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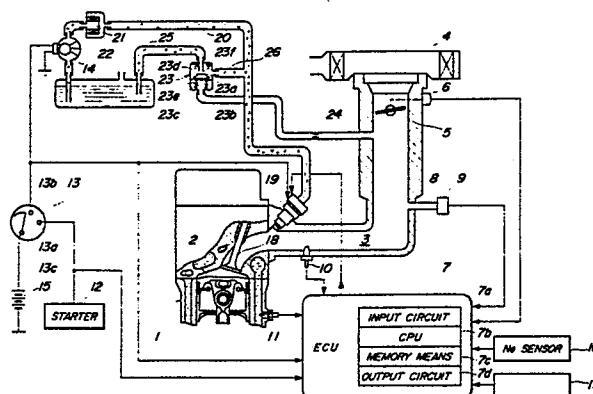
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Fuel supply control method for internal combustion engines at start.

A fuel supply control method for an internal combustion engine (1) at start. The engine has fuel injection valves (19) adapted to be opened over a valve opening period of time set at least based upon engine temperature so as to supply a required fuel quantity to the engine at start. A correction value corresponding to a detected value of a parameter indicative of the pressure of fuel pressurized by a feed pump (14) to be supplied to the fuel injection valves is determined, and the valve opening period of time is corrected by means of the determined correction value. Preferably, the correction value is set to increase with decrease in the pressure of fuel pressurized by the feed pump. Also preferably, the above parameter value is supply voltage supplied from an electric power source (15) connected with the feed pump for supplying the supply voltage thereto.



FUEL SUPPLY CONTROL METHOD

FOR INTERNAL COMBUSTION ENGINES AT START

This invention relates to a fuel supply control method for internal combustion engines at start.

5 A conventional fuel supply control method has been proposed, e.g. by Japanese Provisional Patent Publication (Kokai) No. 57-137633, wherein when the engine is in a starting condition, a valve opening period TOUT for the fuel injection valves is set to a
10 value obtained by adding to or deducting from a basic valve opening period TiCR set, e.g., based upon engine temperature in a manner decreasing with an increase in the engine temperature, a correction value TV
15 dependent on supply voltage supplied from an electric power source such as a battery and a generator to the fuel injection valves to drive same, and the fuel injection valves are controlled to open over a period of time according to the thus set valve opening period TOUT.

20 The correction value TV according to the proposed method is employed for compensation for a delay in the response of the fuel injection valves due to low supply voltage supplied thereto from the electric power source, e.g. during starting of the engine.

25 However, we have found that even with such compensation the startability and drivability of the engine may not be as good as desired.

SUMMARY OF THE INVENTION

30 It is the object of the invention to provide a fuel supply control method for internal combustion engines at start, which is capable of improving the startability and drivability of the engine at start.

35 The present invention provides a method for controlling fuel supply to an internal combustion engine at start, the engine having at least one fuel injection valve and a feed pump for pressurizing fuel and supplying pressurized fuel to the fuel injection

valve, the fuel injection valve being adapted to be opened over a valve opening period of time set at least based upon a temperature of the engine so as to supply a required quantity of fuel to the engine at start thereof.

The method according to the invention is characterized by comprising the following steps: (1) detecting a value of a parameter indicative of the pressure of fuel pressurized by the feed pump to be supplied to the fuel injection valve; (2) determining a correction value corresponding to the parameter value thus detected; and (3) correcting the valve opening period of time by means of the correction value thus determined.

Preferably, the correction value is set to increase the valve opening period with decrease in the pressure of fuel pressurized by the feed pump.

Also preferably, the engine includes an electric power source connected with the feed pump for supplying supply voltage thereto, and fuel pressure regulating means for supplying the fuel injection valve with fuel pressure regulated to a predetermined constant pressure when the pressure of fuel pressurized by the feed pump and supplied therefrom to the fuel pressure regulating means is higher than a predetermined value, the above-mentioned parameter value indicative of the pressure of fuel pressurized by the feed pump being the supply voltage from the electric power source.

Still preferably, the correction value is set to increase the valve opening period with decrease in the supply voltage insofar as the supply voltage is lower than a predetermined value corresponding to the predetermined value of the pressure of fuel pressurized by the feed pump.

Preferably, the step (3) comprises multiplying the valve opening period of time by the determined correction value.

