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⑤④ **Control method for a fuel injection engine.**

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Description

Background of the invention

The present invention relates to a control method and apparatus for fuel injection engines of the type used in vehicles such as automobiles and more particularly to a fuel injection control method so designed that the film mass deposited on the wall of the intake manifold is estimated and the desired fuel injection quantity is determined on the basis of the estimated film mass.

The fuel injected from the fuel injection valve is partly deposited on the intake manifold wall or the fuel deposited as the film mass is vaporized and fed into each cylinder thus failing to wholly supply the injected fuel into the cylinder and in particular the quantity of fuel supplied to the engine deviates considerably from the fuel quantity required from moment during the engine acceleration or deceleration.

EP—A—0 069 219 discloses a method and apparatus for controlling the fuel injection into an engine, wherein the desired combustion chamber fuel (DFC) is calculated on the basis of a basic fuel amount (BF), a temperature etc. correction coefficient (TCC) and an excess air correction coefficient (EXC) derived from an O₂ sensor.

$$(DFC=BF*TCC*EXC).$$

An interrupt routine is initiated in synchronism with the crankshaft rotation at each fuel injection time to calculate an actual fuel command (AFC) for determining the time the injection valve is opened, by the following steps: The actual amount of fuel (SQF) squirted in through the fuel injection valve for the respective injection pulse is obtained by subtracting from the desired fuel amount (DFC) a fuel sucking-off amount (SOA), i.e. the amount of fuel entrained from fuel adhering to the inner manifold surfaces, and dividing the result by a figure (1-AWC) representing the proportion of the injected fuel that does not get adhered to the manifold wall. Further, the amount of fuel (WF) adhering to the manifold surface is renewed by adding to the previously calculated amount a figure (AWA) representing the amount that gets adhered to the wall, and subtracting therefrom the above figure (SOA) representing the sucking-off amount. The actual valve opening duration (AFC) is finally calculated on the basis of the above figure (SQF), increased by a dead time (DT) of the valve.

It is an object of the present invention to provide a method and apparatus for controlling the fuel injection into an engine more accurately.

The invention meets this object by the method and apparatus characterised in claims 1, 3, respectively.

The invention distinguishes from the prior art in that the amount of fuel to be injected is subjected to the correction derived from an O₂ sensor and that this corrected value is utilized in updating the film mass quantity adhering to the manifold wall and in determining the fuel injection pulse width. The film mass correction control miss is thus also fed back. In contrast, the prior art just introduces the correction value (EXC) in determining the desired amount of fuel (DFC) to be supplied to the engine.

Furthermore, while the prior art performs the various calculations to determine the valve opening time for the fuel injection (AFC) by a subroutine initiated only for each fuel injection time, the method and apparatus of the present invention perform the various calculations on a time basis and use the most recent value to control the engine, thereby again achieving higher accuracy and providing a uniform load on the computer.

Formulas relating to the dynamics of fuel injection in the intake system of an internal combustion engine, taking into account wall wetting without O₂-sensor feedback, have been published in SAE-paper 810495.

Brief description of the drawings

Figure 1A is a schematic diagram showing the construction of a fuel injection control apparatus to which the present invention is applied.

Figure 1B is a flow chart showing the fuel injection control procedure of the computer 1.

Figure 2 is a diagram showing the behavior of the inducted air and fuel in the intake manifold.

Figure 3 is a block diagram of the fuel injection control system.

Figure 4 is a flow chart of the ordinary computing processing and interrupt processing.

Figures 5A to 5C are time charts illustrating the time relationship between the strokes and the cycle periods.

Description of the preferred embodiments

An embodiment of a control method for a fuel injection engine according to the invention will now be described with reference to Figures 1A to 2. Figure 1A illustrates a schematic diagram of a fuel injection control apparatus. In the Figure, the mass of air flow Q_a in the intake manifold of an engine is detected by a hot-wire air flow meter 2 and applied to a computer 1. The computer 1 receives the throttle position θ_{th} from a throttle position sensor 3, the intake manifold pressure P from a manifold pressure sensor 4, the cooling water temperature T_w from a water temperature sensor 5, the engine speed N from a crank angle sensor 6 and a binary signal indicative of a lean or rich mixture from an O₂ sensor 7. The computer 1 directs the desired fuel injection quantity G_f to an injector 8.

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As shown in Figure 1B, at a step 1, the computer 1 calculates the rate of deposition of the fuel injection quantity on the intake manifold wall and the rate of vaporization of the film mass deposited on the intake manifold wall from the following equations (1) and (2), respectively, according to the inputted data. If the deposition rate is represented by X and the vaporization rate by 1/τ, the deposition rate X is simply given for example as a function of the throttle position θth as follows

$$X = 0.3 + \frac{0.7}{90} \theta_{th} \quad (1)$$

On the other hand, the vaporization rate 1/τ is given as a function of the water temperature T_w as follows

$$\frac{1}{\tau} = \frac{9}{5} T_w - 38 \quad (2)$$

Here, it is assumed so that 1/τ = 0.026 when T_w ≤ 23°C.

