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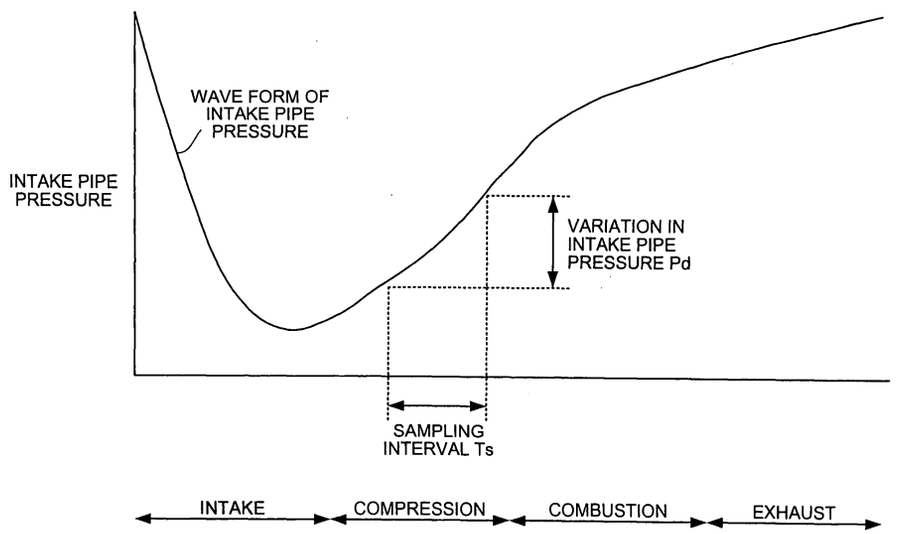
(54) THROTTLE OPENING ESTIMATION METHOD AND ECU (ELECTRONIC CONTROL UNIT)

(57) The vertical axis represents intake pipe pressure in an intake pipe (101), and the horizontal axis, time (or engine stroke). An amount of air leaking and incoming form a throttle valve (102) varies depending on an extent of opening of the throttle valve (102). An intake pipe pressure is measured at one point where a crank angle (crank cycle) of a crank or an engine stroke is synchronous with the measurement, and opening of the throttle valve (102) is estimated based on the intake pipe pressure measured. Thus throttle opening can be obtained without TPS (Throttle Position Sensor). Further, a value obtained by TPS can be corrected to a more accurate value.

FIG.2



EP 1 541 847 A1

Description

TECHNICAL FIELD

[0001] The present invention relates to a throttle opening estimation method and an ECU (Electronic Control Unit) that determines an amount of fuel to be injected by using the throttle opening estimation method, and relates particularly to a throttle opening estimation method and an ECU in which a throttle opening in a single-cylinder FI system is measured and a TPS (Throttle Position Sensor) is corrected.

BACKGROUND ART

[0002] So far, in an FI system, a method of estimating an amount of air for a motor cycle has been performed by using an estimation of amount of air from number of rotations and a throttle opening (αN method) together with an estimation of amount of air from an intake pipe pressure and the number of rotations (SD method). A method of estimating an amount of air only by SD method from the number of rotations and the intake pipe pressure by eliminating TPS with an object of reducing a cost of the FI system is being studied.

[0003] A conventional art is disclosed in Japanese Patent Application Laid-open Application No. H6-93923.

[0004] However, conventionally, since there is no TPS, a movement of throttle cannot be understood so that it is difficult for an operator (rider or driver) to control the throttle.

[0005] Moreover, even in the system in which the SD method and the αN method are used together, it is difficult to maintain accuracy close to a small opening in which an accuracy of the TPS is necessary.

[0006] A first object of the present invention is to provide a method of estimating the throttle opening and an ECU that enable to achieve a throttle opening even if the TPS is not provided.

[0007] A second object of the present invention is to provide a method of estimating the throttle opening and an ECU that enable to correct a value obtained by the TPS to a more accurate value.

DISCLOSURE OF THE INVENTION

[0008] To solve the above problems and achieve the above objects, a throttle opening estimation method according to claim 1 includes an intake pipe pressure measuring step of measuring an intake pipe pressure at any one or a plurality of voluntary points of time when an intake valve is shut; and a throttle opening calculation step of calculating a throttle opening from the intake pipe pressure measured at the intake pipe pressure measuring step.

[0009] Moreover, a throttle opening estimation method according to claim 2, in the throttle opening estimation method according to claim 1, the throttle opening calculation step includes calculating the throttle opening form number of rotations of an engine and the intake pipe pressure measured at the intake pipe pressure measuring step.

[0010] Furthermore, a throttle opening estimation method according to claim 3 includes an intake pipe pressure measuring step of measuring an intake pipe pressure at a plurality of voluntary points of time when an intake valve is shut; and a throttle opening calculation step of calculating a throttle opening from a difference in the intake pipe pressures measured at the intake pipe pressure measuring step.

[0011] Moreover, a throttle opening estimation method according to claim 4, in the throttle opening estimation method according to claim 3, the throttle opening calculation step includes calculating the throttle opening based on number of rotations of an engine and the difference between the intake pipe pressures measured.

[0012] Furthermore, a throttle opening estimation method according to claim 5, in the throttle opening estimation method according to any one of claims 1 to 4, further includes an engine load calculation step of calculating an engine load from a graph of the intake pipe pressures measured, wherein the throttle opening calculation step includes limiting the calculation of the throttle opening based on the number of rotations of the engine and the engine load calculated at the engine load calculation step.

[0013] Moreover, a throttle opening estimation method according to claim 6, in the throttle opening estimation method according to any one of claims 1 to 5, further includes a TPS value correction step at which a TPS value that indicates an actual throttle opening is corrected using the throttle opening calculated at the throttle opening calculation step.

[0014] Furthermore, a throttle opening estimation method according to claim 7, in the throttle opening estimation method according to claim 6, the TPS value correction step includes correcting the TPS value only when the TPS value or the throttle opening calculated at the throttle opening calculation step is judged to be closed to an idle.

[0015] Moreover, a throttle opening estimation method according to claim 8, in the throttle opening estimation method according to any one of claims 1 to 7, the point of time of measurement at the intake pipe pressure measuring step is synchronized with a crank or an engine stroke.

[0016] Furthermore, a throttle opening estimation method according to claim 9, in the throttle opening estimation method according to claim 8, the point of time of measurement at the intake pipe pressure measuring step is let to be variable based on the number of rotations of the engine.

[0017] Moreover, an ECU according to claim 10 includes an input unit that receives a throttle opening calculated based on an intake pipe pressure measured at

one or a plurality of voluntary points of time when an intake valve is shut; and a determining unit that determines an amount of fuel to be injected based on the throttle opening received by the input unit.

[0018] Furthermore, an ECU according to claim 11 includes an input unit that receives a throttle opening calculated based on a difference in intake pipe pressures measured at a plurality of voluntary points of time when an intake valve is shut; and a determining unit that determines an amount of fuel to be injected based on the throttle opening received by the input unit.

[0019] Moreover, an ECU according to claim 10 includes an input unit that receives an amount of variation in a throttle opening calculated based on a value of the intake pipe pressure measured at one or a plurality of voluntary points of time when an intake valve is shut; and a control unit that controls acceleration and deceleration of an amount of fuel to be injected based on the amount of variation received by the input unit.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020]

Fig. 1 is a schematic (cross-sectional view) of a fuel injecting mechanism that includes an ECU (Electronic Control Unit) according to an embodiment of the present invention.

Fig. 2 is a schematic for explaining an outline of the embodiment.

Fig. 3 is a graph (part 1) of intake pipe pressure against throttle opening.

Fig. 4 is a graph (part 2) of intake pipe pressure against throttle opening.

Fig. 5 is a graph (part 3) of intake pipe pressure against throttle opening.

Fig. 6 is a graph (part 1) of intake pipe pressure against number of rotations of an engine.

Fig. 7 is a graph (part 2) of intake pipe pressure against number of rotations of an engine.

Fig. 8 is a graph (part 3) of intake pipe pressure against number of rotations of an engine.

Fig. 9 is an illustration of a data flow in a throttle opening estimation method according to the embodiment.

Fig. 10 is a schematic (flowchart) for explaining a throttle opening estimation method according to the embodiment.

Fig. 11 is another schematic (flowchart) for explaining a throttle opening estimation method according to the embodiment.