The fuel injection quantity Q_f per injection of the fuel injection valves varies as a

function of the pressure difference ΔP (hereinafter referred to as "the fuel pressure difference" unless
5 otherwise specified) between the fuel pressure supplied to the fuel injection valves from the fuel tank through fuel pressurizing means such as a feed pump, and the internal pressure within the intake passage of the engine prevailing in the vicinity of
10 the fuel injection valves, and also as a function of the valve opening period value T_{OUT} , and can be expressed as follows:

$$Q_f \propto \sqrt{\Delta P} \times T_{OUT}$$

In the above-mentioned known method, the valve
15 opening period value T_{OUT} for the fuel injection valves is set on the presumption that the fuel pressure difference ΔP remains constant and assumes a certain value, and accordingly, the set value T_{OUT} does not correspond to fluctuations in the fuel
20 pressure difference ΔP . However, under certain operating conditions of the engine, the fuel pressure difference ΔP does not assume the certain value. For instance, when the starting motor has just been actuated to drive the engine, and the rotational speed
25 of the engine is not yet increased to a value high enough to make either the battery or the generator supply a predetermined supply voltage to the feed pump, the fuel pressure supplied from the feed pump to the fuel injection valves is low and accordingly the
30 fuel pressure difference ΔP is small, resulting in an insufficient fuel injection quantity Q_f per injection of the fuel injection valves even if they are opened over a period of time according to the set valve opening period T_{OUT} , which can deteriorate the
35 startability and driveability of the engine.

The invention is capable of supplying a required quantity of fuel to the engine at start thereof even when the fuel pressure supplied to fuel injection valves of the engine from a feed pump is so
5 low due to low supply voltage from an electric power source at the start of the engine that the fuel pressure difference between the supplied fuel pressure and the internal pressure within the intake passage in the vicinity of the fuel injection valves is smaller
10 than a predetermined constant value, to thereby improve the startability and driveability of the engine at start.

The above and other objects, features and advantages of the invention will be more apparent from
15 the ensuing detailed description of an example of the invention taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a view schematically illustrating the whole arrangement of a fuel supply control system for
20 an internal combustion engine, to which the method according to the invention is applied;

Fig. 2 is a graph of a table showing an example of the relationship between a basic valve opening period T_{iCR} for fuel injection valves applicable at
25 the start of the engine and engine coolant temperature TW ;

Fig. 3 is a graph of a table showing an example of the relationship between an engine rotational speed-dependent correction coefficient K_{Ne} applicable
30 at the start of the engine and the engine rotational speed N_e ;

Fig. 4 is a graph of a table showing an example of the relationship between a supply voltage-dependent

correction variable TV and power source supply voltage VB; and

Fig. 5 is a graph of a table showing an example of the relationship between a supply voltage-dependent correction coefficient KPV according to the invention
5 and the power source supply voltage VB.

Referring first to Fig. 1, there is illustrated the whole arrangement of a fuel supply control system to which is applied the method according to the
10 invention. Reference numeral 1 denotes an internal combustion engine of a four-cylinder type for instance, only one cylinder being shown, to which is connected one end of an intake pipe 3, the other end of which communicates with the atmosphere via an air
15 cleaner 4. A throttle valve 5 is arranged in the intake pipe 3, and a throttle valve opening (θ th) sensor 6 is connected to the throttle valve 5 for detecting its opening and supplying an electrical signal indicative of the detected throttle valve
20 opening to an electronic control unit (hereinafter called "the ECU") 7.

An absolute pressure (PBA) sensor 9 communicates through a conduit 8 with the interior of the intake pipe 3 at a location downstream of the throttle valve
25 5, and an electrical output signal indicative of the detected absolute pressure is supplied to the ECU 7. Further, an intake air temperature (TA) sensor 10 projects into the interior of the intake pipe 3 at a location downstream of the conduit 8, for supplying
30 the ECU 7 with an electrical signal indicative of the detected intake air temperature.

An engine cooling water temperature (TW) sensor 11 is mounted on the main body of the engine 1 in a manner embedded in the peripheral wall of an engine
35 cylinder, for applying an electrical output signal indicative of the detected water temperature TW as representative of the engine temperature to the ECU 7.