Then, at a step 102, in accordance with the resulting deposition rate X and vaporization rate 1/τ, the current film mass quantity is calculated from the film mass quantity obtained during the preceding cycle and the actually injected fuel quantity as follows

$$M_f \leftarrow \left(1 - \frac{1}{\tau} \Delta T\right) M_f + X \cdot \Delta T \cdot \overline{G_f \cdot \gamma} \quad (3)$$

where ΔT is the computing cycle period, M_f is the film mass quantity, G_f is the fuel injection quantity and $\overline{G_f \cdot \gamma}$ is the actually injected fuel quantity in terms of the fuel quantity per unit time.

Then, at a step 103, the fuel injection quantity per unit time is determined in accordance with the deposition rate and the film mass quantity in the following manner. The fuel injection quantity of the engine must correspond to the intake air flow and therefore the desired value of the fuel quantity to be supplied to each cylinder is given as follows.

$$G_{fe}^* = \frac{Q_a}{(A/F)} \quad (4)$$

where Q_a is the intake air flow, (A/F) is the desired air-fuel ratio and G_{fe}^{*} is the desired value of the quantity of fuel injected into the engine cylinder. Figure 2 shows the behavior within the intake manifold of the fuel quantity entering the engine cylinder. As shown in the Figure, if G_f represents the injected fuel quantity, X · G_f represents the quantity of the fuel deposited on an intake manifold wall and (1-X)G_f represents the quantity of the fuel supplied to the cylinder without deposition. Also, M_f/τ represents the quantity of fuel supplied to the cylinder by the vaporization of the previously deposited fuel quantity (film mass quantity) on the intake manifold wall. As a result, if the quantity of fuel supplied to the cylinders is represented by G_{fe}, then the following equation holds

$$G_{fe} = (1-X)G_f + \frac{1}{\tau} M_f \quad (5)$$

If the value of G_{fe} is equal to the fuel quantity G_{fe}^{*} to be supplied to the cylinder, the desired air-fuel ratio will be attained. Thus, assuming that the equations (4) and (5) are equal,

$$\frac{Q_a}{(A/F)} = (1-X)G_f + \frac{1}{\tau} M_f \quad (6)$$

Then, it is only necessary to determine the fuel injection quantity G_f such that the above equation holds. Thus, the following equation holds

$$G_f = \frac{\frac{Q_a}{(A/F)} - \frac{1}{\tau} M_f}{1-X} \quad (7)$$

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The equation (7) is obtained as follows. The fuel quantity $Q_a/(A/F)$ to be supplied to the cylinder to attain the desired air-fuel ratio is obtained in accordance with the intake air flow Q_a and the fuel quantity $1/\tau M_f$ to be carried over to the cylinder is obtained in accordance with the vaporization rate $1/\tau$ and the film mass quantity M_f . The fuel quantity $1/\tau M_f$ is subtracted from the fuel quantity $Q_a/(A/F)$ and the difference is divided by the non-deposition rate $(1-X)$ of the injection fuel to be supplied to the cylinder without deposition thereby determining the desired fuel quantity per unit time.

Since the value of G_f obtained at the step 103 is the fuel injection quantity per unit time, it is then converted to a fuel injection pulse width per stroke of the engine at a step 104, as follows

$$T_i = k_i \cdot \frac{G_f}{N} \cdot \gamma + T_s \quad (8)$$

where N is the engine speed, k_i is a coefficient determined by the characteristics of the injector, γ is the feedback correction factor derived from the O_2 sensor signal and T_s is a dead fuel injection time.

The fuel injection pulse width per stroke T_i is renewed at intervals of the computing cycle and therefore the actual fuel injection takes place for the duration of the fuel injection pulse width T_i existing at the time of arrival of an interrupt signal generated for every stroke. Therefore, as the fuel injection quantity data required for the computer to calculate the quantity of film mass during the next cycle, the actual fuel injection pulse width in terms of the following quantity corresponding to the fuel quantity per unit time is fed back

$$\overline{G_f \cdot \gamma} \quad (9)$$

The expression (9) is used during the next computing cycle as shown by the equation (3).

Figure 3 illustrates a block diagram of the fuel injection control system in the computer 1 of Figure 1A. In the Figure, a fuel injection quantity per unit time G_f is calculated by computing means 12 in accordance with the film mass estimated by computing means 13 for estimating the film mass quantity M_f deposited on the intake manifold wall and the mass of air flow. In response to the signal generated from the O_2 sensor 7, computing means 14 calculates an air-fuel ratio feedback correction factor $\gamma = f(O_2)$ aiming at a stoichiometric air fuel ratio. Computing means 11 calculates the quantity of fuel injected per stroke as shown by equation:

$$T_i = k_i \frac{\overline{\gamma \cdot G_f}}{N} + T_s$$

where k_i is a coefficient which is used in the conversion to the fuel injection quantity per stroke and dependent on the injector characteristics and T_s is a dead injection time.