Fig. 12 is still another schematic (flowchart) for explaining a throttle opening estimation method according to the embodiment.

Fig. 13 is a schematic (flowchart) for explaining a processing procedure performed by an ECU 100 according to the embodiment.

Fig. 14 is another schematic (flowchart) for explaining a processing procedure performed by an ECU 100 according to the embodiment.

BEST MODE FOR CARRYING OUT THE INVENTION

[0021] Exemplary embodiments of a throttle opening estimation method and an ECU are described below in detail with reference to the accompanying diagrams.

Outline of embodiment

[0022] To start with, an outline of an embodiment of the present invention is described. Fig. 1 is a schematic (cross-sectional view) of a fuel injecting mechanism that includes an ECU according the embodiment and Fig. 2 is a schematic (a graph that indicates a variation in intake pipe pressure) for explaining an outline of the embodiment.

[0023] As shown in Fig. 1, reference numeral 100 is an ECU, 101 is an intake pipe, 102 is a throttle valve, 103 is a cylinder (combustion chamber), 104 is an intake valve, 105 is a valve opening-shutting control mechanism that controls opening and shutting of the intake valve 104, 106 is an injector, and 107 are various sensors (for example, sensors including TPS, intake pipe pressure sensor, engine-load sensor etc.).

[0024] Moreover, in Fig. 2, a vertical axis represents an intake pipe pressure of the intake pipe 101 and a horizontal axis represents time (or engine stroke). Here, when the intake valve 104 is shut (compression stroke, combustion stroke, and exhaust stroke), an intake pipe pressure rises with time. This is because, when the intake valve 104 is open (intake stroke), air from downstream of the throttle valve 102 is sucked into the cylinder 103 and the intake pipe pressure drops down, whereas when the intake valve 104 is shut (from the compression stroke onward), a pressure in the intake pipe 101 goes on rising by air that is leaked in through the throttle valve 102.

[0025] Here, an amount of the air that is leaked in through the throttle valve 102 varies according to an opening of the throttle valve 102. For this reason, even if the intake pipe pressure is measured at a certain point where it is synchronous by a crank angle (crank cycle) of a crank that is omitted in the diagram, it is possible to estimate the opening of the throttle valve 102.

[0026] Moreover, for not letting to be affected by an absolute pressure of the intake pipe 101, by estimating from a slope of the rise in the intake pipe pressure, in other words, from a variation Pd in the intake pipe pressure corresponding to a sampling interval Ts, the opening of the throttle valve 102 can be predicted more accurately.

[0027] Thus, it is possible to estimate the throttle opening of a system (for example SD system) without TPS by making use of a variation due to the throttle opening by the variation Pd in the intake pipe pressure for which two or more than two samplings are performed

at a constant time interval Ts of the graph of the intake pipe pressure, as well as to determine more accurately an amount of fuel to be injected in a predetermined position (opening) of the throttle valve even in a system that includes the TPS.

[0028] Fig. 3 to Fig. 5 are graphs of the intake pipe pressure against the throttle opening. Fig. 3 represents a case at a start up of the intake pipe pressure when the throttle opening is small, Fig. 4 represents a case of a start up of the intake pipe pressure when the throttle opening is medium, and Fig. 5 represents a case at a start up of the intake pipe pressure when the throttle opening is large. If the throttle opening is small, the slope at the start up of the intake pipe pressure is gentle. As the throttle opening becomes large, the slope at the start up of the intake pipe pressure becomes steep. Thus, the slope at the start up of the intake pipe pressure varies according to the throttle opening.

[0029] Fig. 6 to Fig. 8 are graphs of the intake pipe pressure against the number of rotations of the engine. Fig. 6 represents a case at a start up of the intake pipe pressure when the number of rotations is low, Fig. 7 represents a case at a start up of the intake pipe pressure when the number of rotations of the engine is medium, and Fig. 8 represents a case at a start up of the intake pipe pressure when the number of rotations of the engine is high. If the number of rotations of the engine is low, the slope at the start up of the intake pipe pressure is steep. As the number of rotations of the engine increases, the slope at the start of the intake pipe pressure becomes gentle. Thus, when viewed in units of crank cycle, the start of the intake pipe pressure varies according to the number of rotations as well. Therefore, a correction by the number of rotations becomes necessary.

[0030] Next, a data flow in the throttle opening estimation method according to the embodiment is described. Fig. 9 is an illustration of the data flow in the throttle opening estimation method according to the embodiment. In Fig. 9, data related to the intake pipe pressure that is measured at a first timing is extracted from among data (901) related to the intake pipe pressure that is obtained by measurement, and let to be a sampling value No. 1 (902). Similarly, data related to the intake pipe pressure that is measured at a second timing, which is different from the first timing, is extracted and let to be a sampling value No. 2 (903).

[0031] A difference between the sampling value No. 1 (902) and the sampling value No. 2 (903) is calculated (904) and the difference is let to be a pressure difference (905). When there is one sampling value, the sampling value is used as it is instead of the pressure difference (905). Then, the pressure difference (905) is corrected by using data 910 related to the number of rotations and corrected data (906) is obtained. The pressure difference (905) that is corrected is converted to data related to the throttle opening and throttle opening conversion data (907) is obtained.

[0032] Next, an estimated value of an engine load is calculated (911) and the engine load (912) is obtained from the estimated value of an engine load. Then, a conversion limit of the throttle opening is set (908) from the engine load (912), and the throttle opening is determined (909) from the set conversion limit and the throttle opening conversion data (907).

Processing procedure of the throttle opening estimation method

[0033] Next, a processing procedure of the throttle opening estimation method according to the embodiment is described. Fig. 10 and Fig. 11 are schematics (flowcharts) for explaining the throttle opening estimation method according to the embodiment. In the flowchart shown in Fig. 10, to start with, a judgment of whether the intake valve 104 has been shut by the valve opening-shutting control mechanism 105 or not is made (step S1001). The judgment of whether the intake valve 104 has been shut or not can be made from the condition of the valve opening-shutting control mechanism 105.

[0034] Then, if the intake valve 104 is shut (Yes at step S1001), next, a judgment of whether a predetermined time is elapsed from a point of time where the intake valve 104 has been shut, is made (step S1002). Here, elapsing of the predetermined time is awaited and when it is elapsed (Yes at step S1002), an intake pipe pressure at that point of time is measured (step S1003). Together with this, according to the requirement, the engine load is calculated (step S1004) as well as the number of rotations of the engine is acquired (step S1005).

[0035] After this, from data acquired at steps from step S1003 to S1005, the throttle opening is calculated (step S1006). Then, a value calculated at step S1006 is output as an estimated value of the throttle opening (step S1007), and a series of processes is terminated. This series of processes is performed repeatedly.

[0036] In the flowchart shown in Fig. 11, to start with, a judgment of whether the intake valve 104 has been shut by the valve opening-shutting control mechanism or not is made (step 1101). Then, if the intake valve 104 has been shut (Yes at step S1101), next, a judgment of whether a predetermined time is elapsed from the point of time where the intake valve has been shut, is made (step S1102). Here, elapsing of the predetermined time is awaited and when it is elapsed (Yes at step 1102), the intake pipe pressure at that point of time (No. 1) is measured (step S1103).

[0037] After this, a judgment of whether a predetermined time is elapsed from the point of time No. 1 is made (step S1104). Here, elapsing of the predetermined time is awaited and when it is elapsed (Yes at step S1104), the intake pipe pressure at that point of time (No. 2) is measured (step S1105). Then, a difference between the values measured at the points of time No. 1 and No. 2 is calculated (step S1106). Regarding steps from S1107 to S1110, since they are similar to

steps S1004 to S1007 indicated in Fig. 10, the description of these steps is omitted.

[0038] In Fig. 10 and Fig. 11, although the point of time of measuring the intake pipe pressure is let to be the predetermined time from the point of time at which the intake valve 104 is shut, it is not restricted to this. In other words, for measuring the pressure of the intake pipe when the intake valve 104 is shut, it is better to let the point of time of measuring the intake pipe pressure at the same point of time throughout the crank cycle.

[0039] Fig. 12 is a schematic (flowchart) for explaining a processing procedure of the throttle opening estimation method according to the embodiment, and is an illustration that indicates a procedure for correcting the TPS value by the estimated value of throttle opening. In the flowchart shown in Fig. 12, to start with, the estimated value of the throttle opening is input (step S1201) as well as the TPS value is input (step S1202).