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A starter (starting motor) 12 is provided for the engine 1 for driving the engine during cranking. The input side of the starter 12 is connected to a terminal 13a of a key switch 13. The key switch 13
5 has a further terminal 13b connected to a feed pump 14 as well as to fuel injection valves 19, hereinafter referred to, and another terminal 13c connected to an electric power supply source 15 such as a generator and a battery. The terminal 13a of the key switch 13
10 is connected to the ECU 7 to supply same with an electrical signal indicative of on and off states of the starter 12. On the other hand, the terminal 13b is connected to the ECU 7 to supply same with an electrical signal indicative of supply voltage VB to
15 be supplied from the power supply source 15 to the feed pump 14 as well as to the fuel injection valves 19.

Reference numeral 16 denotes an engine rotational speed (Ne) sensor arranged in face-to-face relation
20 to, e.g., a camshaft, not shown, of the engine for supplying the ECU 7 with an electrical signal indicative of predetermined crank angles detected thereby.

Further electrically connected to the ECU 7 are
25 other sensors 17 such as an atmospheric pressure (PA) sensor and an exhaust O₂ sensor to supply the ECU with respective electrical signals indicative of detected parameter values.

Fuel injection valves 19 are arranged in the
30 intake pipe 3 each at a location slightly upstream of an intake valve 18 of a corresponding one of the engine cylinders, and connected with a fuel tank 22

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through a conduit 20, a fuel filter 21, and the feed pump 14 to be supplied with fuel pressurized by the feed pump 14.

Reference numeral 23 denotes a pressure regulating valve, a casing of which has its interior divided by a diaphragm 23b into a vacuum chamber 23c and a fuel chamber 23d. The vacuum chamber 23c communicates through a vacuum passage 24 with the interior of the intake pipe 3 at a location downstream of the throttle valve 5, so as to be supplied with a vacuum or negative pressure developed in the intake pipe 3 at a zone downstream of the throttle valve 5, i.e. a negative pressure prevailing in the vicinity of the fuel injection valves 19, through the vacuum passage 24. On the other hand, the fuel chamber 23d communicates through a conduit 26 with the interior of the conduit 20 extending between the fuel tank 22 and the fuel injection valves 19, at a location between the fuel filter 21 and the fuel injection valves 19, whereby the pressure of fuel being supplied to the fuel injection valves 19 is introduced into the fuel chamber 23d. A valve body 23a of the pressure regulating valve 23 is secured to the diaphragm 23b at its substantially central portion and urged via the diaphragm 23b by a spring 23e in a valve closing direction.

At the start of the engine 1, so long as the supply voltage VB supplied from the power supply source 15 to the feed pump 14 is lower than a predetermined value, and the fuel pressure within the fuel chamber 23d is low accordingly, the valve body 23a is seated against a valve seat 23f formed at an

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open end of a conduit 25 communicating with the fuel tank 22, by the force of the spring 23e urging the valve body 23a via the diaphragm 23b, to close the open end, thereby rendering the pressure regulating valve 23 inoperative. Therefore, so long as the
5 supply voltage VB of the power supply source 15 is lower than the predetermined value, the fuel pressure within the conduit 20, i.e. the pressure of fuel being supplied to the fuel injection valves 19 varies with
10 changes in the supply voltage VB supplied from the power supply source 15 to the feed pump 14.

After the start of the engine 1, when the supply voltage VB supplied from the power supply source 15 to the feed pump 14 rises above the predetermined value, and the pressure of fuel being supplied from the feed
15 pump 14 to the fuel injection valves 19 increases accordingly from a value corresponding to the predetermined value of the supply voltage VB, the resulting increased fuel supply pressure to the fuel injection valves 19, i.e. increased fuel pressure
20 within the conduit 20, is introduced to the fuel chamber 23d through the conduit 26, to displace the valve body 23a away from the valve seat 23f against the urging force of the spring 23e. As the fuel
25 supply pressure to the fuel injection valves 19 further increases, the valve seat 23f has its opening area increased to thereby increase the amount of fuel returned to the fuel tank 22 through the valve 23. If
30 the amount of fuel returned to the fuel tank 22 is thus increased, a corresponding drop occurs in the pressure within the conduit 20. On the other hand, as the fuel supply pressure to the fuel injection valves

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19 decreases, the valve body 23a is displaced by the urging force of the spring 23e in the valve closing direction, with its valve opening area decreased to thereby decrease the amount of fuel returned to the fuel tank 22 through the valve 23. If the amount of fuel returned to the fuel tank 22 is thus decreased, a corresponding rise occurs in the pressure within the conduit 20. The negative pressure in the intake pipe 3 is supplied to the other side of the diaphragm 23b. Thus, so long as the supply voltage VB supplied from the power supply source 15 to the feed pump 14 is higher than the predetermined value, the pressure regulating valve 23 operates to maintain constant the fuel pressure difference between the fuel pressure supplied to the fuel injection valves from the fuel tank and the internal pressure within the intake passage of the engine prevailing in the vicinity of the fuel injection valves.

