a multiplier or the like. When acceleration increase is not necessary, that is, when the acceleration increase command 42a is not supplied from the acceleration condition deciding means 42, the stepped correcting means 45 generates 1.0 as the acceleration increase coefficient KACC.

[0068] When the acceleration increase command 42a and the acceleration continuation/termination condition decision output 42b indicative of a condition where acceleration is continued are supplied, the stepped correcting means 45 compares a value (e.g., 1.047) obtained by adding a preset change data (e.g., 0.047) to a previous output value 1.0 with the corrected acceleration increase coefficient KAH output from the acceleration correcting means 44. If the corrected acceleration increase coefficient KAH is larger than the sum (e.g., 1.047), the sum (e.g., 1.047) is output as the acceleration increase coefficient KACC.

[0069] If the corrected acceleration increase coefficient KAH is smaller than the sum (e.g., 1.047), the corrected acceleration increase coefficient KAH is output as the acceleration increase coefficient KACC. This operation is repeated while the acceleration continuation/termination condition decision output 42b indicative of the continuation of acceleration is being supplied. Accordingly, the acceleration increase coefficient KACC is stepwise increased by every preset change data (e.g., 0.047) up to the corrected acceleration increase coefficient KAH obtained by the acceleration correcting means 44 as a target value, thereby preventing a rapid increase in the acceleration increase coefficient KACC.

[0070] Alternatively, a present value of the acceleration increase coefficient KACC may be increased by a value obtained by multiplying a predetermined coefficient (e.g., 0.5) and a difference between a previous value of the acceleration increase coefficient KACC and the corrected acceleration increase coefficient KAH supplied from the acceleration correcting means 44. With this operation, the acceleration increase coefficient KACC can be made quickly approach the corrected acceleration increase coefficient KAH.

[0071] The stepped correcting means 45 monitors the number of increased injections according to an injection signal 52b supplied from the injector driving means 52. At the time the number of increased injections reaches a predetermined increase injections number KN, the stepped correcting means 45 returns the acceleration increase coefficient KACC to 1.0.

[0072] Further, when the acceleration continuation/termination condition decision output 42b indicative of a condition where the acceleration has been terminated is supplied prior to termination of the increased injection by the predetermined increase injections number KN, the stepped correcting means 45 computes a value obtained by subtracting a preset change data (e.g., 0.047) from a previous value of the acceleration increase coefficient KACC, and generates the difference as a present value of the acceleration increase coefficient KACC. This process of subtracting the preset change data (e.g., 0.047) is repeated until the difference becomes not greater than 1.0. When the difference becomes not greater than 1.0, the stepped correcting means 45 generates 1.0 as KACC.

[0073] The fuel injection amount setting means 51 multiplies the basic injection amount Ti output from the basic injection amount computing means 30 and the acceleration increase coefficient KACC supplied from the stepped correcting means 45, and generates the result of this multiplication as the fuel injection amount Tout.

[0074] The injector driving means 52 generates an injector driving signal 52a having an injection time (or duty) determined according to the fuel injection amount Tout, in synchronism with the intake valve opening/closing timing signal 8a, and sequentially supplies this signal 52a to each injector 2. Accordingly, a predetermined amount of fuel is sequentially injected from each injector 2 in synchronism with an intake valve opening/closing timing.

[0075] FIG. 15 is a flowchart showing the whole operation of the electronic fuel injection control device.

[0076] In step P31, the basic injection amount Ti is computed by the basic injection amount computing means 30. Thereafter, the process of acceleration increase correction as shown by step P32 and subsequent steps is executed.

[0077] In step P32, the operational condition of the engine is decided. If the engine is inoperative in the case of engine stall, for example, initialization shown by step P50 is executed. If the engine is operative, it is decided in step P33 whether or not the engine speed NE is in a high-speed region. If the engine speed NE is in a high-speed region, e.g., not less than 10000 rpm, initialization shown by step P50 is executed. If the engine speed NE is less than 10000 rpm, for example, it is decided in step

P34 whether or not the throttle opening θ TH is relatively large. If the throttle opening θTH is less than 15 degrees, for example, initialization shown by step P50 is executed.

[0078] If the throttle opening θ TH is not less than 15 degrees, it is decided that the vehicle is in an accelerated condition or in an acceleration terminated condition, and the process of step P35 and subsequent steps is next executed. In step P35, it is decided whether or not the throttle opening θTH is almost full. If the throttle opening θTH is not full (e.g., less than 85 degrees), and the throttle opening change amount Δ θTH is large (e. g., 8 degrees/100 milliseconds) (step P36), it is decided that the vehicle is in an accelerated condition to next execute the acceleration increase correction process shown by step P37 and subsequent steps.

[0079] In step P37, the increase coefficient map and the correction coefficient map are searched, and the acceleration increase coefficient KAM obtained by the map search is multiplied by the correction coefficient KH obtained by the map search to calculate the corrected acceleration increase coefficient KAH. In step P38, a preset change amount is added to a previous value of the acceleration increase coefficient KACC (which value will be hereinafter referred to simply as previous value). In step P39, the sum obtained in step P38 and the corrected acceleration increase coefficient KAH are compared with each other. If the corrected acceleration increase coefficient KAH is larger than the sum, the sum is set as a present value of the acceleration increase coefficient KACC (which value will be hereinafter referred to simply as present value) (P40), whereas if the corrected acceleration increase coefficient KAH is smaller than the sum, the corrected acceleration increase coefficient KAH is set as the present value (P41).

[0080] In step P42, an increase flag is set to 1. In step P43, the basic injection amount (the computed value obtained in step P31) Ti is multiplied by the present value. In step P44, fuel in an amount according to the product obtained in step P43 is injected from each injector 2. Then, the program returns to step P31 to repeat the above series of processes.

[0081] If the throttle opening θ TH is almost full, e.g., not less than 85 degrees (P35), or if the throttle opening change amount Δ θ TH is small (P36), it is decided that the vehicle is in an acceleration terminated condition to next execute the process of step P45 and subsequent steps.

[0082] In step P45, the state of the increase flag is checked. If the increase flag is 0, it is decided that the vehicle is not in the acceleration terminated condition after acceleration, so that initialization of step P50 is executed. If the increase flag is 1, the number of increased injections is checked in step P46, in which if the number of increased injections has already reached the number of increased injections obtained by the search of the acceleration increase coefficient map, initialization of step P50 is executed. If the number of increased injections is 1 or more, a preset change amount is subtracted from the previous value in step P47. If the difference obtained in step P47 becomes not greater than 1 (P48), the program proceeds to step P50 to end the increase correction after acceleration. If the difference is not less than 1, the difference is set as the present value in step P49 to next execute the process of step P42 and subsequent steps.

[0083] In this manner, when a rapid increase in the throttle opening θ TH to a large value is detected in steps P35 and P36, it is decided that the vehicle is in an accelerated condition, and the process of increasing the fuel injection amount for acceleration is then started. However, a rapid increase in the fuel injection amount is prevented, because the increase coefficient is increased by every preset change amount up to the map computed value as a target value in steps P39 to P41.

[0084] If the engine speed NE becomes very high (e. g., not less than 10000 rpm) (P33), or if the throttle opening θ TH is returned to less than 15 degrees, for example (P34), the program proceeds to step P50 to execute initialization such that the previous value is set to 0, the present value is set to 1.0, the number of increased injections is set to 0, and the increase flag is set to 0, thus stopping the acceleration increase correction for fuel injection amount.

[0085] Further, if the throttle opening θTH becomes almost full (P35), or if the throttle opening change amount Δ θ TH becomes small (i.e., the change becomes slow) (P36), it is decided that the acceleration has been terminated, and the increase fuel injection amount set in the accelerated condition is stepwise decreased by every preset change amount (P47 to P49), thereby preventing a rapid decrease in fuel injection amount just after termination of acceleration to avoid lack of fuel injection amount.

[0086] While the above preferred embodiment has the configuration of obtaining an injection amount by the map search and controlling an injection time according to the injection amount obtained above, the injection time may be obtained by map search.

[0087] FIG. 16 is a flowchart showing a preferred embodiment of atmospheric pressure correction.

[0088] This preferred embodiment shown in FIG. 16 is intended to ensure performance and improve startability when atmospheric pressure varies. In steps P51 and P52, a low-load atmospheric pressure correction coefficient KpaL and a high-load atmospheric pressure correction coefficient KpaH are respectively calculated by referring to the atmospheric pressure correction coefficient (PA - Kpa) table shown in FIG. 7. In step P53, a starting atmospheric pressure correction coefficient Kpacr is calculated by referring to a starting atmospheric pressure correction coefficient (PA - Kpacr) table.

[0089] FIG. 17 is a graph showing an example of the starting atmospheric pressure correction coefficient Kpacr.

[0090] The starting atmospheric pressure correction

coefficient Kpacr is set to 1.0 at a lowland, and is decreased with a decrease in atmospheric pressure. At a highland where atmospheric pressure is low, a fuel injection amount is decreased with a decrease in fuel amount required by the engine, thereby improving the startability of the engine.

[0091] In step P54, the map designating command 56a is checked. If the intake manifold vacuum (PB) map is designated, the load condition decision threshold PBsud according to a present amount pressure is calculated in step P55, and a load condition is decided according to a present average intake manifold vacuum PBH in step P56. If the engine is in a high-load condition, the high-load atmospheric pressure correction coefficient KpaH is set to the atmospheric pressure correction coefficient Kpa (step P57), whereas if the engine is in a low-load condition, the low-load atmospheric pressure correction coefficient KpaL is set to the atmospheric pressure correction Kpa (step P58).

[0092] In step P59, the bank condition of the engine is checked. If the rear bank (e.g., #1 and #3 cylinders of a V4-engine) is subjected to load, the rear intake manifold vacuum PBR is used to search a second atmospheric pressure correction coefficient table (PB - CPAB table) and calculate a second atmospheric pressure correction coefficient CPAB in step P60. If the front bank (e.g., #2 and #4 cylinders of a V4-engine) is subjected to load, the front intake manifold vacuum PBF is used to search the second atmospheric pressure correction coefficient table (PB - CPAB table) and calculate the second atmospheric pressure correction coefficient CPAB. A back pressure applied to each exhaust port changes with load, and a rate of this change at a highland is different from that at a lowland. Accordingly, the fuel injection amount is corrected by using the second atmospheric pressure correction coefficient CPAB.

[0093] FIG. 18 is a graph showing an example of the second atmospheric pressure correction coefficient CPAB.

[0094] As apparent from FIG. 18, the larger the intake manifold vacuum PB, the larger the second atmospheric pressure correction coefficient CPAB.

[0095] In step P62, the atmospheric pressure correction coefficient Kpa obtained according to the load condition of the engine is multiplied by the second atmospheric pressure correction coefficient CPAB to obtain a total atmospheric pressure correction coefficient KPA.

[0096] If it is decided in step P54 that the throttle (TH) map is used, the starting atmospheric pressure correction coefficient Kpacr is set to the total ' atmospheric pressure correction coefficient KPA in step P63, thereby adjusting the fuel injection amount in using the throttle map according to atmospheric pressure. Accordingly, the performance of the engine can be ensured even at a highland or the like where atmospheric pressure is low. The starting atmospheric pressure correction coefficient Kpacr is used both at starting and in using the throttle map.