[0040] Next, a judgment of whether the estimated value of throttle opening or the TPS value is close to idle is made (step S1203). Here, if none of the estimated value of throttle opening or the TPS value is close to idle (No at step S1203), without taking any action, the TPS value that is input is output (step S1204) and a series of processes is terminated.

[0041] On the other hand, at step S1203, if any of the estimated value of the throttle opening or the TPS value is close to idle (Yes at step S1203), the TPS value is corrected by the estimated value of the throttle opening (step S1205) and a corrected value is output (step S1206). Then, a series of processes is terminated.

[0042] Next, a processing procedure performed by the ECU 100 according to the embodiment is described. Fig. 13 and Fig. 14 are schematics (flowcharts) for explaining the processing procedure performed by the ECU 100 according to the embodiment. In the flowchart shown in Fig. 13, to start with, a judgment of whether there has been an input of the estimated value of throttle opening is made (step S1301). Here, if the estimated value of throttle opening is calculated in the ECU 100, a judgment of whether the estimated value of throttle opening is determined or not may be made. Moreover, the TPS value or the TPS corrected value may be used instead of the estimated value of throttle opening.

[0043] At step S1301, an input of the estimated value of throttle opening is awaited and when there is the input (Yes at step S1301), an amount of fuel to be injected by the injector 106 is determined (step S1302) from the estimated value of throttle opening. Then, a control signal (injection signal) related to the amount of fuel to be injected that is determined is output to the injector 106 (step S1303) and a series of processes is terminated.

[0044] On the other hand, in the flowchart shown in Fig. 14, to start with, a judgment of whether there has been an input of the estimated value of throttle opening (variation amount) is made (step S1401). Then, the input of the estimated value of throttle opening (variation amount) is awaited, and when there is the input (Yes at step S1401), from the estimated value of throttle opening, a control amount of acceleration and deceleration of an amount of fuel to be injected by the injector 106 is determined (step S1402). Further, from the control amount a control signal (injection signal) for controlling the fuel injection by the injector 106 is output to the injector 106 (step S1403), and a series of processes is terminated.

[0045] As described above, according to the embodiment, since the intake pipe pressure at one or a plurality of arbitrary points of time when the intake valve 104 is shut is measured, and the throttle opening is calculated from the intake pipe pressure, from the graphs of the intake pipe pressure, it is possible to estimate the throttle opening from sampling pressure value at one or more than one point where the pressure rises with respect to the crank angle, and to detect detailed operation of the throttle by the operator.

[0046] Moreover, the throttle opening can be calculated from the number of rotations of the engine and the value of the throttle opening that is measured, and the throttle opening (estimated value of throttle opening) obtained by this can be corrected according to the number of rotations of the engine at that time. The graph of intake pipe pressure differs according to the number of rotations of the engine even if the throttle opening is the same. For this reason, by performing the correction by the number of rotations of the engine, the accuracy of estimation can be improved.

[0047] Furthermore, according to this embodiment, the intake pipe pressure at the plurality of voluntary points of time when the intake valve 104 is shut is measured and based on the difference in the intake pipe pressure at the plurality of points of time measured the throttle opening can be calculated. In other words, it is possible to improve the accuracy of estimation the throttle opening by detecting the slope from the difference in pressure at two points of the start up of the graph of the intake pipe pressure. Particularly, since the variation in the intake pipe pressure corresponding to the variation in the throttle opening is large near a low opening, it is possible to obtain the throttle opening more accurately than that obtained by the TPS. Moreover, an actual amount of air is reflected in the opening that is obtained, and it is ideal as data for fuel calculation.

[0048] Moreover, according to this embodiment, the throttle opening may let to be calculated based on the difference in the intake pipe pressure at the plurality of points of time and the number of rotations of the engine. By doing so, by performing the correction by the number of rotations of the engine, the accuracy of estimation can be improved.

[0049] Furthermore, according to this embodiment, the engine load may by calculated from the graph that indicates the value of the intake pipe pressure and the calculation of the throttle opening may be let to be limited based on the engine load that is calculated and the number of rotations of the engine.

[0050] Moreover, according to this embodiment, it is possible to correct the TPS value that indicates the actual throttle opening, based on the value of the throttle opening that is calculated. When there is an error in the actual TPS due to a variation in the elapsed time, it is possible to improve the accuracy of the value of the throttle opening by correcting an actual TPS opening by a TPS opening that is estimated from the graph of the intake pipe pressure. Particularly, the estimation of the throttle opening by the intake pipe pressure has better accuracy near the small opening, and it is possible to obtain an accurate value by correction.

[0051] Therefore, the TPS value can be corrected only when the TPS value or the throttle opening that is calculated is judged to be close to the idle, in other words, when it is judged to be close to idle from the graph of the intake pipe pressure. Conventionally, a correction of an ID position of the TPS had to be performed by judging that in the idle condition the throttle strikes an idle stop screw, however it has to be close to the idle and need not be judged to be striking the idle stop screw.

[0052] Moreover, according to this embodiment, it is advisable to synchronize the point of time of the measurement of the intake pipe pressure with the engine stroke. In other words, by synchronizing a pressure sampling period with the crank or with the engine stroke (for example, the combustion cycle where the intake valve is shut), a measurement value can be sampled more accurately.

[0053] Furthermore, according to this embodiment, the point of time of the measurement of the intake pipe pressure may be let to be varying based on the number of rotations of the engine. With the same throttle opening, the intake pipe pressure that is sampled varies. For this reason, the accuracy of estimation can be improved further by estimating the throttle opening by correcting by the number of rotations.

[0054] The throttle opening estimation method according to this embodiment may be performed in the various sensors 107 shown in Fig. 1 and estimation results may be transmitted to the ECU 100, or may be performed in the ECU 100 shown in Fig. 1. In this case, the ECU 100 may be let to receive from the various sensors 107 an input of the estimated value of throttle opening that is calculated based on the value of the intake pipe pressure that is measured at one or the plurality of voluntary points of time when the intake valve is shut, and to determined the amount of fuel to be injected based on the estimated value of the throttle opening that is received as input.

[0055] The estimated value of throttle opening at this time may let to be a value that is calculated based on a difference in the intake pipe pressure that is calculated at the plurality of voluntary points of time. Furthermore, the ECU 100 may be let to receive an input of an amount of variation of the throttle opening that is calculated based on the value of the intake pipe pressure that is measured at one or plurality of voluntary points of time and to control the acceleration and deceleration of the amount of fuel to be injected based on the amount of variation in the throttle opening that is received as input.

[0056] Moreover, the throttle opening estimation method according to this embodiment may be let to be a computer readable program that is arranged in advance or that program may be executed by running in a computer such as a micro computer.

INDUSTRIAL APPLICABILITY

[0057] As described above, according to the present invention, a throttle opening estimation method and an ECU that enable to obtain a throttle opening even if a TPS is not provided, can be achieved.

[0058] Moreover, according to the present invention, a throttle opening estimation method and an ECU that enable to correct a value that is obtained by the TPS to even more accurate value can be achieved.

Claims

1. A throttle opening estimation method comprising:

   an intake pipe pressure measuring step of measuring an intake pipe pressure at any one or a plurality of voluntary points of time when an intake valve is shut; and
   a throttle opening calculation step of calculating a throttle opening from the intake pipe pressure measured at the intake pipe pressure measuring step.

2. The throttle opening estimation method according to claim 1, wherein the throttle opening calculation step includes calculating the throttle opening form number of rotations of an engine and the intake pipe pressure measured at the intake pipe pressure measuring step.

3. A throttle opening estimation method comprising:

   an intake pipe pressure measuring step of measuring an intake pipe pressure at a plurality of voluntary points of time when an intake valve is shut; and
   a throttle opening calculation step of calculating a throttle opening from a difference in the intake pipe pressures measured at the intake pipe pressure measuring step.

4. The throttle opening estimation method according to claim 3, wherein the throttle opening calculation step includes calculating the throttle opening based on number of rotations of an engine and the difference between the intake pipe pressures measured.

5. The throttle opening estimation method according to any one of claims 1 to 4, further comprising:

an engine load calculation step of calculating an engine load from a graph of the intake pipe pressures measured, wherein
the throttle opening calculation step includes limiting the calculation of the throttle opening based on the number of rotations of the engine and the engine load calculated at the engine load calculation step.