Each of the fuel injection valves 19, formed of an on-off type solenoid valve, has its solenoid, not shown, connected to the ECU 7 so that when energized by a driving signal from the ECU 7, it opens with its valve body, not shown, lifted through a constant stroke and for a period of time corresponding to the duration of the driving signal, as hereinafter referred to. Therefore, so long as the pressure of fuel supplied to the fuel injection valves 19 remains constant and at the same time the fuel pressure difference ΔP between the fuel supply pressure supplied to the fuel injection valves 19 and the intake pipe (negative) pressure in the vicinity of the fuel injection valves 19 remains constant, the engine is supplied with an amount of fuel corresponding to the time period for which the driving signal is applied to the fuel injection valves 19 from the ECU

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7, i.e. the duration of the driving signals (the valve opening period). On the other hand, as the fuel supply pressure drops, the engine is supplied with a correspondingly decreased amount of fuel so long as the valve opening period remains constant.

The ECU 7 comprises an input circuit 7a having functions of shaping waveforms of pulses of input signals from the aforementioned sensors indicative of various operating parameters of the engine 1, shifting voltage levels of the input signals, and converting analog values of the input signals into digital signals, etc., a central processing unit (hereinafter called "the CPU") 7b, memory means 7c for storing various calculation programs to be executed within the CPU 7b, calculated data from the CPU 7b, and calculation data such as a TiCR - TW table, KNe - Ne table, and KPV - VB table, all hereinafter described, and an output circuit 7d for supplying driving signals to the fuel injection valves 19.

The fuel supply control system constructed as above operates as follows:

When the key switch 13 is turned to connect the terminal 13c with the terminal 13b, supply voltage VB is supplied from the power supply source 15 to the feed pump 14 via the key switch 13, and is also supplied to the ECU 7. When the key switch 13 is further turned so that the terminal 13c is also connected with the terminal 13a, the starter 12 is actuated to start the engine 1, and a signal indicative of on and off states of the starter 12 is supplied to the ECU 7.

After the engine 1 is thus started and a signal

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from the Ne sensor 16 indicative of the predetermined crank angles is inputted to the ECU 7, the ECU 7 determines operating conditions of the engine such as a starting condition on the basis of output signals
5 from the various sensors indicative of engine operating parameters such as engine coolant temperature TW, supply voltage VB, and on and off states of the starter 12, and calculates the valve opening period TOUT for the fuel injection valves 19
10 in accordance with the determined operating conditions of the engine 1.

At the start of the engine, the ECU 7 calculates the valve opening period TOUT by the use of the following equation (1):

15
$$TOUT = TiCR \times KNe \times KPV + TV \dots\dots\dots (1)$$

wherein TiCR represents a basic value of the valve opening period TOUT which is applied at the start of the engine, and determined, e.g. based upon the engine coolant temperature TW detected by the TW sensor 11. To be specific, the basic valve opening period value TiCR is read from a TiCR - TW table shown
20 in Fig. 2, for example. As shown in Fig. 2, predetermined values TCR1 - TCR5 as the basic valve opening period value are stored and correspond, respectively, to predetermined values TWCR1 - TWCR5 of
25 the engine coolant temperature TW, which are set to larger values as the engine coolant temperature TW decreases. When the detected temperature TW value falls between two adjacent ones of the predetermined values TWCR1 - TWCR5, the basic valve opening period
30 value TiCR is calculated by an interpolation method.

KPV represents a supply voltage-dependent

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correction coefficient according to the invention which is determined in dependence on the supply voltage VB to be supplied from the power source 15 to the feed pump 14, e.g., by reading a value of the coefficient KPV corresponding to the supply voltage VB from a KPV - VB table shown in Fig. 5, hereinafter described.