[0097] Finally, the total correction coefficient Ktotal is calculated by using the total amount pressure correction coefficient KPA obtained above. Therefore, fuel can be injected in an amount according to the load condition of the engine even when atmospheric pressure varies, so that the engine performance can be ensured in running even at a highland where atmospheric pressure is low. Furthermore, also at starting the engine, the fuel injection amount is controlled according to atmospheric pressure, so that a good startability of the engine can be ensured even at a highland. Further, also in the condition where the basic injection amount is obtained by using the intake manifold vacuum (PB) map, atmospheric pressure correction for injection amount is performed to allow injection of fuel in an amount according to engine load condition. Accordingly, the engine performance can be ensured in running even at a highland where atmospheric pressure is low.

[0098] To perform correction of a fuel injection amount according to atmospheric pressure with a high precision over the whole range from a low-load condition to a high-load condition of an engine even when the engine is a multiple throttle valve type engine.

[0099] In an electronic fuel injection control device for performing ccrrection of a basic fuel injection amount set according to intake manifold vacuum, according to atmospheric pressure, atmospheric pressure correction coefficient setting means 21 includes atmospheric pressure correction coefficient tables 21a and 21b preliminarily storing atmospheric pressure correction coefficients KpaL and KpaH respectively for a low-load condition and a high-load condition, and applicable table selecting means 21c. Load condition deciding means 21d decides an engine load condition according to intake manifold vacuum PB, and the applicable table selecting means 21c selects either the atmospheric pressure correction coefficient KpaL or KpaH according to a decision output 21f from the load condition deciding means 21d. Load condition decision threshold computing means 21e can vary a load condition decision threshold PBsud according to atmospheric pressure PA.

Claims

1. An electronic fuel injection control device (1) of an internal combustion engine (4), performing correction of a basic fuel injection amount (Tout) set according to at least an intake manifold vacuum (PBR, PBF), according to an atmospheric pressure (PA) and according to an atmospheric pressure correction coefficient (Kpa) which varies with a change in said atmospheric pressure (PA); wherein
it further comprises atmospheric pressure correction coefficients (KpaL, KpaH) which vary with a change in said atmospheric pressure (PA), and said atmospheric pressure correction coefficients (KpaL, KpaH) are to be selectively used as the at-

mospheric pressure correction coefficient (Kpa) in accordance with a low-load condition and a high-load condition of said engine (4),

characterized in that whether said engine (4) is in said low-load condition or said high-load condition is decided according to said intake manifold vacuum (PBR, PBF), and a criterion of decision of said low-load condition or said high-load condition varies with a change in said atmospheric pressure (PA).

Patentansprüche

1. Elektronische Kraftstoffeinspritzsteuervorrichtung (1) eines Verbrennungsmotors (4) zur Durchführung einer Korrektur einer Basis-Kraftstoffeinspritzmenge (Tout), die gemäß zumindest einem Ansaugkrümmerunterdruck (PBR, PBF), gemäß einem Atmosphärendruck (PA) und gemäß einem Atmosphärendruck-Korrekturkoeffizienten (Kpa), der mit einer Änderung in dem Atmosphärendruck (PA) variiert, gesetzt ist; worin
sie ferner Atmosphärendruck-Korrekturkoeffizienten (KpaL, KpaH) aufweist, die mit einer Änderung in dem Atmosphärendruck (PA) variieren, und die Atmosphärendruck-Korrekturkoeffizienten (KpaL, KpaH) gemäß einem Niederlastzustand und einem Hochlastzustand des Motors (4) selektiv als der Atmosphärendruck-Korrekturkoeffizient (Kpa) zu verwenden sind,
dadurch gekennzeichnet, dass gemäß dem Ansaugkrümmerunterdruck (PBR, PBF) entschieden wird, ob der Motor (4) in dem Niederlastzustand oder dem Hochlastzustand ist, und ein Entscheidungskriterium des Niederlastzustands oder des Hochlastzustands mit einer Änderung in dem Atmosphärendruck(PA) variiert.

Revendications

1. Dispositif de commande électronique d'injection de carburant (1) d'un moteur à combustion interne (4) effectuant une correction de la quantité de base d'injection de carburant (Tout) fixée conformément à au moins une dépression de collecteur d'admission (PBR, PBF), par rapport à une pression atmosphérique (PA) et conformément à un coefficient de correction de pression atmosphérique (Kpa) qui varie avec un changement de ladite pression atmosphérique (PA),
dans lequel
il comporte en outre des coefficients de correction de pression atmosphérique (KpaL, KpaH) qui varient avec un changement de ladite pression atmosphérique (PA), et lesdits coefficients de correction de pression atmosphérique (KpaL, KpaH) sont utilisés sélectivement en tant que coefficient de correction de pression atmosphérique (Kpa) conformément à un état à faible charge et un état à charge élevée dudit moteur (4),

caractérisé en ce qu'on décide que le moteur
(4) est dans ledit état à faible charge ou ledit état à charge élevée conformément à ladite dépression de collecteur d'admission (PBR, PBF), et un critère de décision dudit état à faible charge ou dudit état à charge élevée varie avec un changement de ladite pression atmosphérique (PA) .

Fig. 1

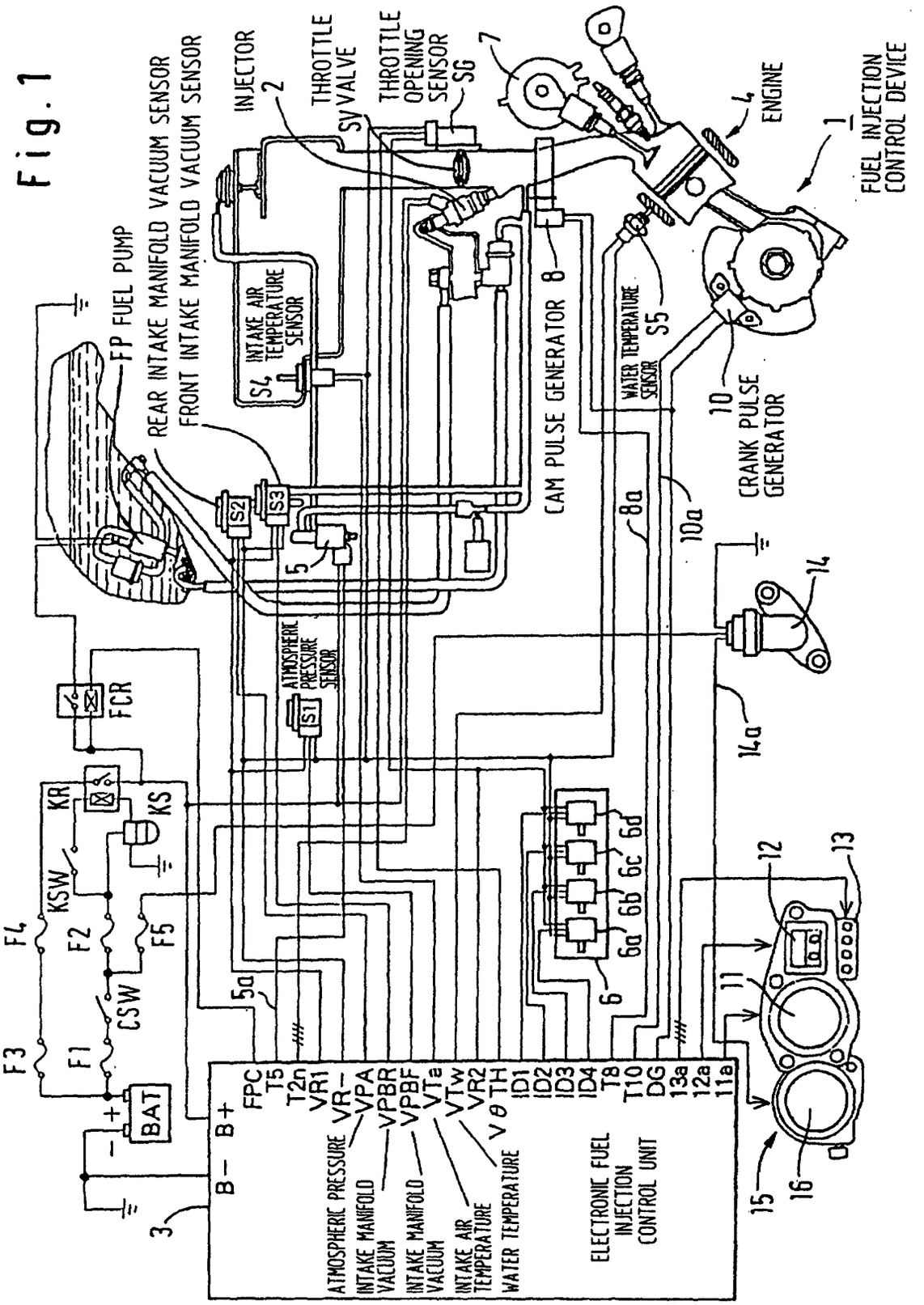

FUEL INJECTION CONTROL DEVICE
ENGINE
THROTTLE OPENING SENSOR SG
THROTTLE VALVE SV
INJECTOR 2
FP FUEL PUMP
REAR INTAKE MANIFOLD VACUUM SENSOR
FRONT INTAKE MANIFOLD VACUUM SENSOR
INTAKE AIR TEMPERATURE SENSOR S4
CAM PULSE GENERATOR 8
WATER TEMPERATURE SENSOR S5
CRANK PULSE GENERATOR 10
ATMOSPHERIC PRESSURE SENSOR S1
FCR
KR
KS
KSW
CSW
BAT
F1
F2
F3
F4
F5
ATMOSPHERIC PRESSURE
INTAKE MANIFOLD VACUUM
INTAKE MANIFOLD VACUUM
INTAKE AIR TEMPERATURE
WATER TEMPERATURE
ELECTRONIC FUEL INJECTION CONTROL UNIT
B+
B-
FPC
T5
T2n
VR1
VR-
VPA
VPBR
VPBF
VTa
VTw
VR2
VθTH
ID1
ID2
ID3
ID4
T8
T10
DG
13a
12a
11a