6. The throttle opening estimation method according to any one of claims 1 to 5, further comprising:

a TPS value correction step at which a TPS (Throttle Position Sensor) value that indicates an actual throttle opening is corrected using the throttle opening calculated at the throttle opening calculation step.

7. The throttle opening estimation method according to claim 6, wherein the TPS value correction step includes correcting the TPS value only when the TPS value or the throttle opening calculated at the throttle opening calculation step is judged to be closed to an idle.

8. The throttle opening estimation method according to any one of claims 1 to 7, wherein the point of time of measurement at the intake pipe pressure measuring step is synchronized with a crank or an engine stroke.

9. The throttle opening estimation method according to claim 8, wherein the point of time of measurement at the intake pipe pressure measuring step is let to be variable based on the number of rotations of the engine.

10. An ECU (Electronic Control Unit) comprising:

an input unit that receives a throttle opening calculated based on an intake pipe pressure measured at one or a plurality of voluntary points of time when an intake valve is shut; and
a determining unit that determines an amount of fuel to be injected based on the throttle opening received by the input unit.

11. An ECU (Electronic Control Unit) comprising:

an input unit that receives a throttle opening calculated based on a difference in intake pipe pressures measured at a plurality of voluntary points of time when an intake valve is shut; and
a determining unit that determines an amount of fuel to be injected based on the throttle opening received by the input unit.

12. An ECU (Electronic Control Unit) comprising:

an input unit that receives an amount of variation in a throttle opening calculated based on a value of the intake pipe pressure measured at one or a plurality of voluntary points of time when an intake valve is shut; and
a control unit that controls acceleration and deceleration of an amount of fuel to be injected based on the amount of variation received by the input unit.

FIG.1

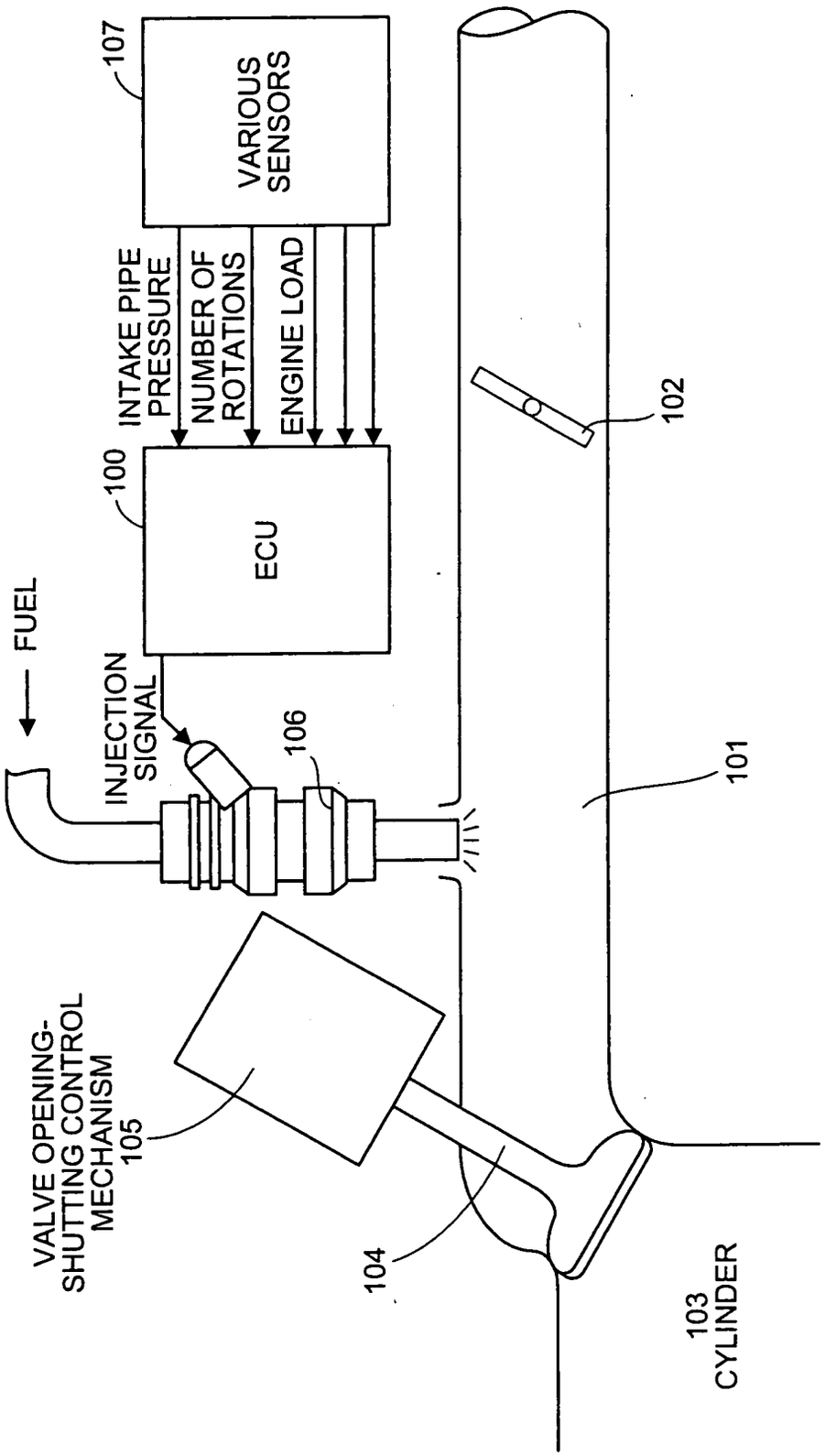

107
VARIOUS SENSORS
INTAKE PIPE PRESSURE
NUMBER OF ROTATIONS
ENGINE LOAD
100
ECU
FUEL
INJECTION SIGNAL
106
102
101
VALVE OPENING-SHUTTING CONTROL MECHANISM
105
104
103
CYLINDER