Further, KNe represents an engine rotational speed-dependent correction coefficient applicable at the start of the engine, which is determined in dependence on the engine rotational speed Ne detected by the Ne sensor 16. To be specific, the coefficient KNe is read from a KNe - Ne table shown in Fig. 3 showing an example of the relationship between the correction coefficient KNe and the engine rotational speed Ne. As shown in Fig. 3, when the detected engine speed Ne is equal to or lower than a predetermined lower limit value Ne1, the value of the coefficient KNe is held at a value KNe1=1, and when the detected engine speed Ne is equal to or higher than a predetermined upper limit value Ne2, the value of the coefficient KNe is held at KNe2=0.5. When the detected engine speed Ne falls between the predetermined lower and upper limit values Ne1 and Ne2, the value of the correction coefficient KNe is calculated by an interpolation method.

Furthermore, TV represents a supply voltage-dependent correction variable for increasing and decreasing the basic valve opening period value TiCR in response to changes in the supply voltage VB supplied from the power source 15 to the fuel injection valves 19 to drive same, the value of which

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is, for example, read from a TV - VB table shown in Fig. 4, in response to the supply voltage VB. As shown in Fig. 4, the correction variable TV is set to smaller values as the supply voltage VB increases. For example, when the supply voltage VB is 8, 13, and 16 volts, the correction variable TV is set to 1.75, 0.9, and 0.3 ms, respectively.

The supply voltage-dependent correction variable TV is employed to compensate for a delay in the response of the fuel injection valves 19 due to low supply voltage VB supplied from the power source 15 to the valves 19. By employing the correction variable TV, the actual valve opening time period of the fuel injection valves 19 can be made equal to the first term ($T_{iCR} \times K_{Ne} \times K_{PV}$) at the right side of the equation (1) which is obtained when the supply voltage VB has a normal value. On the other hand, the supply voltage-dependent correction coefficient KPV according to the invention is employed to compensate for a shortage of the fuel injection quantity Q_f due to a small fuel pressure difference ΔP caused by a change in the supply voltage VB supplied from the power supply source 15 to the feed pump 14 at the start of the engine, by increasing the valve opening period of the fuel injection valves 19. Thus, by virtue of the supply voltage-dependent correction variable TV and the supply voltage-dependent correction coefficient KPV, the fuel injection quantity Q_f per injection of the fuel injection valves 19 can be controlled to a value required at the start of the engine.

Next, a manner of calculation of the supply voltage-dependent correction coefficient KPV according

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to the invention is described with reference to Fig. 5. Fig. 5 shows a KPV - VB table showing an example of the relationship between the supply voltage-dependent correction coefficient KPV and the supply voltage VB. As shown in Fig. 5, predetermined values KPV1 (e.g. 1.2), KPV2 (e.g. 1.15), KPV3 (e.g. 1.07), and KPV4 (e.g. 1.0) of the coefficient KPV are stored and correspond, respectively, to predetermined values VBP1 (e.g. 6v), VBP2 (e.g. 7v), VBP3 (e.g. 8v), and VBP4 (e.g. 9v) of the supply voltage VB, in a manner such that the coefficient KPV is set to smaller values with increase in the supply voltage VB so long as the value of the supply voltage VB is lower than the predetermined value VBP4. When the actual supply voltage VB falls between two adjacent ones of the predetermined values VBP1 - VBP4, the value of the correction coefficient KPV is calculated by interpolation. When the supply voltage VB is equal to or higher than the predetermined value VBP4, the value of the correction coefficient KPV is held at 1.0, since the fuel pressure difference ΔP can be maintained at a constant value by the operation of the pressure regulating valve 23 which operates to maintain constant the fuel supply pressure to the fuel injection valves 19 through the conduit 20. On the other hand, when the supply voltage VB is lower than the predetermined value VBP4 below which the fuel supply pressure to the fuel injection valves 19, and accordingly the fuel pressure difference ΔP can decrease substantially in proportion to decrease in the supply voltage VB, the set value of the correction coefficient KPV is applied to the equation (1) whereby

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the basic valve opening period value T_{iCR} is multiplied by the correction coefficient KPV , thus making it possible to obtain a valve opening period T_{OUT} value appropriate for supplying a required
5 quantity of fuel to the engine at start.

The ECU 7 supplies the fuel injection valves 19 with driving signals corresponding to the thus calculated valve opening period T_{OUT} , to open same over the time period T_{OUT} .

10 Incidentally, although in the foregoing embodiment, the basic valve opening period T_{iCR} is set based upon the engine coolant temperature TW , this is not limitative, but the basic valve opening period may be set based upon the engine coolant temperature TW ,
15 and one or more operating parameters of the engine such as the engine rotational speed N_e , intake air quantity, and intake pipe absolute pressure PBA , to be corrected by means of the supply voltage-dependent correction coefficient KPV of the invention.