Fig. 2

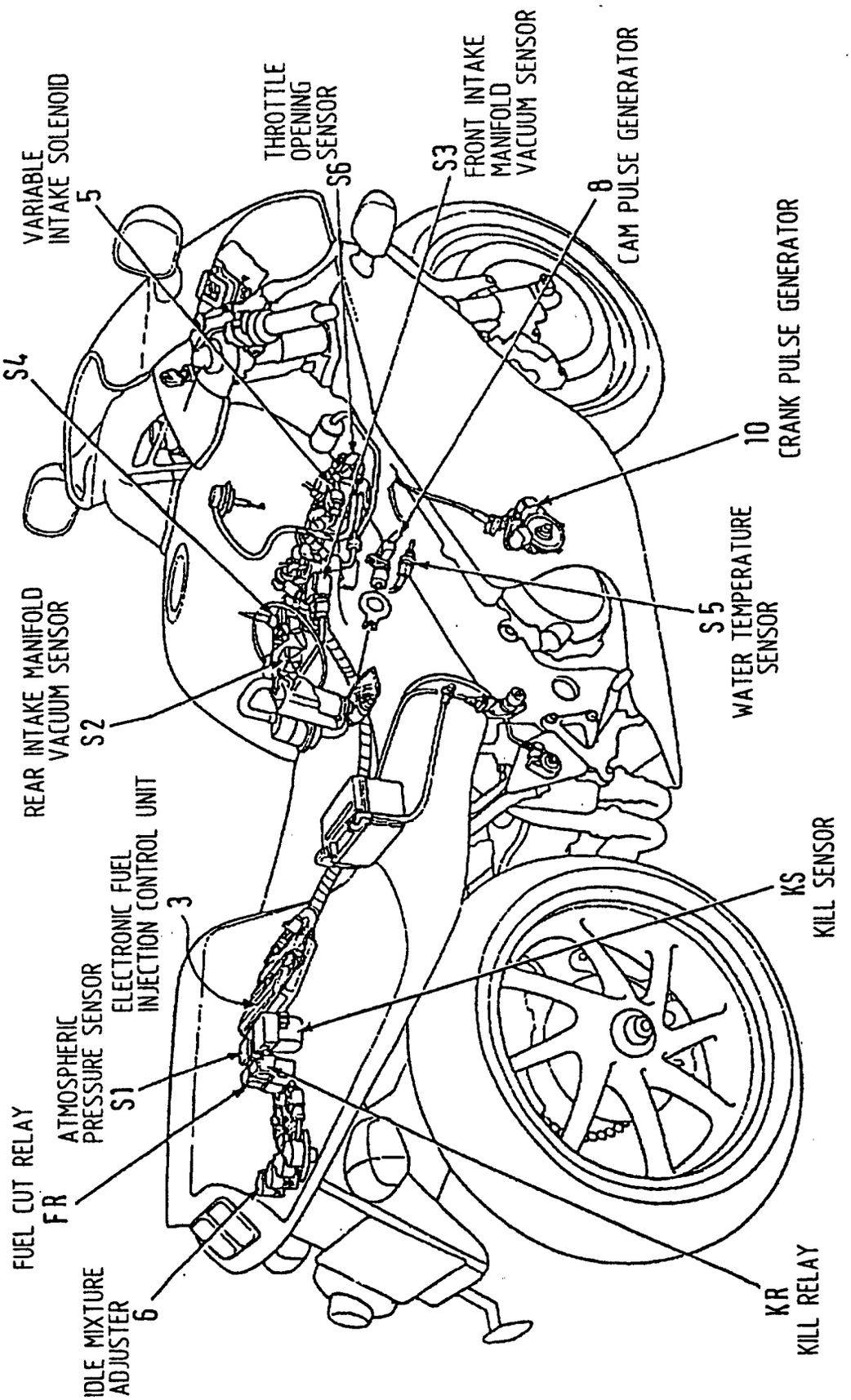

INTAKE AIR TEMPERATURE SENSOR S4
VARIABLE INTAKE SOLENOID 5
THROTTLE OPENING SENSOR S6
S3 FRONT INTAKE MANIFOLD VACUUM SENSOR
8 CAM PULSE GENERATOR
10 CRANK PULSE GENERATOR
S5 WATER TEMPERATURE SENSOR
REAR INTAKE MANIFOLD VACUUM SENSOR S2
ELECTRONIC FUEL INJECTION CONTROL UNIT 3
ATMOSPHERIC PRESSURE SENSOR S1
FUEL CUT RELAY FR
IDLE MIXTURE ADJUSTER 6
KS KILL SENSOR
KR KILL RELAY

Fig.3

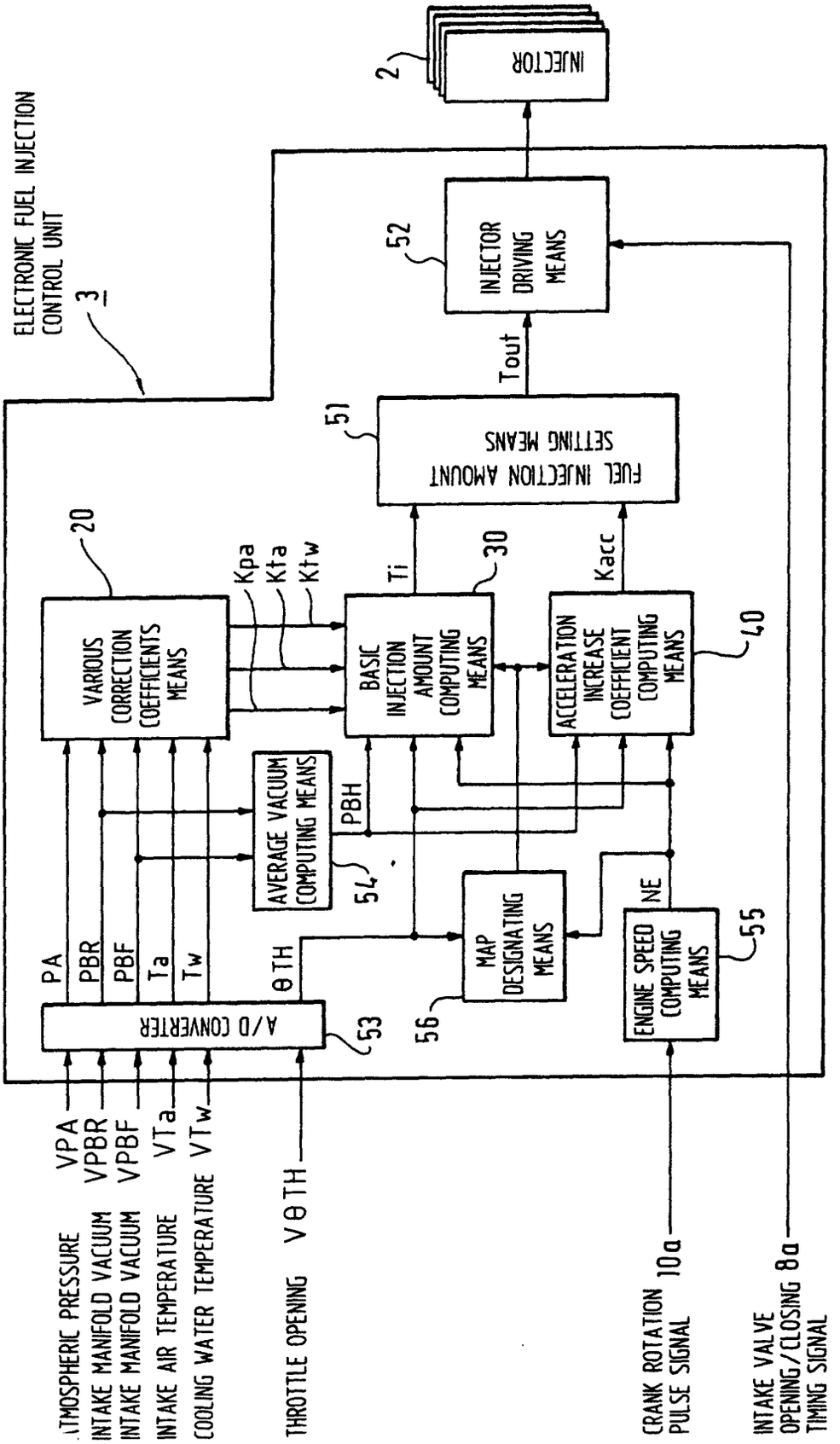

ELECTRONIC FUEL INJECTION CONTROL UNIT
3
INJECTOR
2
INJECTOR DRIVING MEANS
52
Tout
FUEL INJECTION AMOUNT SETTING MEANS
51
VARIOUS CORRECTION COEFFICIENTS MEANS
20
Kpa
Kta
Ktw
Ti
BASIC INJECTION AMOUNT COMPUTING MEANS
30
Kacc
ACCELERATION INCREASE COEFFICIENT COMPUTING MEANS
40
AVERAGE VACUUM COMPUTING MEANS
PBH
54
MAP DESIGNATING MEANS
56
ENGINE SPEED COMPUTING MEANS
NE
55
A/D CONVERTER
53
PA
PBR
PBF
Ta
Tw
θTH
VPA
VPBR
VPBF
VTa
VTw
VθTH
ATMOSPHERIC PRESSURE
INTAKE MANIFOLD VACUUM
INTAKE MANIFOLD VACUUM
INTAKE AIR TEMPERATURE
COOLING WATER TEMPERATURE
THROTTLE OPENING
CRANK ROTATION PULSE SIGNAL
10a
INTAKE VALVE OPENING/CLOSING TIMING SIGNAL
8a