FIG.2

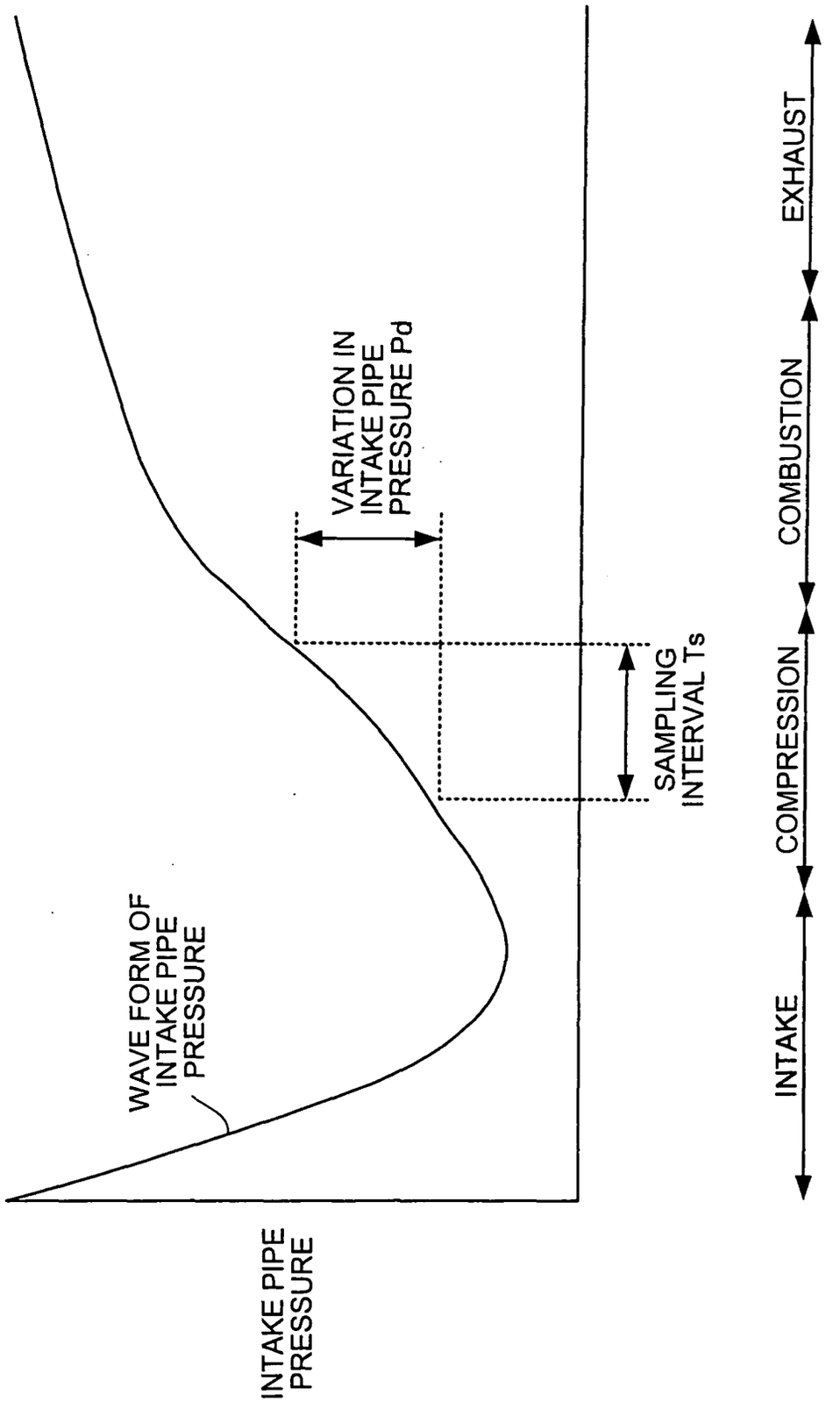

INTAKE PIPE PRESSURE
WAVE FORM OF INTAKE PIPE PRESSURE
VARIATION IN INTAKE PIPE PRESSURE Pd
SAMPLING INTERVAL Ts
INTAKE
COMPRESSION
COMBUSTION
EXHAUST