The computing means 13 computes the quantity of film mass in the intake manifold in accordance with equation (3):

$$M_{f_{n+1}} \left(1 - \frac{1}{\tau} \Delta T \right) + X \cdot \Delta T \cdot \overline{\gamma \cdot G_{fn}} \quad (10)$$

Here, the right member M_{fn} represents the film mass quantity for the preceding cycle and the left member $M_{f_{n+1}}$ is the newly estimated film mass quantity. Also, $1/\tau$ represents the rate of vaporization of the film mass and X represents the rate of fuel deposition on the intake manifold wall to the injected fuel quantity (referred to as a deposition rate). Represented by ΔT is one cycle period of the computation by the blocks of Figure 3. Thus, the following in the right member represents the quantity of fuel delivered to the cylinder by the vaporization of the film mass during one cycle period

$$\frac{1}{\tau} \Delta T M_f \quad (11)$$

Also, of the quantity of fuel actually injected per unit time the quantity of fuel deposition during the cycle period is given by the second term of the right member in the equation (11) or the following expression

$$X \cdot \Delta T \cdot \overline{\gamma \cdot G_f} \quad (12)$$

While a description will be made later of $\overline{\gamma \cdot G_f}$ in consideration of the time relationship between the time per stroke and the cycle period of computation, the fuel injection quantity per unit time $\overline{\gamma \cdot G_f}$ resulting from the integration of the feedback correction factor γ represents the quantity of fuel injected per unit time

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which is renewed in response to the application of a stroke start signal from the crank angle sensor. While the deposition rate X and the vaporization rate $1/\tau$ (τ is a vaporization time constant) are obtained by experiments in accordance with the throttle position θ th, the water temperature T_w , the manifold pressure P , the mass air flow Q_a , etc., in this embodiment the deposition rate X is given as a function of the throttle position for purposes of simplicity, as in equation (1):

$$X = 0.3 + \frac{0.7}{90} \theta \text{th}$$

Also, the vaporization rate is given as a function of the water temperature as in equation (2)

$$\frac{1}{\tau} = \frac{1}{60} \left(\frac{9}{5} T_w - 38 \right)$$

Here, it is assumed that $1/\tau = 0.0566$ when $T_w \leq 23^\circ\text{C}$.

As described hereinabove, a feature of the construction of the control system resides, as will also be seen from Figure 3, in the fact that the feedback loop for feeding back the correction factor γ in response to the O_2 sensor signal and the loop of the fuel injection quantity $\gamma \cdot G_f$ for calculating the deposited quantity or the deposited part of the injected fuel overlap doubly.

Next, the timing of the injection per stroke and the timing of the computing cycle will be described. The computational operations shown in Figure 3 are performed at intervals of a given period T and the injection pulse width is renewed by injection timing adjusting means 16 of Figure 3 at a step 31 of Figure 4 for every period. The actual injection is initiated by an interrupt signal INT generated for every stroke. As a result, the fuel is actually injected for the duration of the most lately calculated injection pulse width T_i as shown in Figures 5A to 5C. Figures 5A to 5C respectively show interrupt signals each generated for every stroke, injection pulse widths and calculated $\gamma \cdot G_f$ with the lapse of time. In accordance with the embodiment, when an interrupt signal is applied, the timely existing $\gamma \cdot G_f$ is stored in a $\gamma \cdot G_f$ memory. This operation is performed by injection synchronizing means 15 of Figure 3 and its timing corresponds to the application of the interrupt signal as shown at a step 32 of Figure 4. By performing these operations, the actually injected fuel quantity is fed back and used for the accurate estimation of the quantity of film mass.

In accordance with the present invention, the occurrence of lean spikes during the engine acceleration and the occurrence of rich spikes during the engine deceleration are eliminated as compared with the conventional method in which a basic fuel injection quantity is determined in accordance with the flow of intake air. This has the effect of improving the engine performance during the acceleration and ensuring effective removal of the harmful gases during the deceleration. Thus, it is possible to reduce the amount of the three-way catalyst by this method making it also effective economically. Further, while it has been necessary in the past to prepare various memory maps for providing acceleration and deceleration corrections on the basis of changes in the throttle position, etc., and search for the corresponding map values, in accordance with the present invention the desired acceleration and deceleration corrections can be provided by matching only the deposition rate of the fuel injection and the vaporization rate of the film mass in accordance with the acceleration and deceleration air-fuel ratios and thus the invention has the effect of providing more efficient manufacturing steps.