Fig. 4

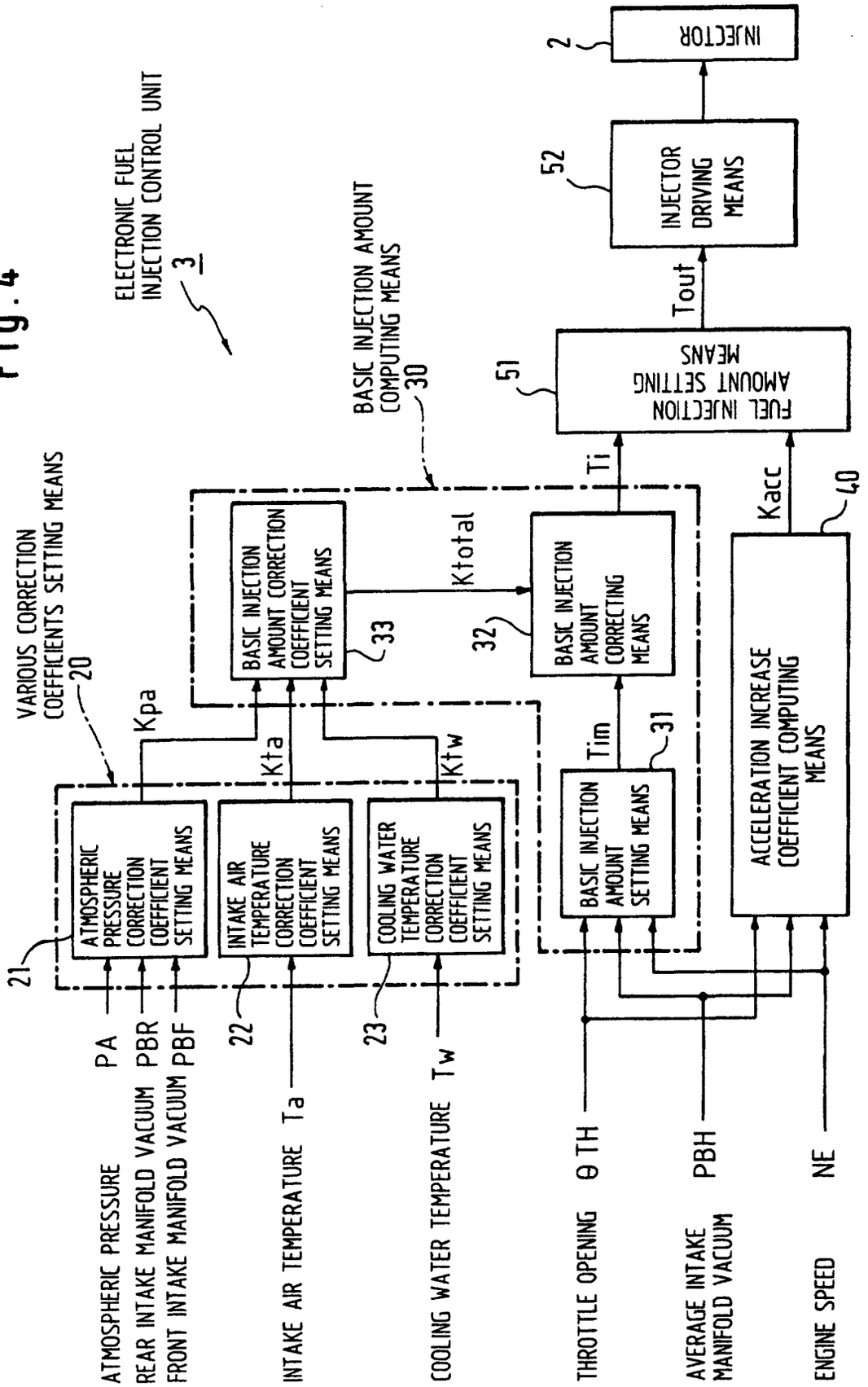

ELECTRONIC FUEL INJECTION CONTROL UNIT
3
VARIOUS CORRECTION COEFFICIENTS SETTING MEANS
20
BASIC INJECTION AMOUNT COMPUTING MEANS
30
ATMOSPHERIC PRESSURE CORRECTION COEFFICIENT SETTING MEANS
INTAKE AIR TEMPERATURE CORRECTION COEFFICIENT SETTING MEANS
COOLING WATER TEMPERATURE CORRECTION COEFFICIENT SETTING MEANS
BASIC INJECTION AMOUNT CORRECTION COEFFICIENT SETTING MEANS
33
BASIC INJECTION AMOUNT CORRECTING MEANS
32
BASIC INJECTION AMOUNT SETTING MEANS
31
ACCELERATION INCREASE COEFFICIENT COMPUTING MEANS
40
FUEL INJECTION AMOUNT SETTING MEANS
51
INJECTOR DRIVING MEANS
52
INJECTOR
2
21
22
23
Kpa
Kta
Ktw
Ktotal
Tim
Ti
Kacc
Tout
PA
PBR
PBF
Ta
Tw
θ TH
PBH
NE
ATMOSPHERIC PRESSURE
REAR INTAKE MANIFOLD VACUUM
FRONT INTAKE MANIFOLD VACUUM
INTAKE AIR TEMPERATURE
COOLING WATER TEMPERATURE
THROTTLE OPENING
AVERAGE INTAKE MANIFOLD VACUUM
ENGINE SPEED

Fig. 5

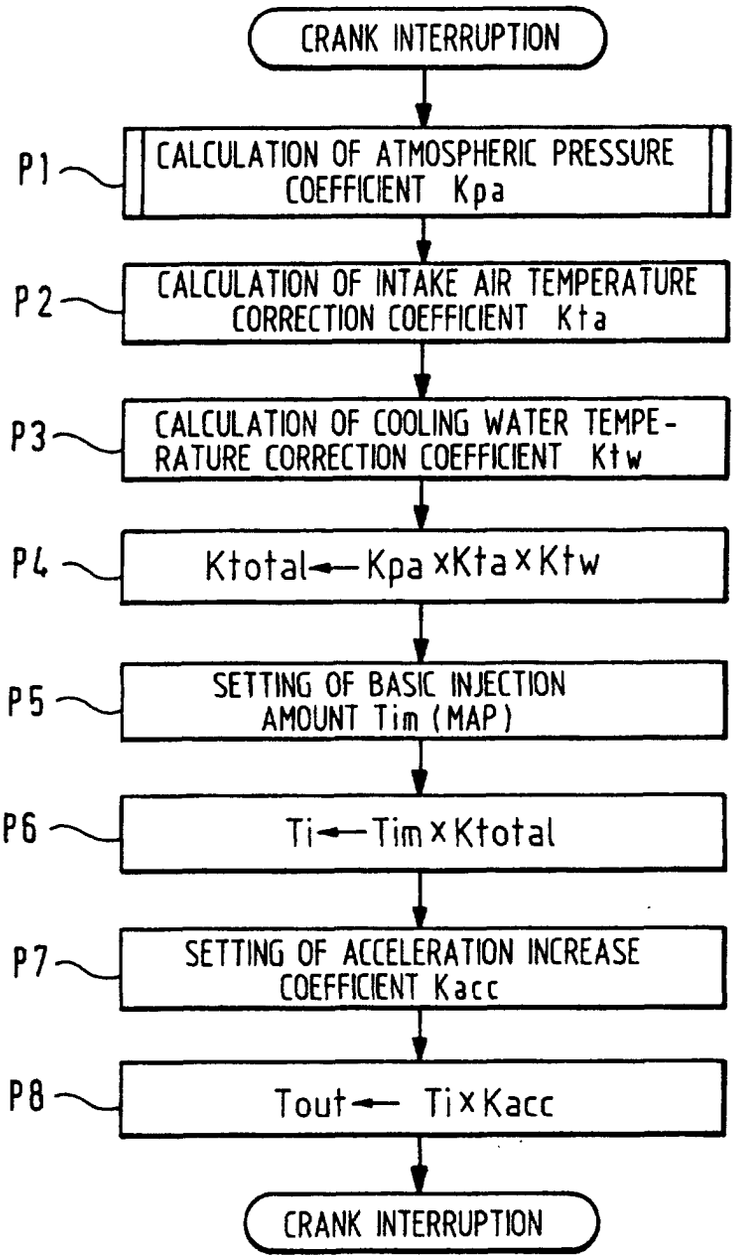

CRANK INTERRUPTION
P1
CALCULATION OF ATMOSPHERIC PRESSURE COEFFICIENT Kpa
P2
CALCULATION OF INTAKE AIR TEMPERATURE CORRECTION COEFFICIENT Kta
P3
CALCULATION OF COOLING WATER TEMPERATURE CORRECTION COEFFICIENT Ktw
P4
Ktotal ← Kpa x Kta x Ktw
P5
SETTING OF BASIC INJECTION AMOUNT Tim (MAP)
P6
Ti ← Tim x Ktotal
P7
SETTING OF ACCELERATION INCREASE COEFFICIENT Kacc
P8
Tout ← Ti x Kacc
CRANK INTERRUPTION

Fig. 6

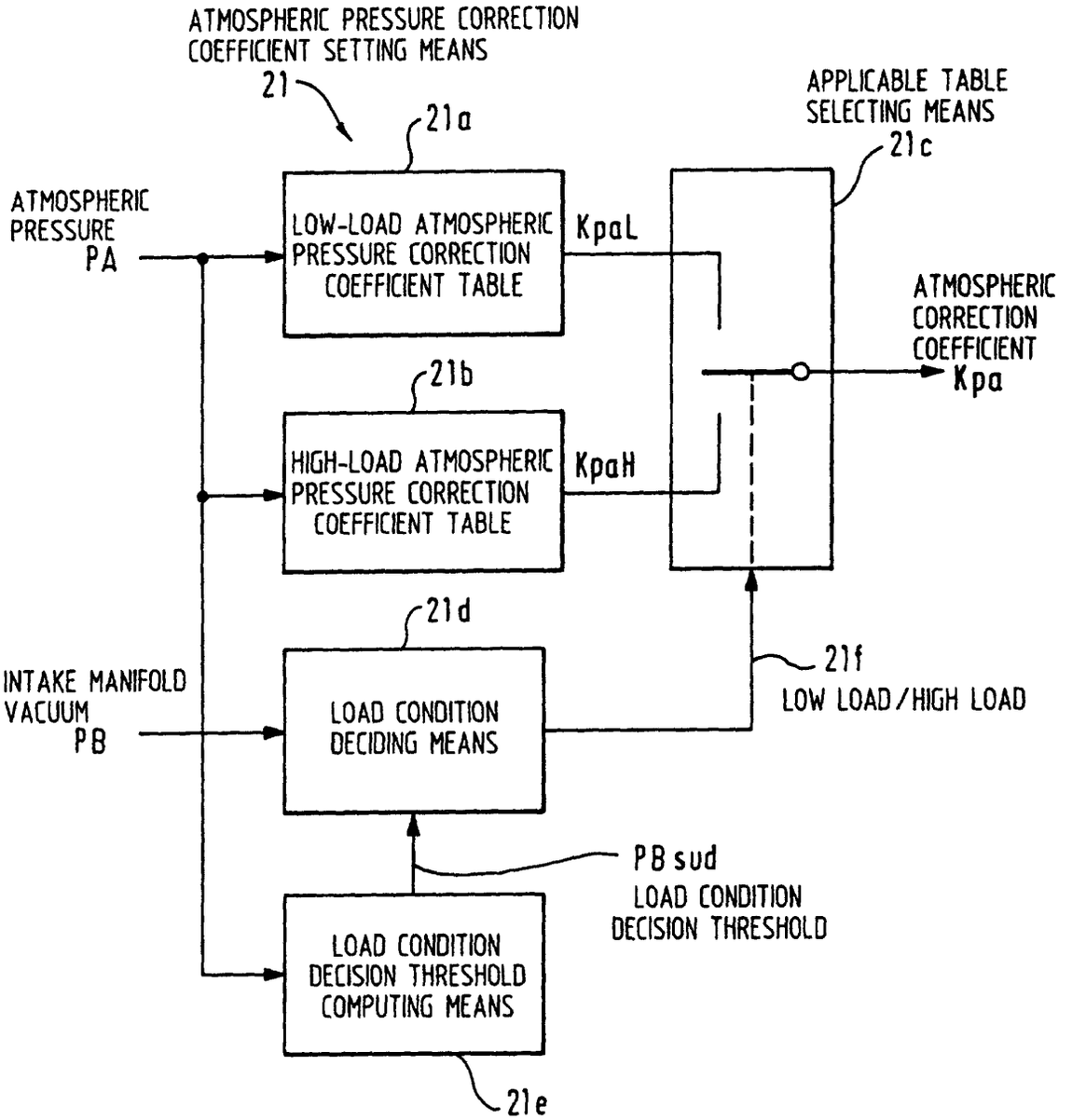

ATMOSPHERIC PRESSURE CORRECTION COEFFICIENT SETTING MEANS
21
21a
APPLICABLE TABLE SELECTING MEANS
21c
ATMOSPHERIC PRESSURE
PA
LOW-LOAD ATMOSPHERIC PRESSURE CORRECTION COEFFICIENT TABLE
KpaL
ATMOSPHERIC CORRECTION COEFFICIENT
Kpa
21b
HIGH-LOAD ATMOSPHERIC PRESSURE CORRECTION COEFFICIENT TABLE
KpaH
21d
INTAKE MANIFOLD VACUUM
PB
LOAD CONDITION DECIDING MEANS
21f
LOW LOAD/HIGH LOAD
PBsud
LOAD CONDITION DECISION THRESHOLD
LOAD CONDITION DECISION THRESHOLD COMPUTING MEANS
21e