FIG.3

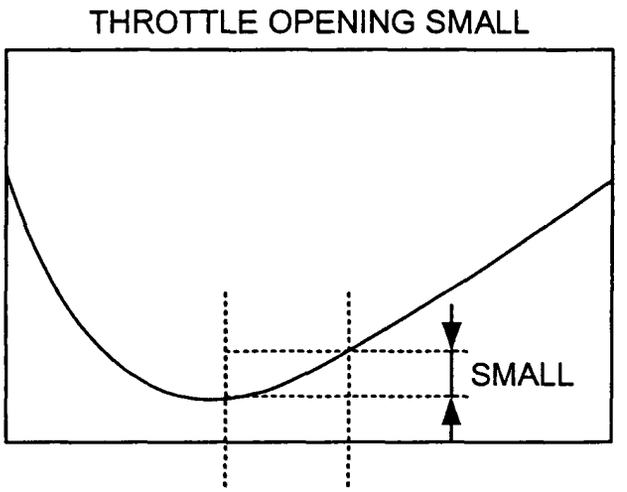

THROTTLE OPENING SMALL
SMALL

FIG.4

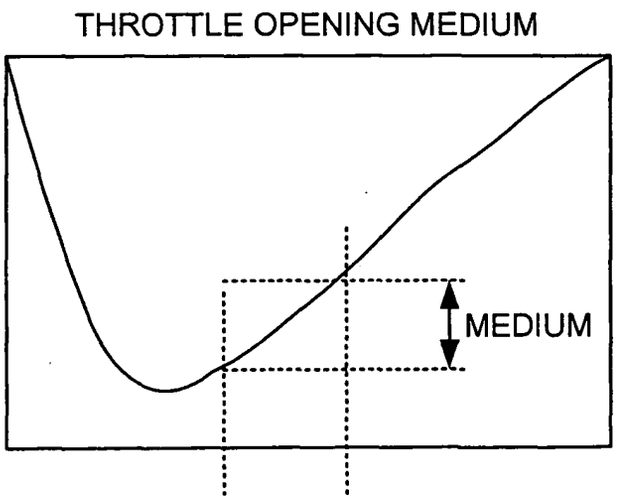

THROTTLE OPENING MEDIUM
MEDIUM

FIG.5

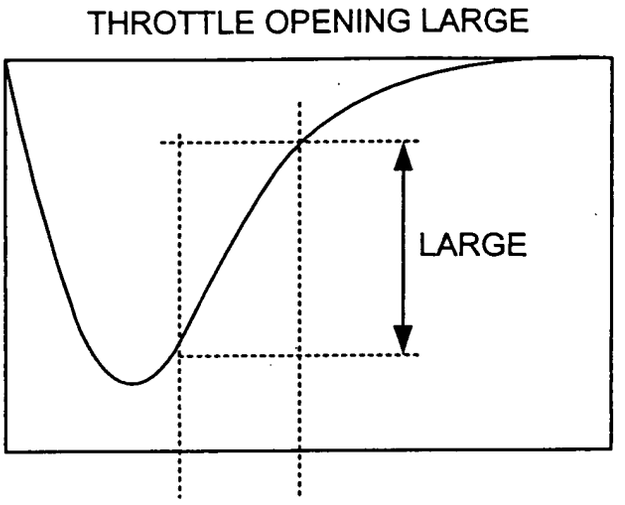

THROTTLE OPENING LARGE
LARGE

FIG.6

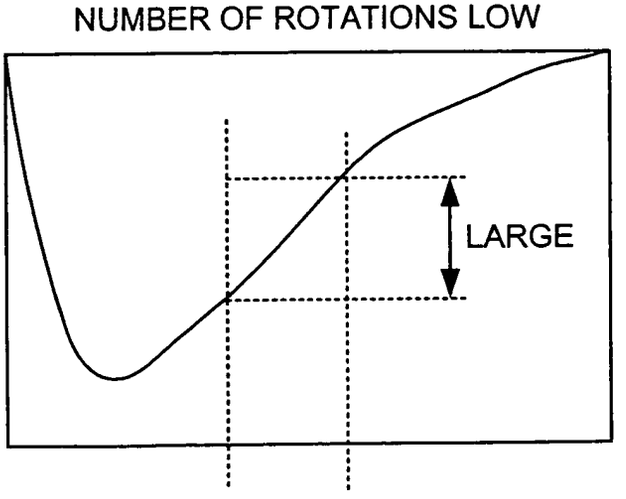

NUMBER OF ROTATIONS LOW
LARGE

FIG.7

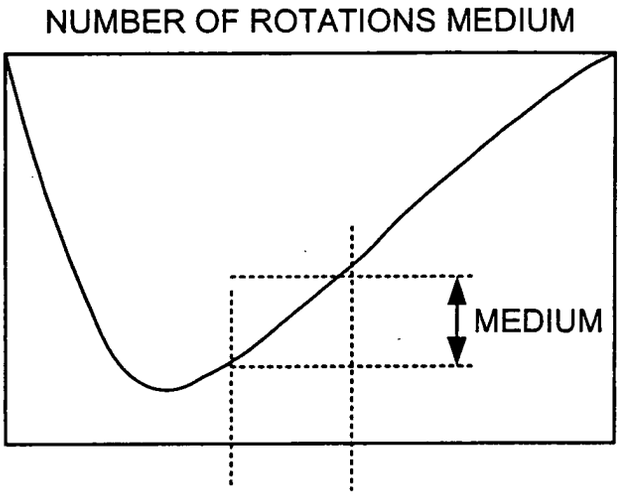

NUMBER OF ROTATIONS MEDIUM
MEDIUM

FIG.8

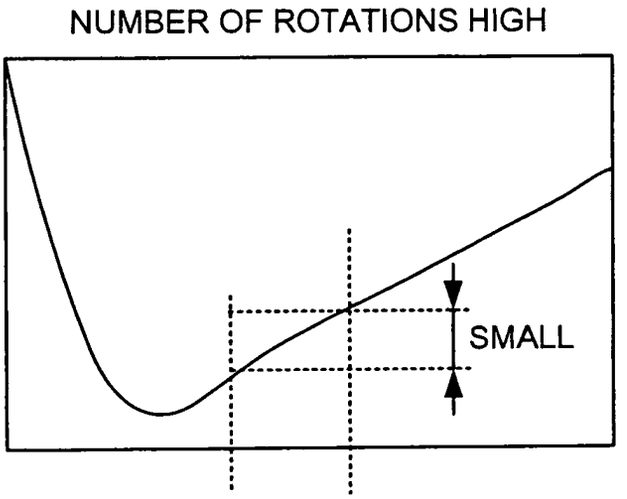

NUMBER OF ROTATIONS HIGH
SMALL

FIG.9

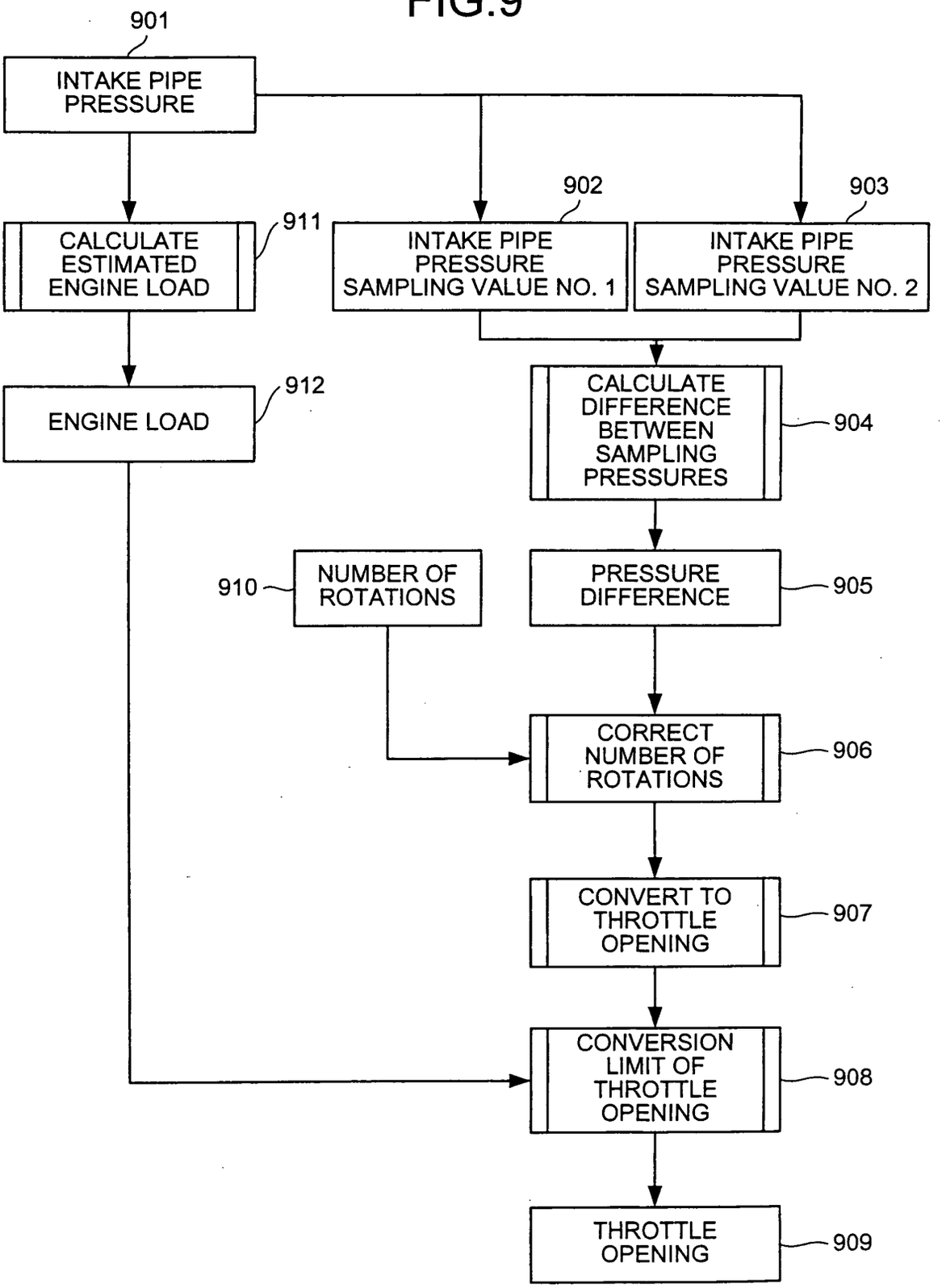

901
INTAKE PIPE PRESSURE
902
903
911
CALCULATE ESTIMATED ENGINE LOAD
INTAKE PIPE PRESSURE SAMPLING VALUE NO. 1
INTAKE PIPE PRESSURE SAMPLING VALUE NO. 2
912
ENGINE LOAD
CALCULATE DIFFERENCE BETWEEN SAMPLING PRESSURES
904
910
NUMBER OF ROTATIONS
PRESSURE DIFFERENCE
905
CORRECT NUMBER OF ROTATIONS
906
CONVERT TO THROTTLE OPENING
907
CONVERSION LIMIT OF THROTTLE OPENING
908
THROTTLE OPENING
909

FIG.10

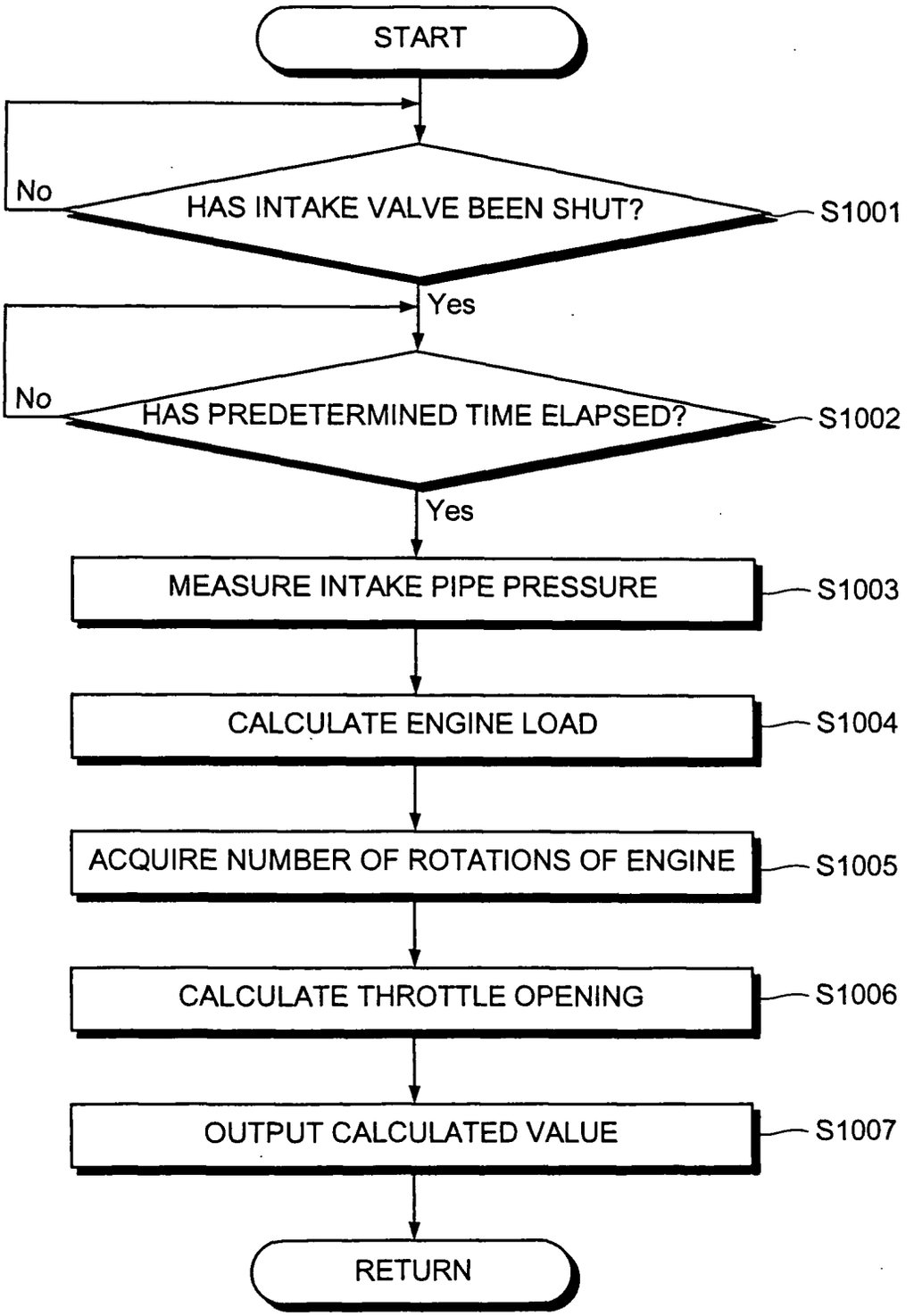

START
No
HAS INTAKE VALVE BEEN SHUT?
S1001
Yes
No
HAS PREDETERMINED TIME ELAPSED?
S1002
Yes
MEASURE INTAKE PIPE PRESSURE
S1003
CALCULATE ENGINE LOAD
S1004
ACQUIRE NUMBER OF ROTATIONS OF ENGINE
S1005
CALCULATE THROTTLE OPENING
S1006
OUTPUT CALCULATED VALUE
S1007
RETURN