20 As described above in detail, according to the fuel supply control method for an internal combustion engine at start, the parameter value VB indicative of the pressure of fuel supplied to the fuel injection valves 19 is detected, the correction
25 value KPV corresponding to the detected parameter value VB is determined, and the basic valve opening period T_{iCR} set at least based upon the engine temperature TW is corrected by means of the thus determined correction value KPV . Therefore, it is
30 possible to supply a required quantity of fuel to the engine at start even when the fuel pressure difference ΔP is small between the fuel pressure supplied to the

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fuel injection valves 19 and the intake passage
pressure in the vicinity of the fuel injection valves
19, which is caused by low supply voltage VB supplied
from the fuel supplying means 14, to thereby improve
5 the startability and driveability of the engine.

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Claims

1. A method of controlling fuel supply to an internal combustion engine at start, said engine having at least one fuel injection valve and a feed
5 pump for pressurizing fuel and supplying pressurized fuel to said fuel injection valve, said fuel injection valve being adapted to be opened over a valve opening period of time set at least based upon a temperature of said engine so as to supply a required quantity of
10 fuel to said engine at start thereof, the method comprising the steps of: (1) detecting a value of a parameter indicative of the pressure of fuel pressurized by said feed pump to be supplied to said fuel injection valve; (2) determining a correction
15 value corresponding to said parameter value thus detected; and (3) correcting said valve opening period of time by means of said correction value thus determined.

2. A method as claimed in claim 1, wherein said
20 correction value is set to increase the valve opening period with decrease in the pressure of fuel pressurized by said feed pump.

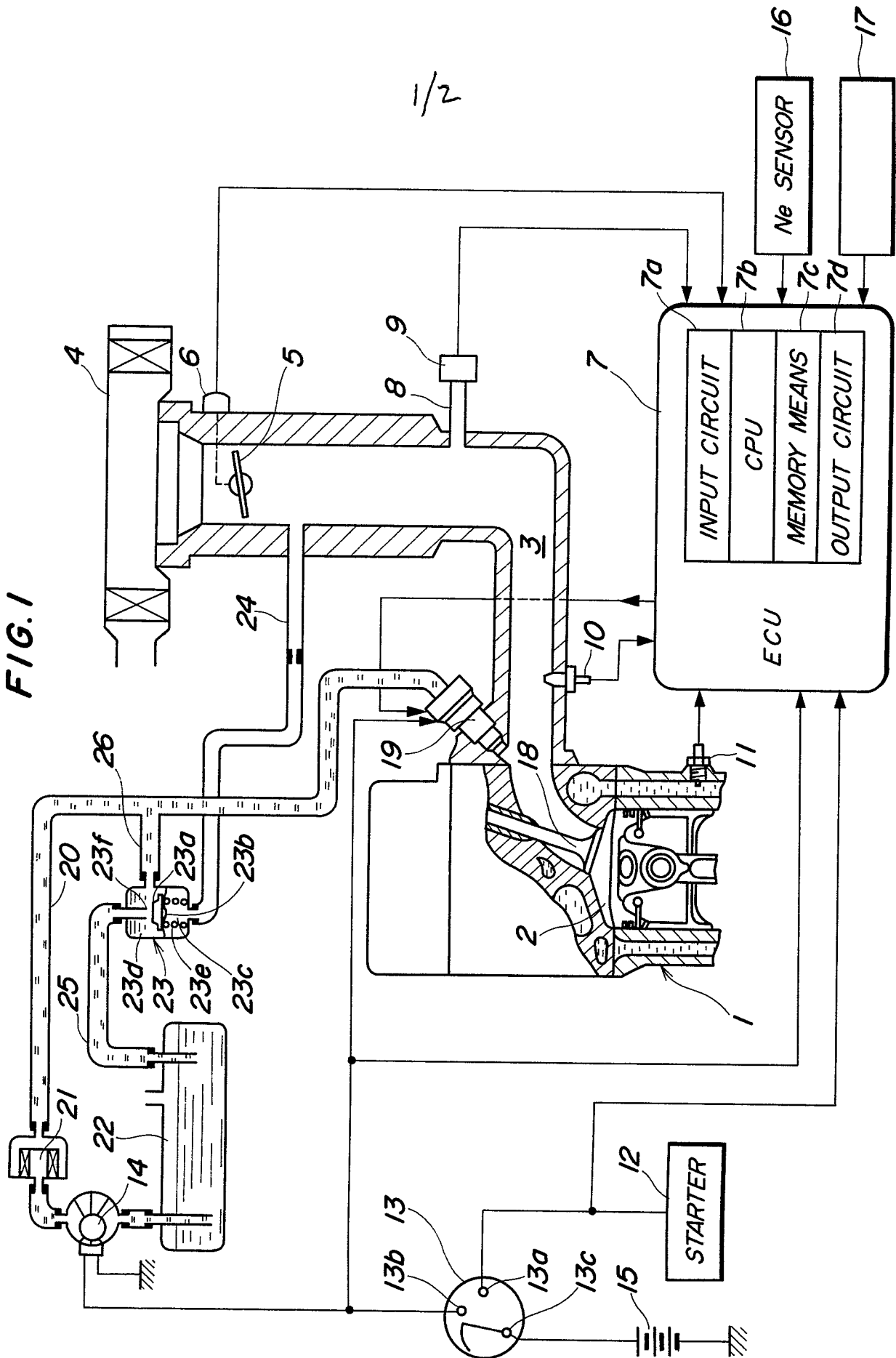
3. A method as claimed in claim 1 or 2, wherein said engine includes an electric power source connected with said feed pump for supplying supply voltage
25 thereto, and fuel pressure regulating means for supplying said fuel injection valve with fuel at a pressure regulated to a predetermined constant pressure when the pressure of fuel pressurized by said feed pump and supplied therefrom to said fuel pressure regulating
30 means is higher than a predetermined value, said parameter value indicative of the pressure of fuel pressurized by said feed pump being said supply voltage from said electric power source.