Fig. 7

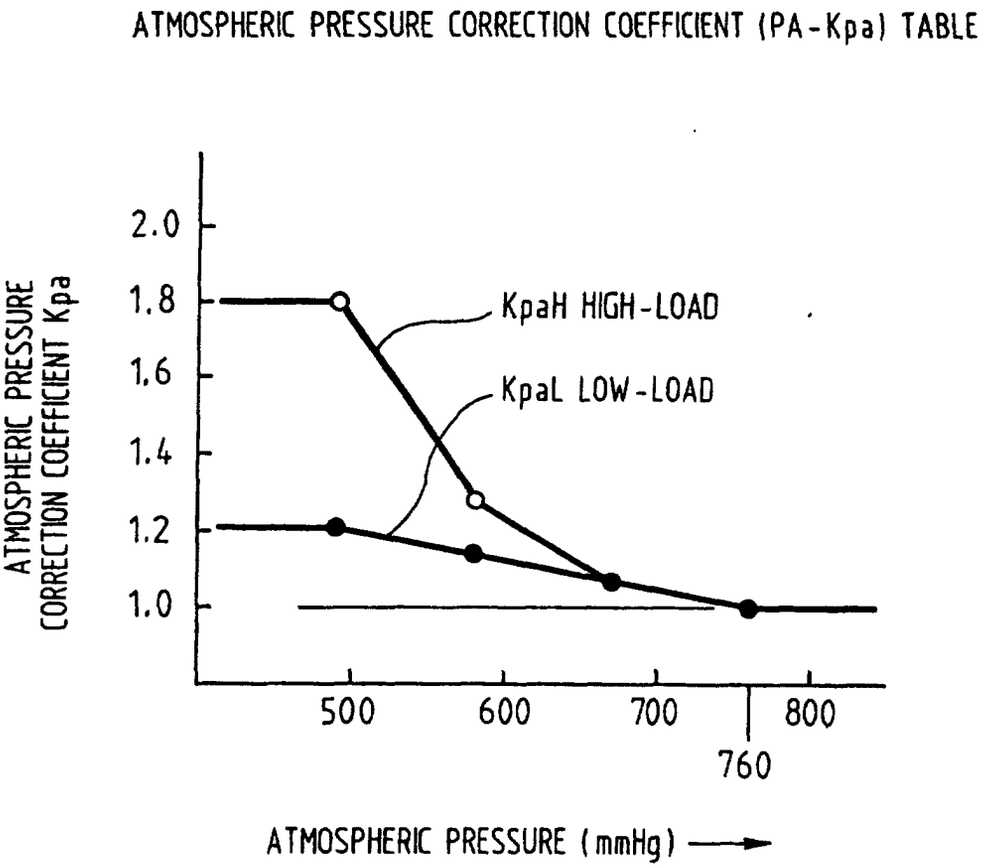

ATMOSPHERIC PRESSURE CORRECTION COEFFICIENT (PA-Kpa) TABLE
ATMOSPHERIC PRESSURE CORRECTION COEFFICIENT Kpa
2.0
1.8
1.6
1.4
1.2
1.0
KpaH HIGH-LOAD
KpaL LOW-LOAD
500
600
700
800
760
ATMOSPHERIC PRESSURE (mmHg)

Fig.8

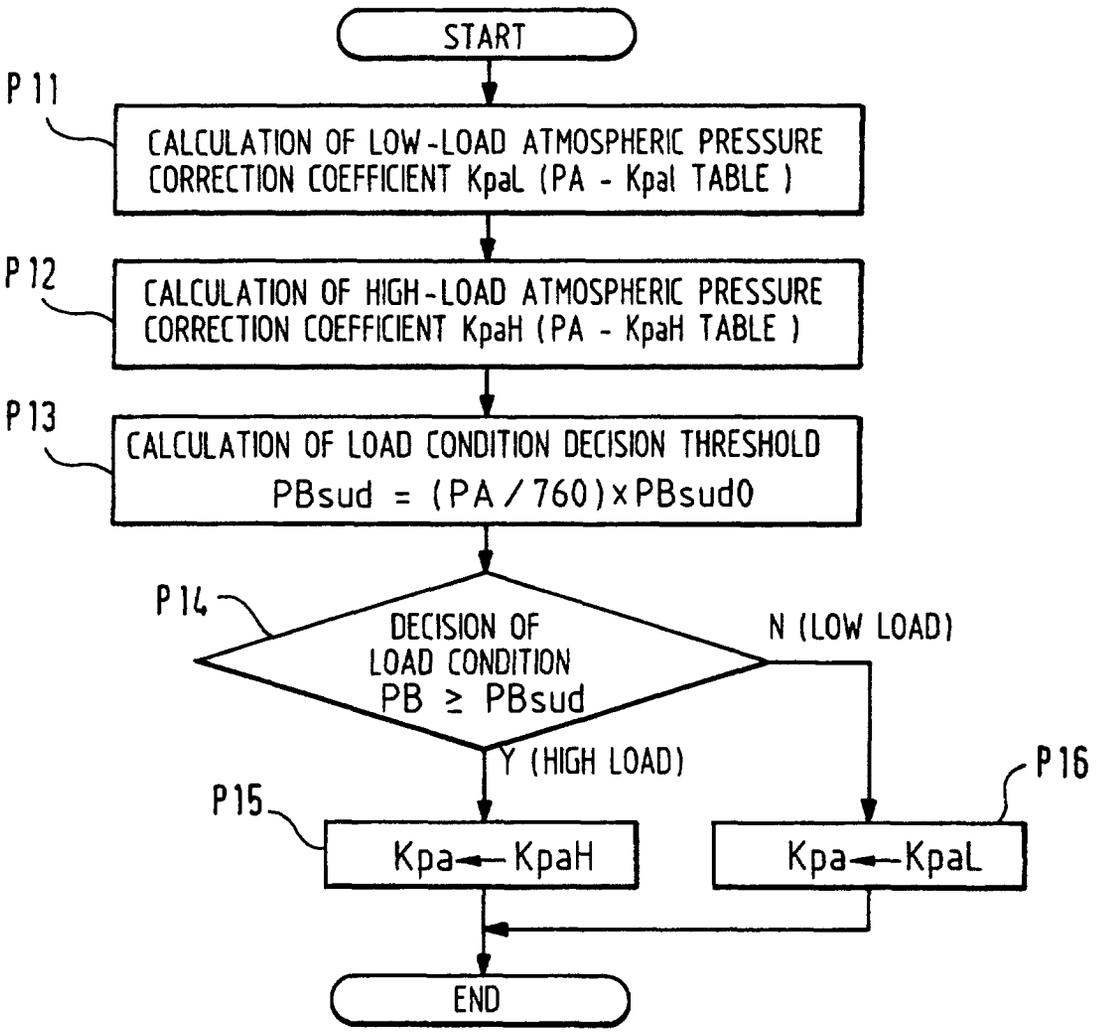

START
P11
CALCULATION OF LOW-LOAD ATMOSPHERIC PRESSURE CORRECTION COEFFICIENT KpaL (PA - Kpal TABLE)
P12
CALCULATION OF HIGH-LOAD ATMOSPHERIC PRESSURE CORRECTION COEFFICIENT KpaH (PA - KpaH TABLE)
P13
CALCULATION OF LOAD CONDITION DECISION THRESHOLD
PBsud = (PA / 760) x PBsud0
P14
DECISION OF LOAD CONDITION
PB ≥ PBsud
N (LOW LOAD)
Y (HIGH LOAD)
P15
Kpa ← KpaH
P16
Kpa ← KpaL
END

Fig. 9

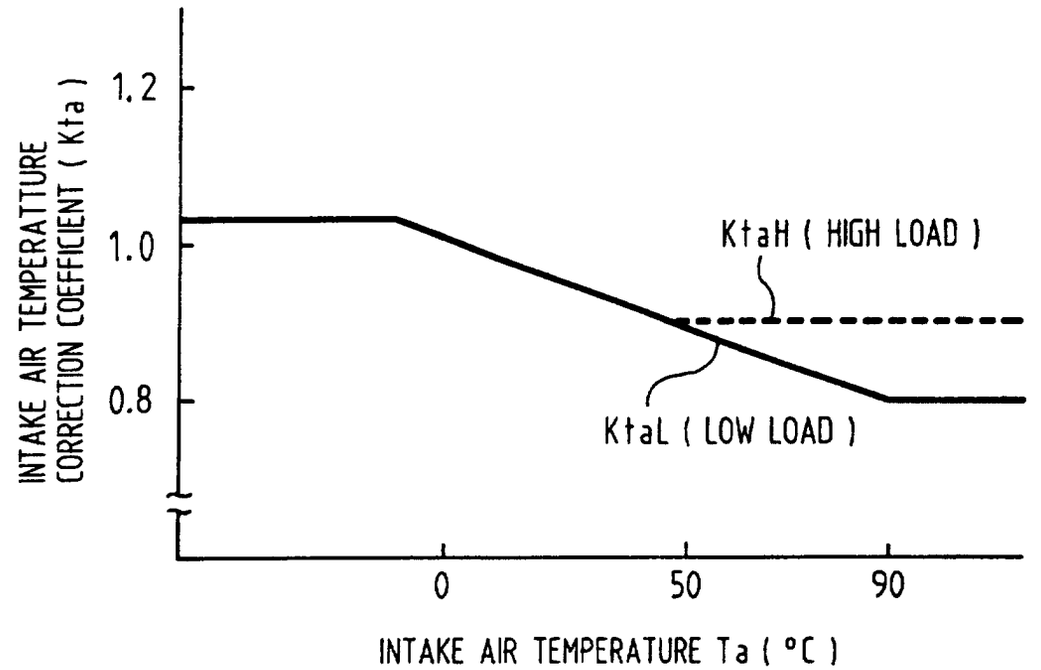

INTAKE AIR TEMPERATTURE CORRECTION COEFFICIENT (Kta)
1.2
1.0
0.8
KtaH (HIGH LOAD)
KtaL (LOW LOAD)
0
50
90
INTAKE AIR TEMPERATURE Ta (°C)

Fig. 10

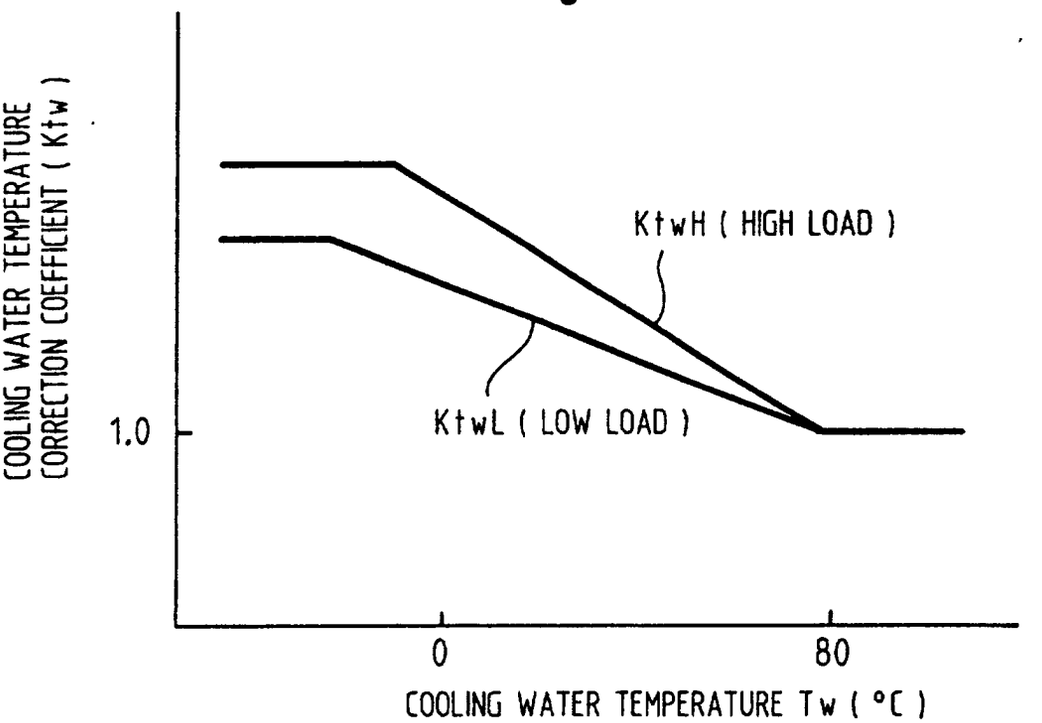

COOLING WATER TEMPERATURE CORRECTION COEFFICIENT (Ktw)
1.0
KtwH (HIGH LOAD)
KtwL (LOW LOAD)
0
80
COOLING WATER TEMPERATURE Tw (°C)