FIG.11

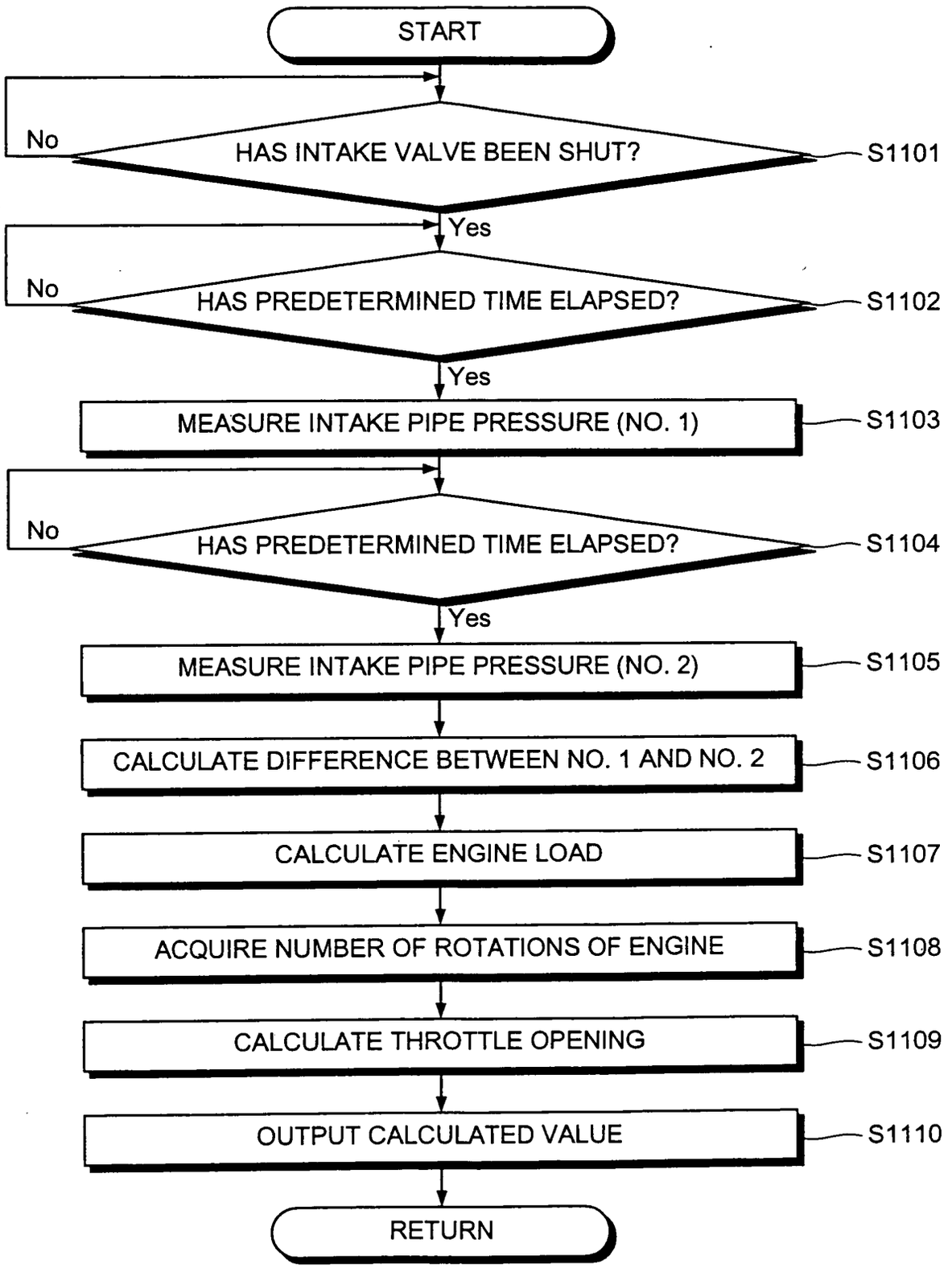

START
No
HAS INTAKE VALVE BEEN SHUT?
S1101
Yes
No
HAS PREDETERMINED TIME ELAPSED?
S1102
Yes
MEASURE INTAKE PIPE PRESSURE (NO. 1)
S1103
No
HAS PREDETERMINED TIME ELAPSED?
S1104
Yes
MEASURE INTAKE PIPE PRESSURE (NO. 2)
S1105
CALCULATE DIFFERENCE BETWEEN NO. 1 AND NO. 2
S1106
CALCULATE ENGINE LOAD
S1107
ACQUIRE NUMBER OF ROTATIONS OF ENGINE
S1108
CALCULATE THROTTLE OPENING
S1109
OUTPUT CALCULATED VALUE
S1110
RETURN