Further, in accordance with the invention, by virtue of the fact that the quantity of the film mass deposited on the intake manifold wall is estimated by newly estimating the film mass quantity by using the actually injected fuel quantity, it is possible to estimate an accurate film mass quantity closer to the actual film mass quantity. By using the method which determines the desired fuel injection quantity in consideration of such estimated film mass, the air-fuel ratio of the mixture supplied to the engine can be controlled at around the stoichiometric air-fuel ratio even during the engine acceleration and deceleration. Thus, the invention has the effect of improving the exhaust gas purification and the engine performance.

Claims

1. A method for controlling the fuel injection into an engine, wherein the following steps are performed in each one of successive computing cycles:

(a) determining a current fuel injection quantity G_{fn} per engine stroke according to the formula

$$G_{fn} = \frac{G_{fen} - 1/\tau \cdot M_{fn}}{1 - X}$$

wherein

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G_{fen} =desired fuel quantity to be supplied to the engine (10),
 $1/\tau \cdot M_{fn}$ =fuel quantity vaporizing from a film mass quantity M_{fn} deposited on the intake manifold wall (21),

- 5 X=portion of the injected fuel quantity G_{fn} which deposits on said wall (21),
 (b) calculating a fuel injection quantity feedback correction factor γ aiming at a stoichiometric air-fuel ratio A/F based on a signal generated by an O_2 sensor (7),
 (c) determining a fuel injection pulse width T_i according to the formula

$$10 \quad T_i = k_i \cdot \gamma \cdot G_{fn} \cdot \frac{1}{N} + T_s$$

wherein

- k_i =coefficient dependent on the characteristics of the injector (8),
 $\gamma \cdot G_{fn}$ =actual fuel injection quantity G_{fn} corrected by said factor γ ,
 15 N=engine speed,
 T_s =fuel injection dead time,

(d) determining the film mass quantity M_{fn+1} for the subsequent computing cycle according to the formula

$$20 \quad M_{fn+1} = \left(1 - \frac{1}{\tau} \cdot \Delta T\right) M_{fn} + X \cdot \Delta T \cdot \gamma \cdot G_{fn}$$

wherein

- 25 ΔT =computing cycle period.
 2. The method of claim 1, wherein the fuel quantity actually injected into said engine (10) is that current fuel injection quantity G_{fn} which has been determined in the last computing cycle preceding the injection time point.

3. An apparatus for controlling the fuel injection into an engine, comprising
 30 (a) means (12) for determining a current fuel injection quantity G_{fn} per engine stroke according to the formula

$$35 \quad G_{fn} = \frac{G_{fen} - 1/\tau \cdot M_{fn}}{1 - X}$$

wherein

- G_{fen} =desired fuel quantity to be supplied to the engine (10),
 $1/\tau \cdot M_{fn}$ =fuel quantity vaporizing from a film mass quantity M_{fn} deposited on the intake manifold wall (21),

- 40 X=portion of the injected fuel quantity G_{fn} which deposits on said wall (21),
 (b) means (14) for calculating a fuel injection quantity feedback correction factor γ aiming at a stoichiometric airfuel ratio A/F based on a signal generated by an O_2 sensor (7),
 (c) means (11) for determining a fuel injection pulse width T_i according to the formula

$$45 \quad T_i = k_i \cdot \gamma \cdot G_{fn} \cdot \frac{1}{N} + T_s$$

50 wherein

- k_i =coefficient dependent on the characteristics of the injector (8),
 $\gamma \cdot G_{fn}$ =actual fuel injection quantity G_{fn} corrected by said factor γ ,
 N=engine speed,
 T_s =fuel injection dead time,

- 55 (d) means (13) for determining the film mass quantity M_{fn+1} for the subsequent computing cycle according to the formula

$$60 \quad M_{fn+1} = \left(1 - \frac{1}{\tau} \cdot \Delta T\right) M_{fn} + X \cdot \Delta T \cdot \gamma \cdot G_{fn}$$

wherein

- ΔT =computing cycle period,
 wherein said means (a) to (d) are adapted to perform their functions sequentially and repeatedly in
 65 each one of successive computing cycles.

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4. The apparatus of claim 3, including means (16) for converting said current fuel injection quantity G_{fn} into a width value of a fuel injection pulse applied to said injector (8).