Fig.11

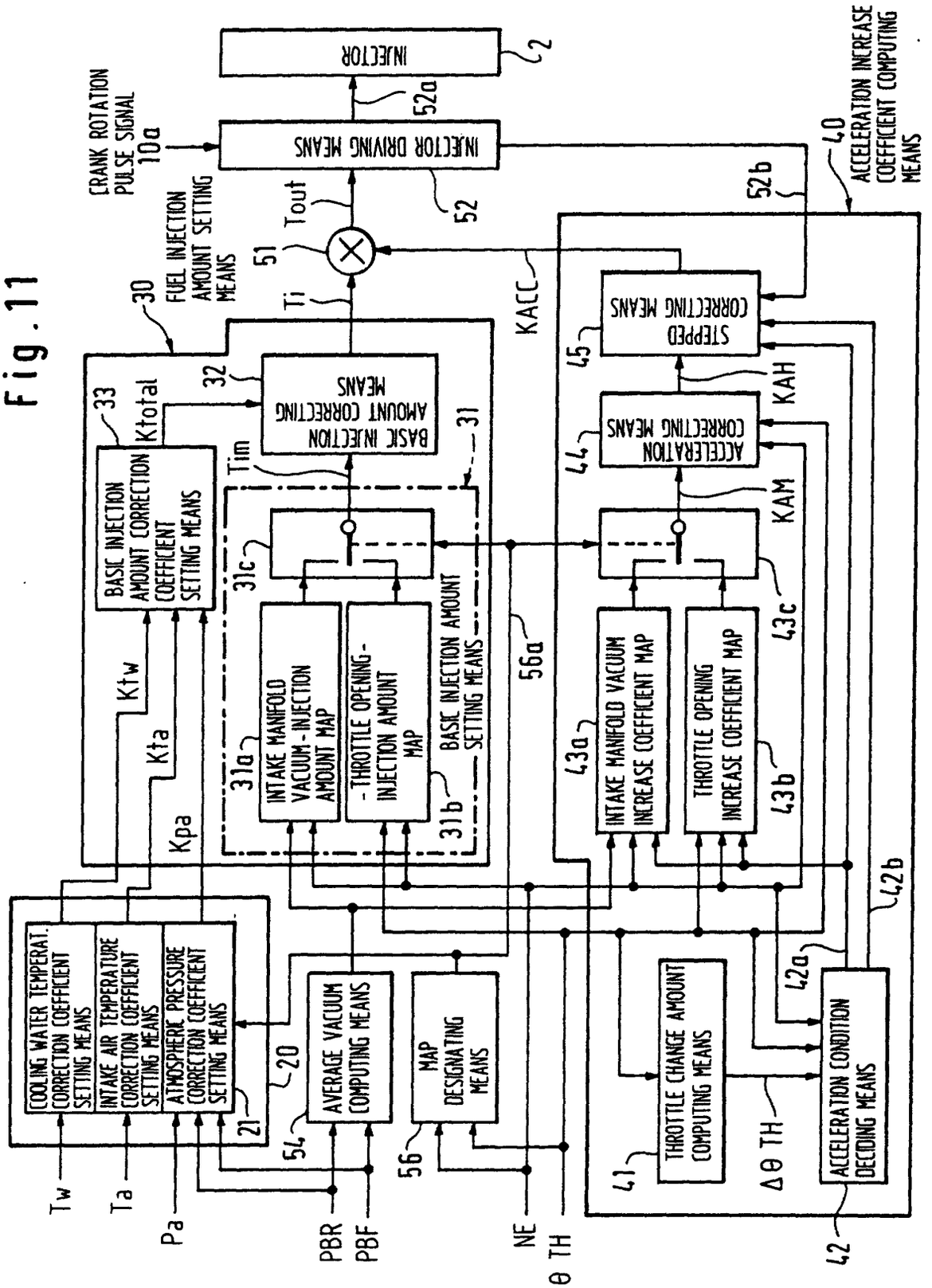

INJECTOR
2
52a
INJECTOR DRIVING MEANS
52
CRANK ROTATION PULSE SIGNAL
10a
FUEL INJECTION AMOUNT SETTING MEANS
30
51
Tout
Ti
52b
40
ACCELERATION INCREASE COEFFICIENT COMPUTING MEANS
KACC
STEPPED CORRECTING MEANS
45
KAH
ACCELERATION CORRECTING MEANS
44
KAM
BASIC INJECTION AMOUNT CORRECTING MEANS
32
31
Tim
Ktotal
33
BASIC INJECTION AMOUNT CORRECTION COEFFICIENT SETTING MEANS
Ktw
Kta
Kpa
31c
31a
INTAKE MANIFOLD VACUUM-INJECTION AMOUNT MAP
31b
-THROTTLE OPENING-INJECTION AMOUNT MAP
BASIC INJECTION AMOUNT SETTING MEANS
56a
43a
INTAKE MANIFOLD VACUUM INCREASE COEFFICIENT MAP
THROTTLE OPENING INCREASE COEFFICIENT MAP
43b
43c
42b
COOLING WATER TEMPERAT. CORRECTION COEFFICIENT SETTING MEANS
INTAKE AIR TEMPERATURE CORRECTION COEFFICIENT SETTING MEANS
ATMOSPHERIC PRESSURE CORRECTION COEFFICIENT SETTING MEANS
21
20
AVERAGE VACUUM COMPUTING MEANS
54
MAP DESIGNATING MEANS
56
THROTTLE CHANGE AMOUNT COMPUTING MEANS
41
42a
ΔθTH
ACCELERATION CONDITION DECIDING MEANS
42
Tw
Ta
Pa
PBR
PBF
NE
θTH

Fig. 12

DESIGNATION OF MAP TO BE USED

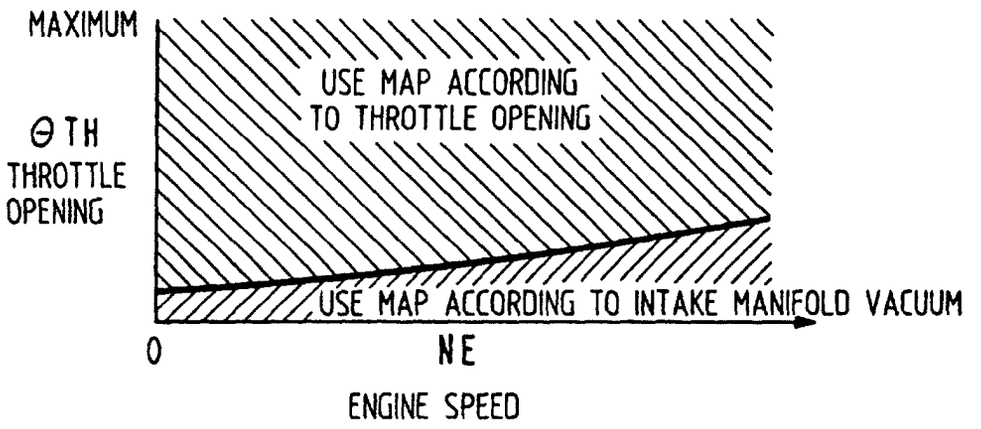


Fig.13

ACCELERATION CORRECTION (CORRECTION OF ACCELERATION INCREASE COEFFICIENT OBTAINED BY MAP SEARCH)