FIG.12

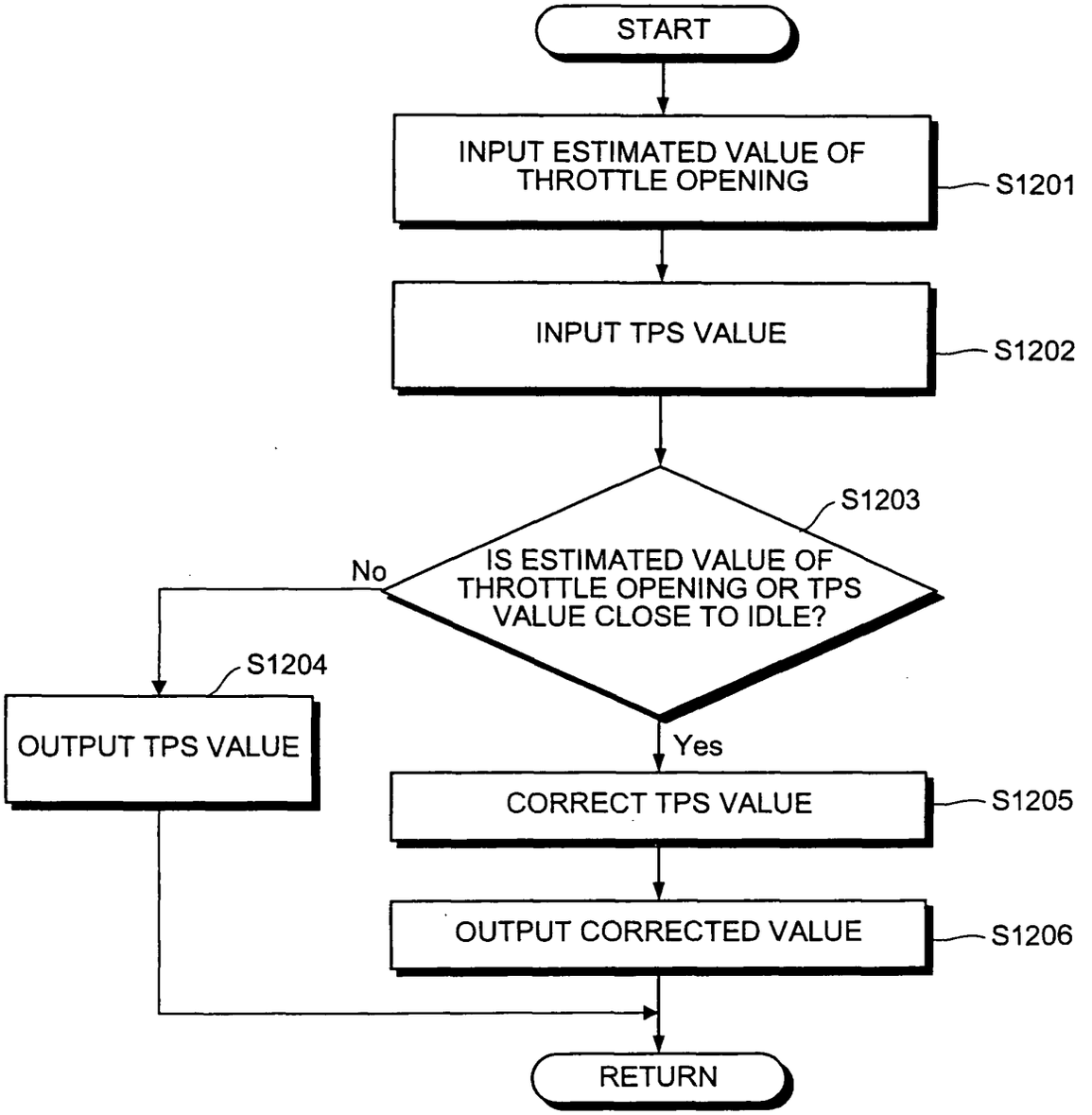

START
INPUT ESTIMATED VALUE OF THROTTLE OPENING
S1201
INPUT TPS VALUE
S1202
S1203
IS ESTIMATED VALUE OF THROTTLE OPENING OR TPS VALUE CLOSE TO IDLE?
No
Yes
S1204
OUTPUT TPS VALUE
CORRECT TPS VALUE
S1205
OUTPUT CORRECTED VALUE
S1206
RETURN

FIG.13

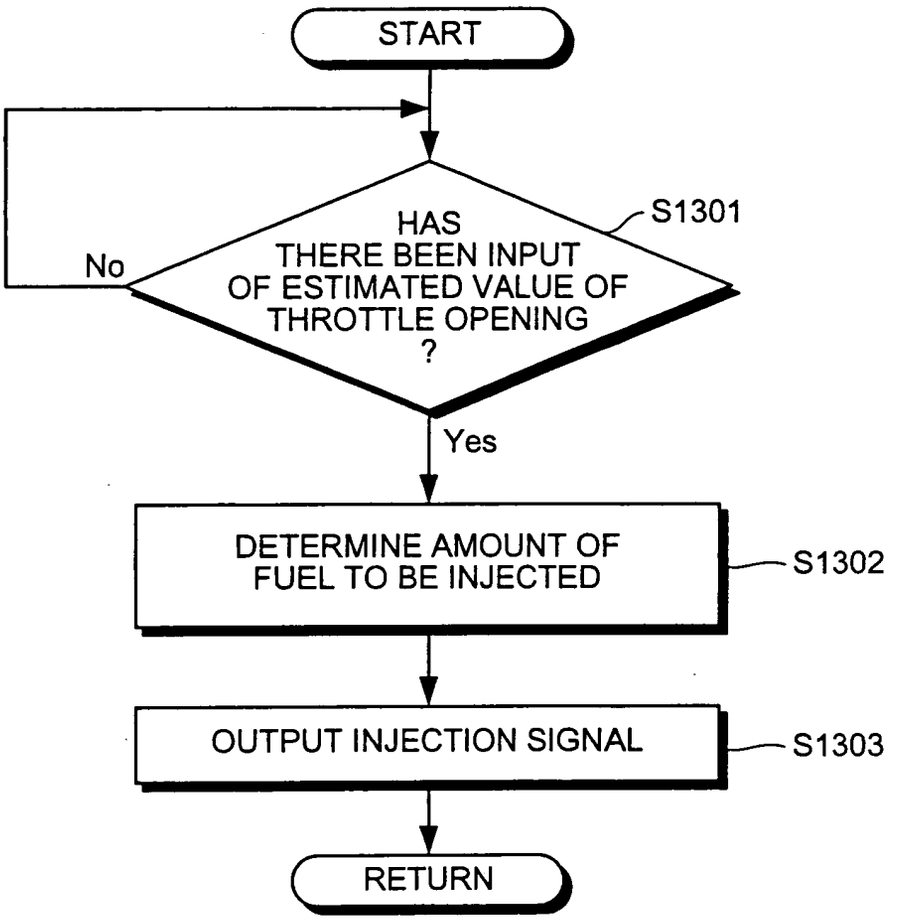
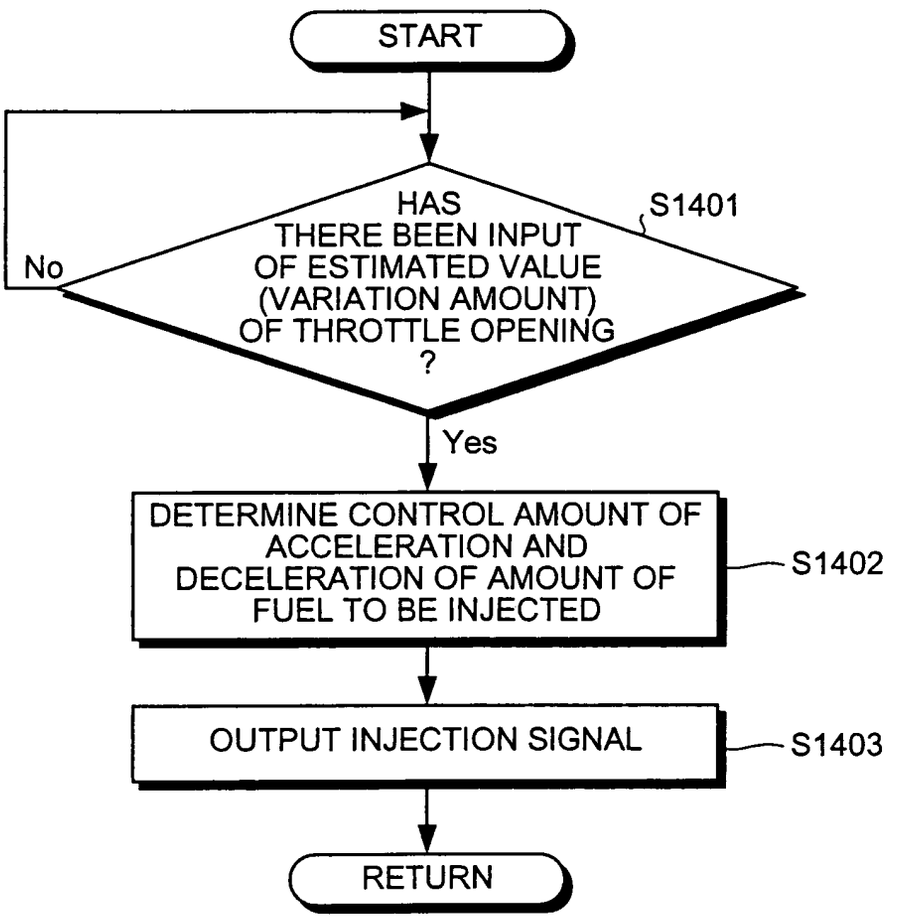

START
HAS THERE BEEN INPUT OF ESTIMATED VALUE OF THROTTLE OPENING ?
S1301
No
Yes
DETERMINE AMOUNT OF FUEL TO BE INJECTED
S1302
OUTPUT INJECTION SIGNAL
S1303
RETURN

FIG.14


START
HAS THERE BEEN INPUT OF ESTIMATED VALUE (VARIATION AMOUNT) OF THROTTLE OPENING ?
S1401
No
Yes
DETERMINE CONTROL AMOUNT OF ACCELERATION AND DECELERATION OF AMOUNT OF FUEL TO BE INJECTED
S1402
OUTPUT INJECTION SIGNAL
S1403
RETURN

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP03/11610

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl[7] F02D45/00, F02D41/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int.Cl[7] F02D45/00, F02D41/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2003
Kokai Jitsuyo Shinan Koho	1971-2003	Toroku Jitsuyo Shinan Koho	1994-2003

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 3-92567 A (Hitachi, Ltd.), 17 April, 1991 (17.04.91), Full text; all drawings (Family: none)	1-12
A	JP 9-29783 A (Mitsubishi Motors Corp.), 12 August, 1997 (12.08.97), Full text; all drawings (Family: none)	1-12
A	JP 7-208253 A (Suzuki Motor Corp.), 08 August, 1985 (08.08.85), Full text; all drawings (Family: none)	1-12

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
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"&" document member of the same patent family

Date of the actual completion of the international search 14 November, 2003 (14.11.03)	Date of mailing of the international search report 09 December, 2003 (09.12.03)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

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