Patentansprüche

5

1. Verfahren zur Steuerung der Kraftstoffeinspritzung in einen Motor, wobei in jedem von aufeinanderfolgenden Rechenzyklen die folgenden Schritte durchgeführt werden:

(a) Bestimmen einer momentanen Kraftstoff-Einspritzmenge G_{fn} pro Maschinentakt nach der Formel

10

$$G_{fn} = \frac{G_{fen} - 1/\tau \cdot M_{fn}}{1 - X}$$

wobei

15

G_{fen} = die dem Motor (10) zuzuführende Kraftstoff-Sollmenge,

$1/\tau \cdot M_{fn}$ = die Kraftstoffmenge, die von einer an der Wand (21) der Ansaugleitung niedergeschlagenen Filmmenge M_{fn} verdampft,

X = Anteil der eingespritzten Kraftstoffmenge G_{fn} , der an der besagten Wand (21) niederschlägt,

20

(b) Berechnen eines Rückkopplungs-Korrekturfaktors γ für die Kraftstoff-Einspritzmenge mit dem Ziel eines stöchiometrischen Luft/Kraftstoff - Verhältnisses A/F aufgrund eines von einem O_2 -Fühler (7) erzeugten Signals,

(c) Bestimmen einer Kraftstoffeinspritz-Impulsbreite T_i nach der Formel

25

$$T_i = k_i \cdot \gamma \cdot G_{fn} \cdot \frac{1}{N} + T_s$$

wobei

30

k_i = ein von den Eigenschaften der Einspritzeinrichtung (8) abhängiger Koeffizient,

$\gamma \cdot G_{fn}$ = die um den Faktor γ korrigierte Kraftstoffeinspritz - Istmenge G_{fn} ,

N = Motordrehzahl,

T_s = Kraftstoffeinspritz-Totzeit,

(d) Bestimmen der Filmmenge M_{fn+1} für den anschließenden Rechenzyklus nach der Formel

35

$$M_{fn+1} = \left(1 - \frac{1}{\tau} \cdot \Delta T\right) M_{fn} + X \cdot \Delta T \cdot \gamma \cdot G_{fn}$$

wobei

40

ΔT = Periode des Rechenzyklus.

2. Verfahren nach Anspruch 1, wobei die in den Motor (10) eingespritzte Kraftstoff - Istmenge diejenige momentane Kraftstoff - Einspritzmenge G_{fn} ist, die in dem letzten, dem Einspritz - Zeitpunkt vorangehenden Rechenzyklus bestimmt worden ist.

3. Vorrichtung zur Steuerung der Kraftstoffeinspritzung in einen Motor, umfassend

45

(a) eine Einrichtung (12) zum Bestimmen einer momentanen Kraftstoff-Einspritzmenge G_{fn} pro Motortakt nach der Formel

50

$$G_{fn} = \frac{G_{fen} - 1/\tau \cdot M_{fn}}{1 - X}$$

wobei

55

G_{fen} = die dem Motor (10) zuzuführende Kraftstoff-Sollmenge,

$1/\tau \cdot M_{fn}$ = die Kraftstoffmenge, die von einer an der Wand (21) der Ansaugleitung niedergeschlagenen Filmmenge M_{fn} verdampft,

X = Anteil der eingespritzten Kraftstoffmenge G_{fn} , der an der besagten Wand (21) niederschlägt,

(b) eine Einrichtung (14) zum Berechnen eines Rückkopplungs - Korrekturfaktors γ der Kraftstoff - Einspritzmenge mit dem Ziel eines stöchiometrischen Luft/Kraftstoff - Verhältnisses A/F aufgrund eines von einem O_2 -Fühler (7) erzeugten Signals

60

(c) eine Einrichtung (11) zum Bestimmen einer Kraftstoffeinspritz - Impulsbreite T_i nach der Formel

65

wobei

$$T_i = k_i \cdot \gamma \cdot G_{fn} \cdot \frac{1}{N} + T_s$$

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k_i =ein von den Eigenschaften der Einspritzeinrichtung (8) abhängiger Koeffizient,

$\gamma \cdot \overline{G_{fn}}$ =die um den Faktor γ korrigierte Kraftstoffeinspritz - Istmenge G_{fn} ,

N =Motordrehzahl,

T_s =Kraftstoffeinspritz - Totzeit,

5 (d) eine Einrichtung (13) zum Bestimmen der Filmmenge M_{fn+1} für den anschließenden Rechenzyklus nach der Formel

$$10 \quad M_{fn+1} = \left(1 - \frac{1}{\tau} \cdot \Delta T\right) M_{fn} + X \cdot \Delta T \cdot \overline{\gamma \cdot G_{fn}}$$

wobei

ΔT =Periode des Rechenzyklus

15 und wobei die Einrichtungen (a) bis (d) so ausgelegt sind, daß sie ihre Funktionen sequentiell und wiederholt in jedem von aufeinanderfolgenden Rechenzyklen ausführen.

4. Vorrichtung nach Anspruch 3, mit einer Einrichtung (16) zum Umsetzen der momentanen Kraftstoff - Einspritzmenge G_{fn} in den Wert einer Breite eines der Einspritzeinrichtung (8) zugeführten Kraftstoffeinspritz - Impulses.