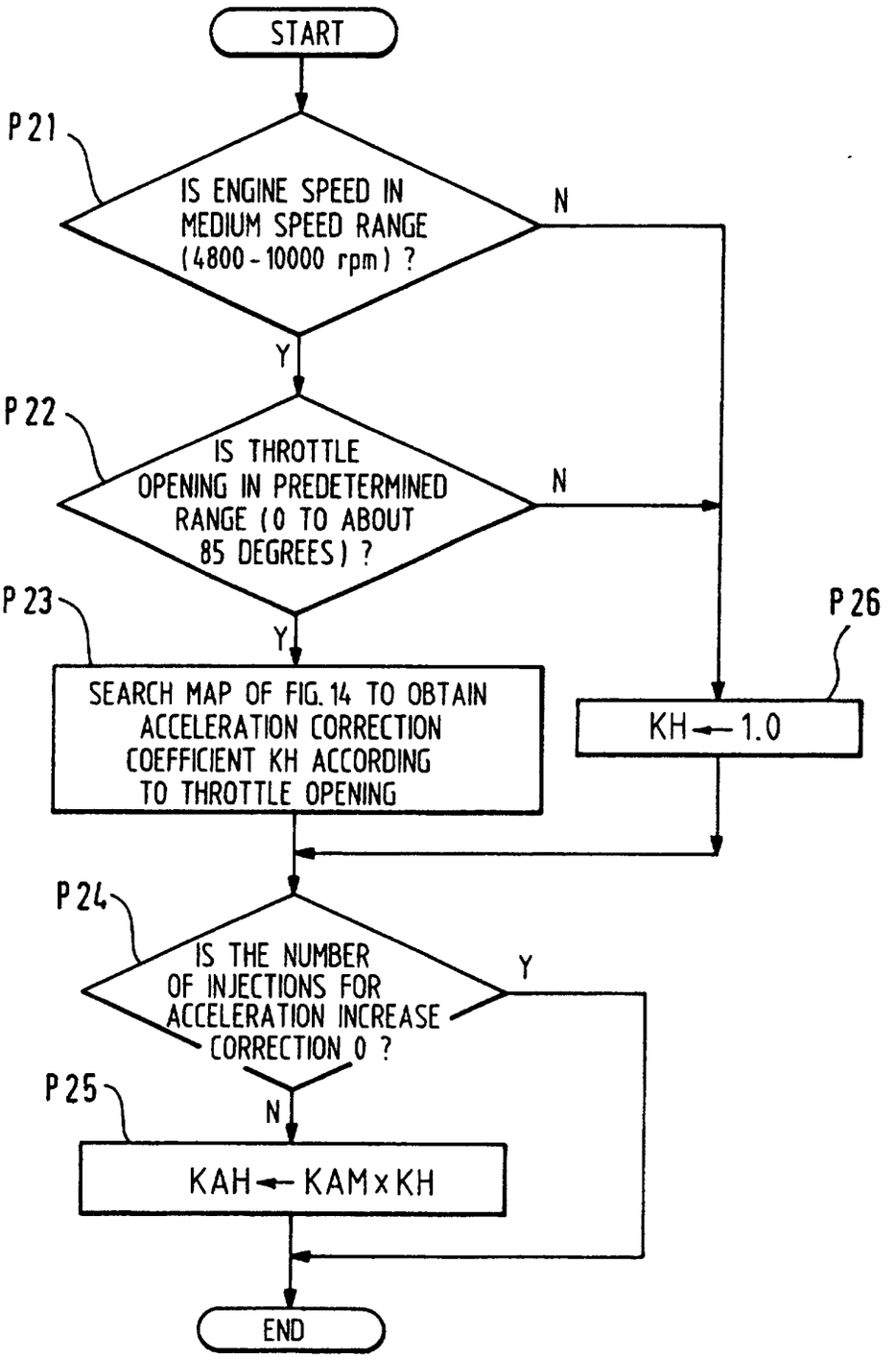


Fig.14

RELATION BETWEEN THROTTLE OPENING
AND CORRECTION COEFFICIENT

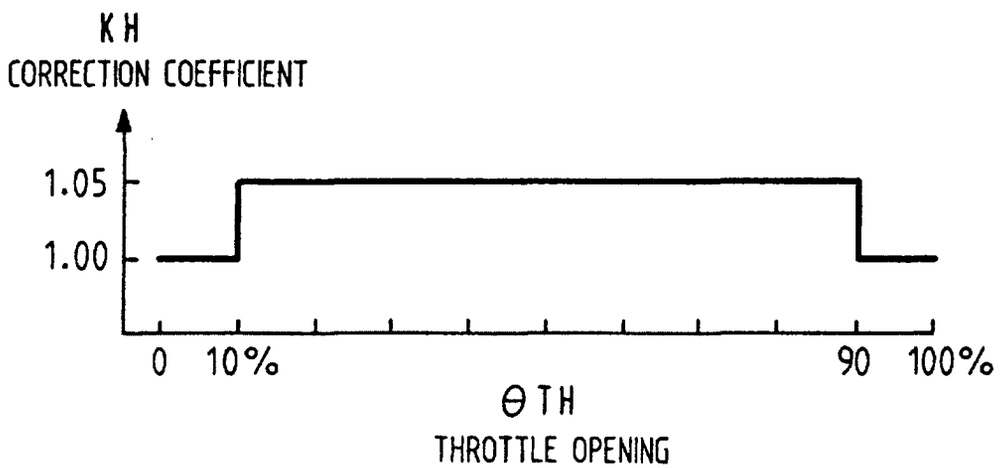


Fig.15

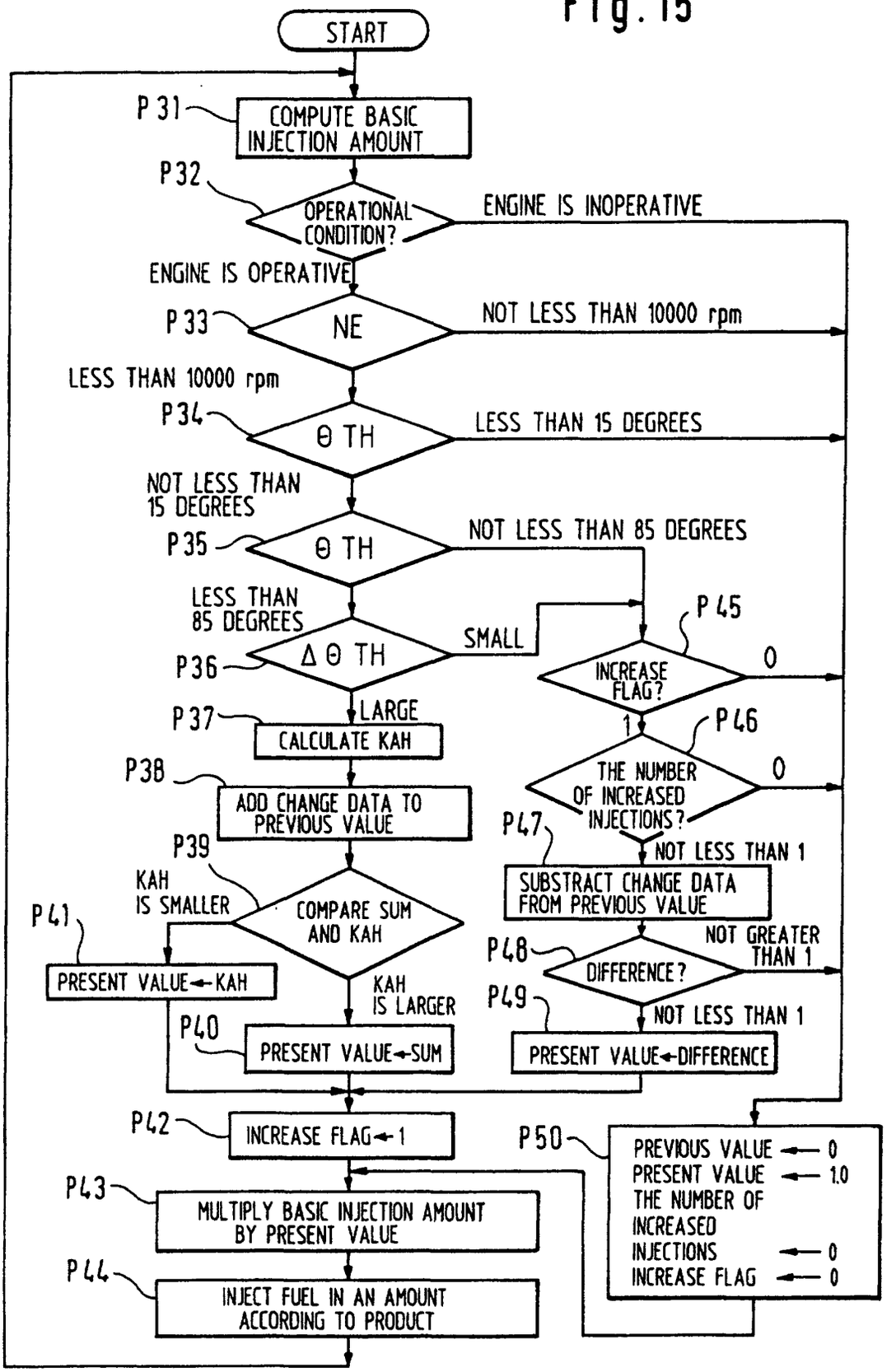

START
P31
COMPUTE BASIC INJECTION AMOUNT
P32
OPERATIONAL CONDITION?
ENGINE IS INOPERATIVE
ENGINE IS OPERATIVE
P33
NE
NOT LESS THAN 10000 rpm
LESS THAN 10000 rpm
P34
θ TH
LESS THAN 15 DEGREES
NOT LESS THAN 15 DEGREES
P35
θ TH
NOT LESS THAN 85 DEGREES
LESS THAN 85 DEGREES
P36
Δ θ TH
SMALL
LARGE
P37
CALCULATE KAH
P38
ADD CHANGE DATA TO PREVIOUS VALUE
P39
KAH IS SMALLER
COMPARE SUM AND KAH
P41
PRESENT VALUE←KAH
KAH IS LARGER
P40
PRESENT VALUE←SUM
P45
INCREASE FLAG?
0
1
P46
THE NUMBER OF INCREASED INJECTIONS?
0
P47
NOT LESS THAN 1
SUBSTRACT CHANGE DATA FROM PREVIOUS VALUE
P48
DIFFERENCE?
NOT GREATER THAN 1
P49
NOT LESS THAN 1
PRESENT VALUE←DIFFERENCE
P42
INCREASE FLAG←1
P43
MULTIPLY BASIC INJECTION AMOUNT BY PRESENT VALUE
P44
INJECT FUEL IN AN AMOUNT ACCORDING TO PRODUCT
P50
PREVIOUS VALUE ← 0
PRESENT VALUE ← 1.0
THE NUMBER OF INCREASED INJECTIONS ← 0
INCREASE FLAG ← 0

Fig. 16

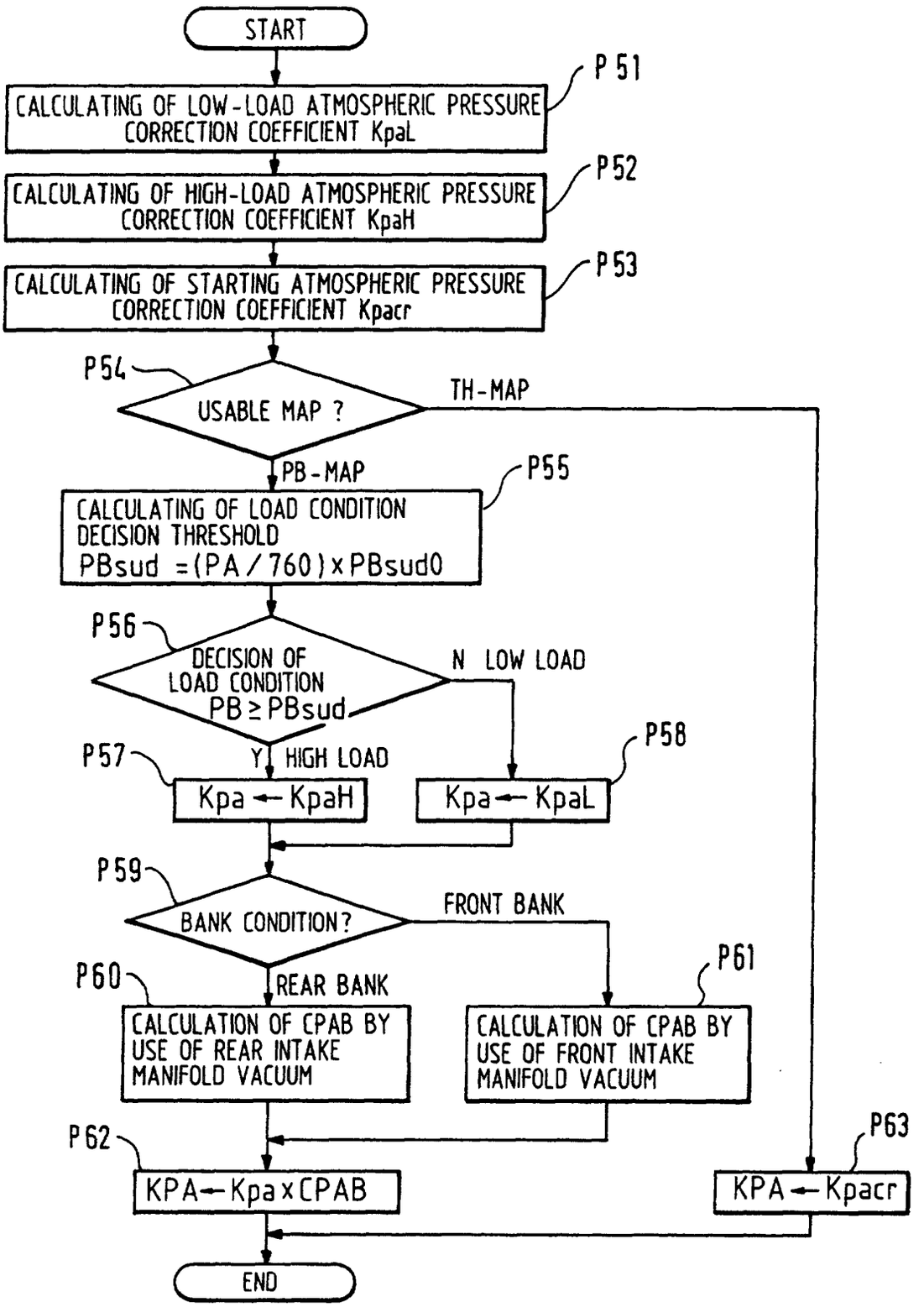

START
P51
CALCULATING OF LOW-LOAD ATMOSPHERIC PRESSURE CORRECTION COEFFICIENT KpaL
P52
CALCULATING OF HIGH-LOAD ATMOSPHERIC PRESSURE CORRECTION COEFFICIENT KpaH
P53
CALCULATING OF STARTING ATMOSPHERIC PRESSURE CORRECTION COEFFICIENT Kpacr
P54
USABLE MAP ?
TH-MAP
PB-MAP
P55
CALCULATING OF LOAD CONDITION DECISION THRESHOLD
PBsud =(PA/760)xPBsud0
P56
DECISION OF LOAD CONDITION
PB≥PBsud
N LOW LOAD
Y HIGH LOAD
P57
Kpa←KpaH
P58
Kpa←KpaL
P59
BANK CONDITION?
FRONT BANK
REAR BANK
P60
CALCULATION OF CPAB BY USE OF REAR INTAKE MANIFOLD VACUUM
P61
CALCULATION OF CPAB BY USE OF FRONT INTAKE MANIFOLD VACUUM
P62
KPA←KpaxCPAB
P63
KPA←Kpacr
END