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4. A method as claimed in claim 3, wherein said correction value is set to increase the valve opening period with decrease in said supply voltage insofar as said supply voltage is lower than a predetermined value corresponding to said
5 predetermined value of the pressure of fuel pressurized by said feed pump.

5. A method as claimed in any preceding claim wherein said step (3) comprises multiplying said valve opening period of time by said determined correction value.

FIG. 1



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FIG.3

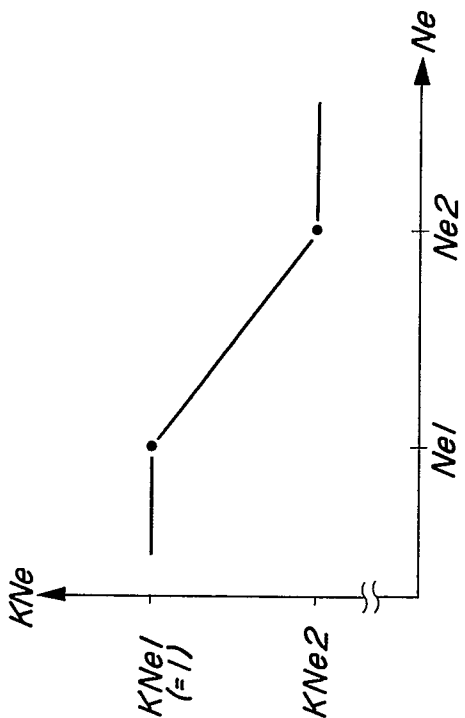


FIG.5

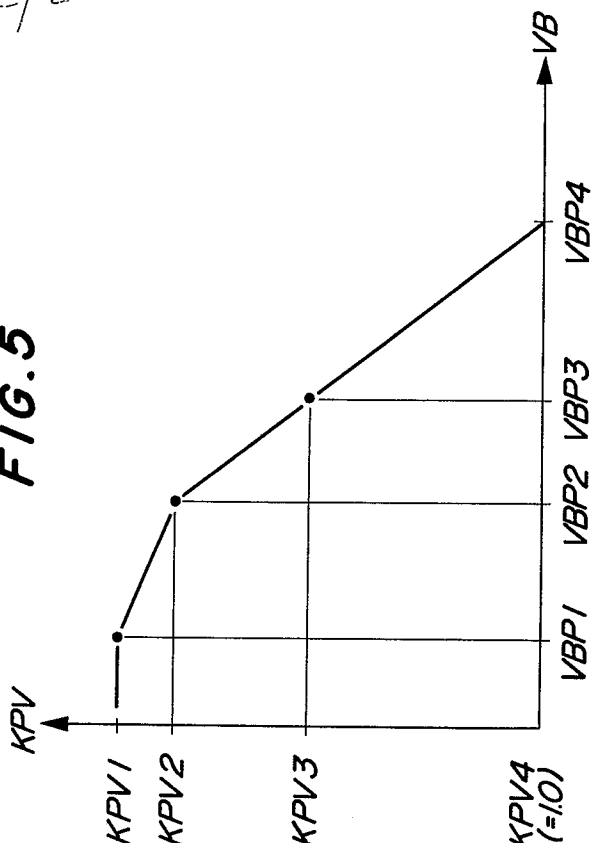


FIG.2

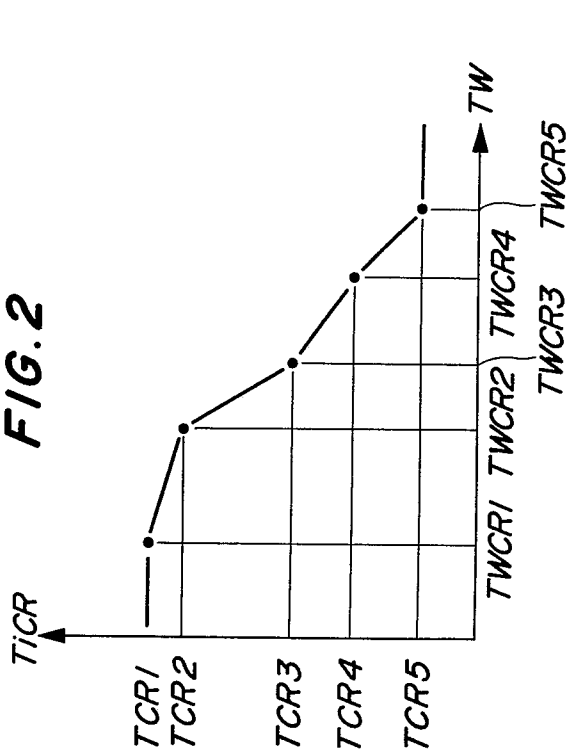
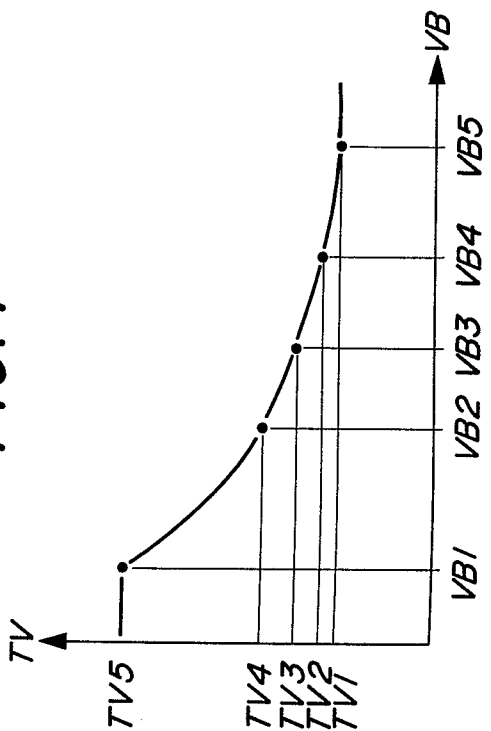


FIG.4





European Patent
Office

EUROPEAN SEARCH REPORT

0 206 485

Application number

EP 86 30 3498

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. 4)
Y	FR-A-1 555 024 (ASSOCIATED ENGINEERING LTD.) * Page 1, column 2, lines 13-27; page 2, column 2, lines 2-49 * ---	1-3	F 02 D 41/06 F 02 D 41/30
Y	PATENTS ABSTRACTS OF JAPAN, vol. 7, no. 110 (M-214)[1255], 13th May 1983; & JP-A-58 30 422 (MITSUBISHI DENKI K.K.) 22-02-1983 ---	1-3	
A	US-A-4 445 483 (HUSAGAWA) * Column 10, line 48 - column 11, line 23 * & JP-A-57 137 633 (HONDA) (Cat. D,A) ---	1,5	
A	EP-A-0 121 028 (THE BENDIX CORP.) ---		TECHNICAL FIELDS SEARCHED (Int. Cl. 4)
A	US-A-3 011 486 (PRIBBLE) -----		F 02 D 41
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 07-10-1986	Examiner MOUALED R.
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			