20

Revendications

1. Procédé de commande de l'injection de carburant dans un moteur, dans lequel les étapes suivantes sont effectuées dans chacun de cycles de calcul successifs:

25 (a) détermination d'une quantité d'injection de carburant courante G_{fn} par temps du moteur selon la formule

$$30 \quad G_{fn} = \frac{G_{fen} - 1/\tau \cdot M_{fn}}{1 - X}$$

dans laquelle

G_{fen} =la quantité de carburant désirée à délivrer au moteur (10),

35 $1/\tau \cdot M_{fn}$ =quantité de carburant se vaporisant à partir d'une quantité massique du film M_{fn} déposé sur la paroi de la tubulure d'admission (21),

X =La partie de la quantité de carburant injecté G_{fn} qui se dépose sur ladite paroi (21),

(b) calcul d'un facteur de correction γ de rétroaction de quantité d'injection de carburant visant à un rapport air-carburant stœchiométrique A/F basé sur un signal généré par un capteur O_2 (7),

(c) détermination d'une largeur d'impulsion d'injection de carburant T_i selon la formule

40

$$T_i = k_i \cdot \overline{\gamma \cdot G_{fn}} \cdot \frac{1}{N} + T_s$$

45 où

k_i =coefficient dépendant des caractéristiques de l'injecteur (8),

$\gamma \cdot \overline{G_{fn}}$ =quantité d'injection de carburant réelle corrigée par ledit facteur γ ,

N =vitesse du moteur,

T_s =temps mort d'injection de carburant,

50 (d) détermination de la quantité massique de film M_{fn+1} pour le cycle de calcul ultérieur selon la formule

$$55 \quad M_{fn+1} = \left(1 - \frac{1}{\tau} \cdot \Delta T\right) M_{fn} + X \cdot \Delta T \cdot \overline{\gamma \cdot G_{fn}}$$

où

T =période du cycle de calcul.

60 2. Procédé selon la revendication 1, dans lequel la quantité de carburant réellement injectée dans ledit moteur (10) est la quantité d'injection de carburant courante G_{fn} qui a été déterminée dans le dernier cycle de calcul précédant l'instant d'injection.

3. Dispositif de commande de l'injection de carburant dans un moteur, comportant

(a) des moyens (12) pour déterminer une quantité d'injection de carburant courante G_{fn} par temps du moteur selon la formule

65

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$$G_{fn} = \frac{G_{ten} - 1/\tau \cdot M_{fn}}{1 - X}$$

5 où

G_{ten} = quantité de carburant désirée à délivrer au moteur (10),
 $1/\tau \cdot M_{fn}$ = quantité de carburant se vaporisant à partir d'une quantité massique de film M_{fn} déposée sur la paroi de la tubulure d'admission (21),

X = partie de la quantité de carburant injecté G_{fn} qui se dépose sur ladite paroi (21),

10 (b) des moyens (14) pour calculer un facteur de correction γ de rétroaction de quantité d'injection de carburant visant à un rapport air-carburant stœchiométrique A/F basé sur un signal généré par un capteur O_2 (7),

(c) des moyens (11) pour déterminer une largeur d'impulsion d'injection de carburant T_i selon la formule

15

$$T_i = k_i \cdot \gamma \cdot \overline{G_{fn}} \cdot \frac{1}{N} + T_s$$

20 où

k_i = coefficient fonction des caractéristiques de l'injecteur (8),

$\gamma \cdot \overline{G_{fn}}$ = quantité d'injection de carburant réelle G_{fn} corrigée par ledit facteur γ ,

N = vitesse du moteur,

T_s = temps mort d'injection de carburant,

25 (d) des moyens (13) pour déterminer la quantité massique de film M_{fn+1} pour le cycle de calcul ultérieur selon la formule

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$$M_{fn+1} = \left(1 - \frac{1}{\tau} \cdot \Delta T\right) M_{fn} + X \cdot \Delta T \cdot \overline{G_{fn}}$$

où

T = la durée du cycle de calcul,

35 dans lequel lesdits moyens (a) à (d) sont aptes à accomplir leurs fonctions séquentiellement et de façon répétitive dans chacun des cycles de calcul successifs.

4. Dispositif selon la revendication 3, comprenant des moyens (16) pour convertir ladite quantité d'injection de carburant courante G_{fn} en une valeur de largeur d'une impulsion d'injection de carburant appliquée audit injecteur (8).