Fig. 17

STARTING ATMOSPHERIC PRESSURE CORRECTION COEFFICIENT
(PA - Kpacr) TABLE

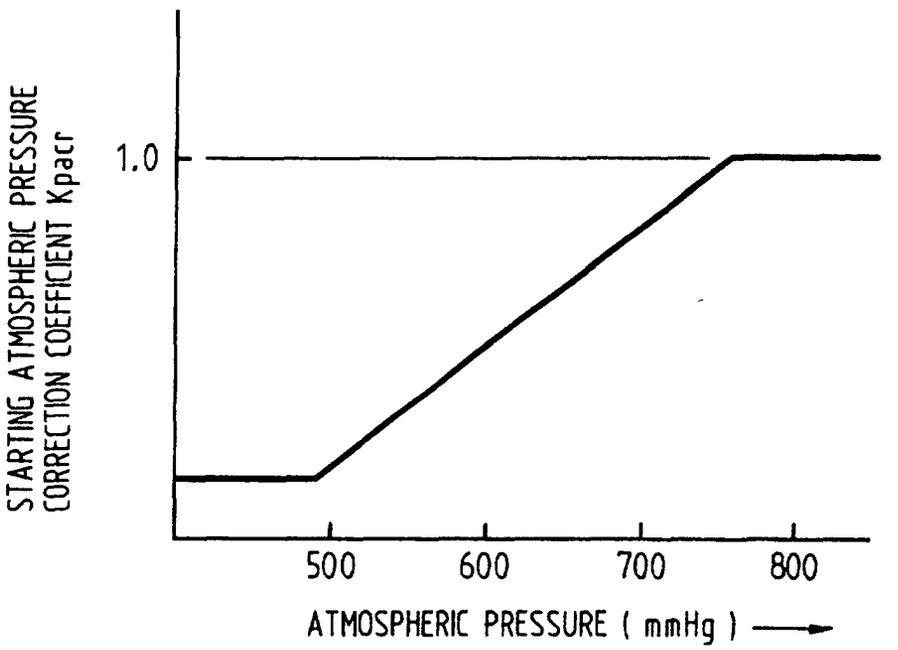


Fig.18

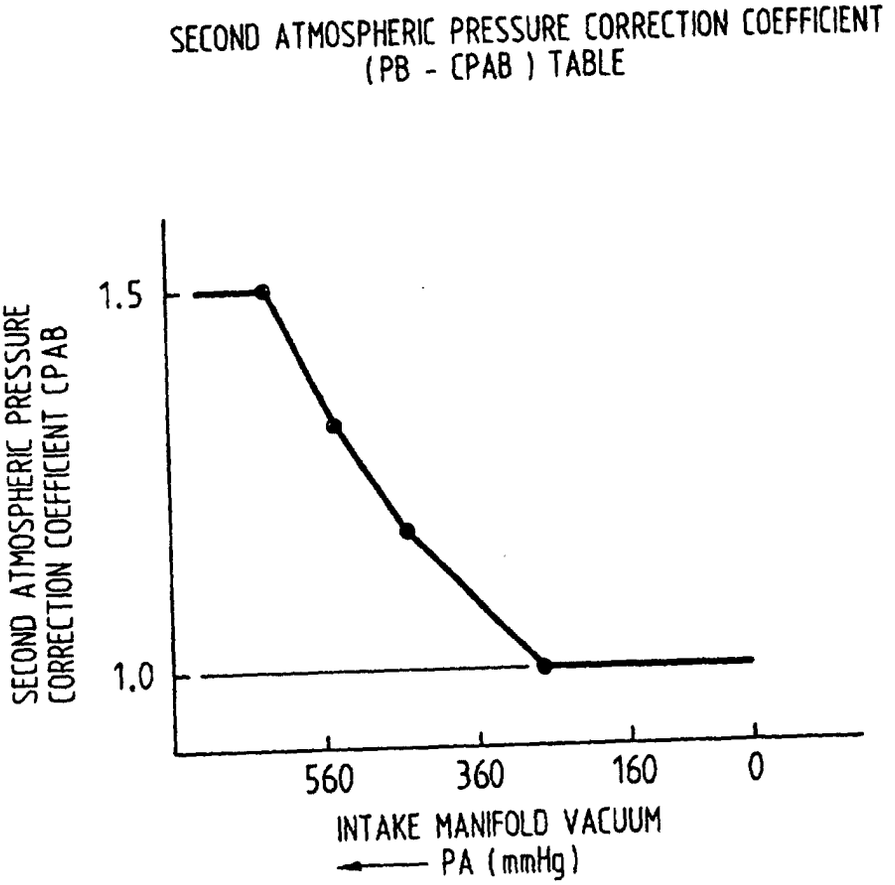
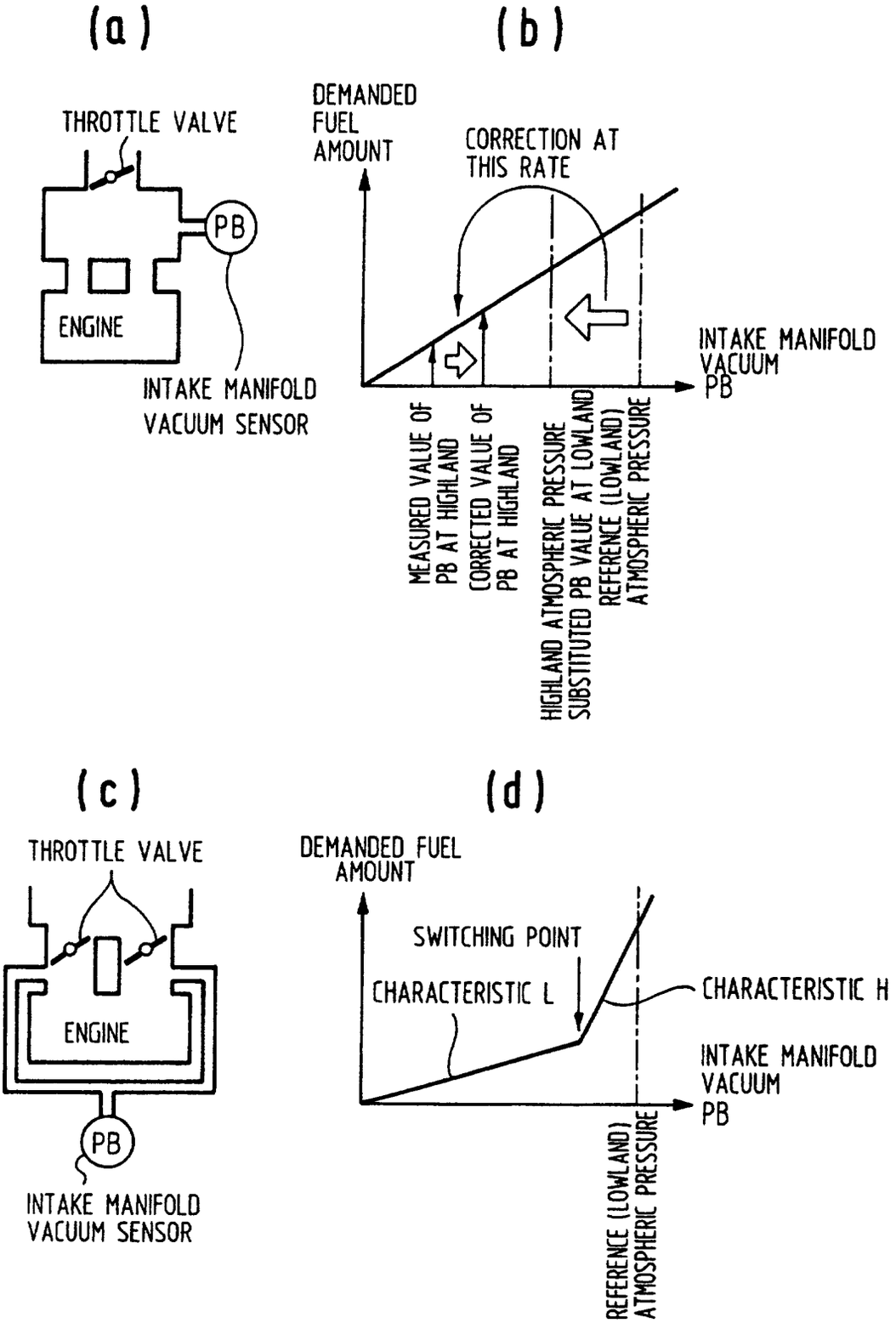

SECOND ATMOSPHERIC PRESSURE CORRECTION COEFFICIENT
(PB - CPAB) TABLE
SECOND ATMOSPHERIC PRESSURE CORRECTION COEFFICIENT CPAB
1.5
1.0
560
360
160
0
INTAKE MANIFOLD VACUUM
PA (mmHg)

Fig.19


(a)
THROTTLE VALVE
PB
ENGINE
INTAKE MANIFOLD VACUUM SENSOR
(b)
DEMANDED FUEL AMOUNT
CORRECTION AT THIS RATE
INTAKE MANIFOLD VACUUM PB
MEASURED VALUE OF PB AT HIGHLAND
CORRECTED VALUE OF PB AT HIGHLAND
HIGHLAND ATMOSPHERIC PRESSURE SUBSTITUTED PB VALUE AT LOWLAND
REFERENCE (LOWLAND) ATMOSPHERIC PRESSURE
(c)
THROTTLE VALVE
ENGINE
PB
INTAKE MANIFOLD VACUUM SENSOR
(d)
DEMANDED FUEL AMOUNT
SWITCHING POINT
CHARACTERISTIC L
CHARACTERISTIC H
INTAKE MANIFOLD VACUUM PB
REFERENCE (LOWLAND) ATMOSPHERIC PRESSURE