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FIG. 1A

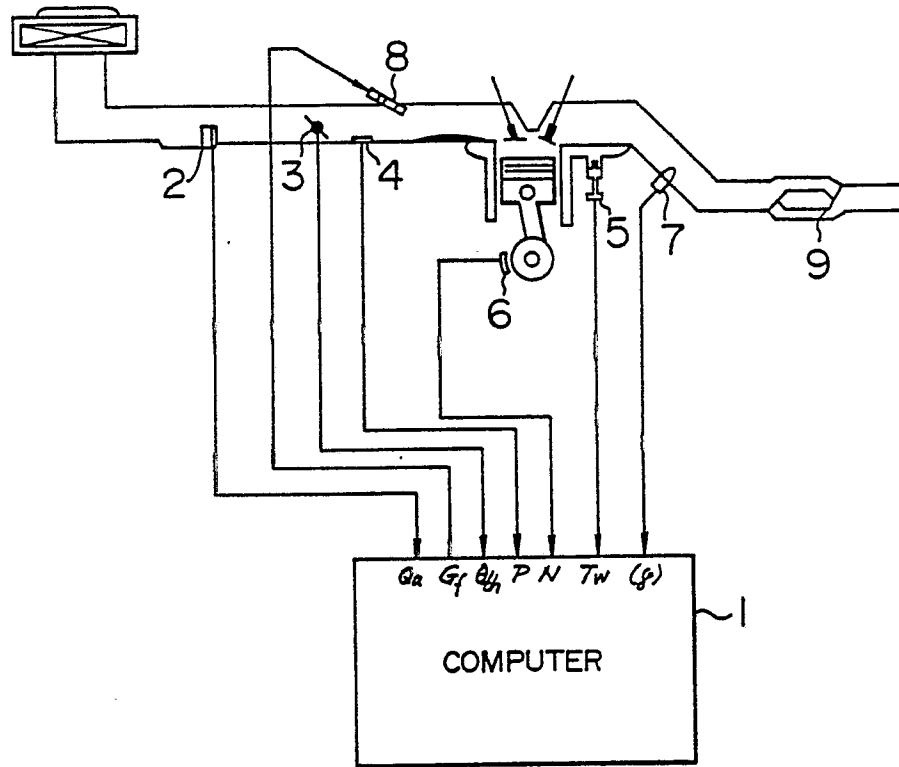


FIG. 1B

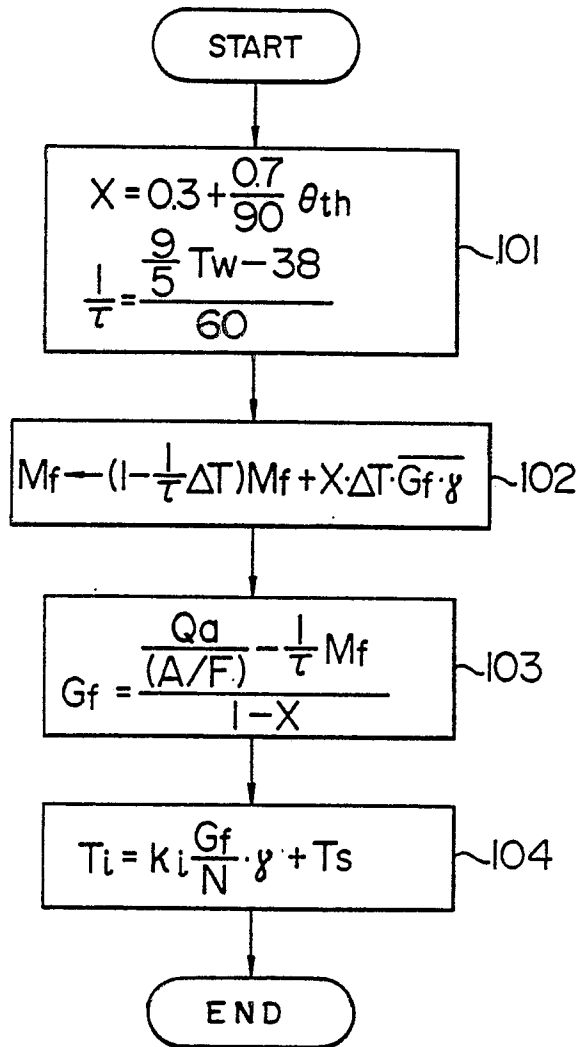


FIG. 2

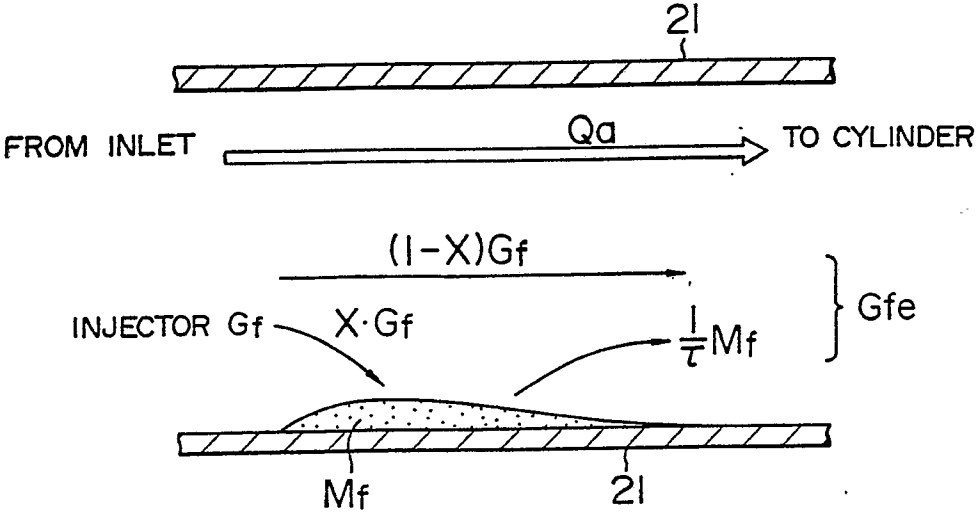


FIG. 3

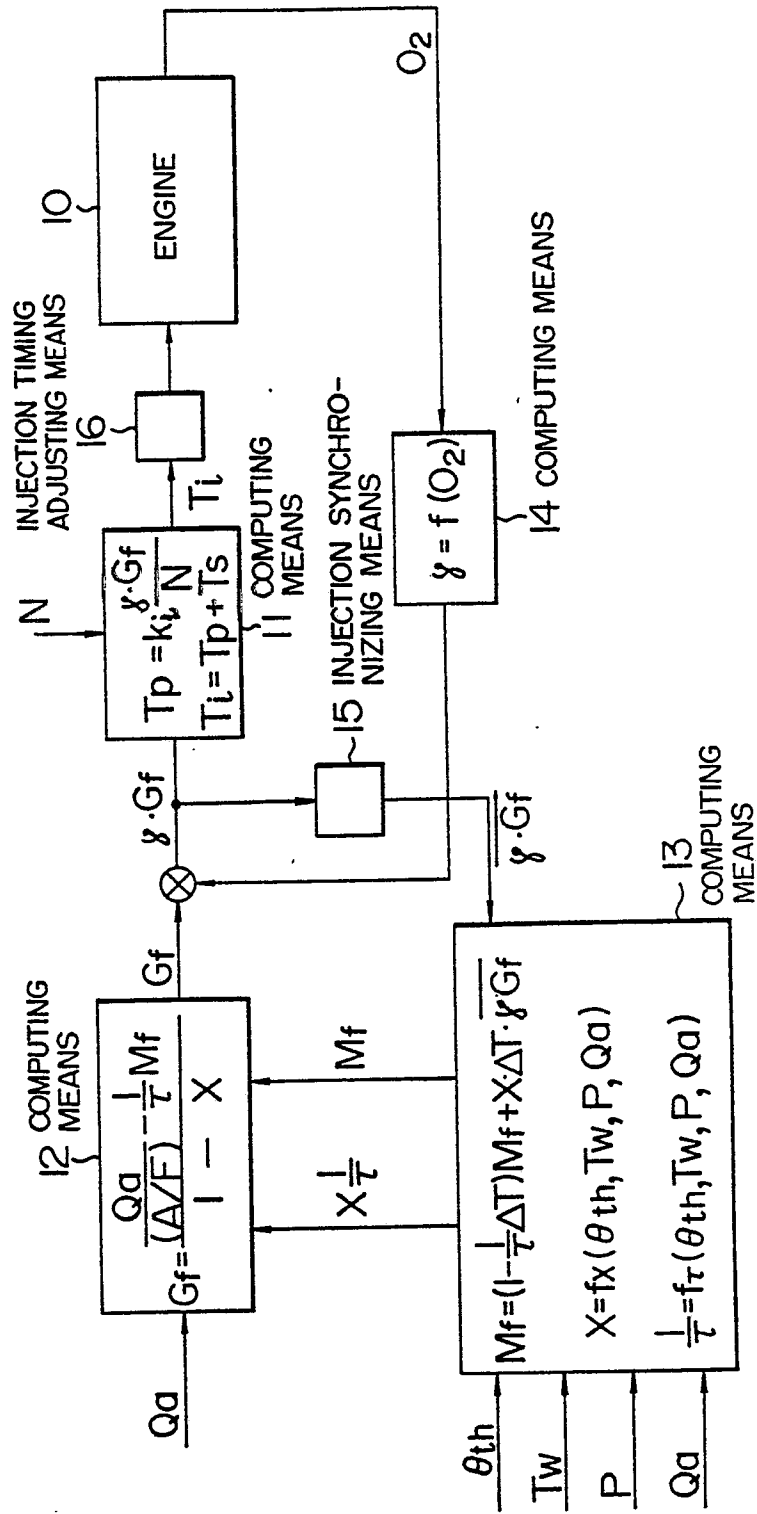


FIG. 4

