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Masaki et al.

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[45] Jan. 21, 1975

# [54] AIR-FUEL MIXTURE SUPPLY CONTROL SYSTEM FOR USE WITH CARBURETORS FOR INTERNAL COMBUSTION ENGINES

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[73] Assignee: **Nissan Motors Company, Limited,** Yokohama, Japan

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[21] Appl. No.: **351,009**

[30] **Foreign Application Priority Data**
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[51] **Int. Cl.** .. **F02d 35/00,** F02b 15/00, F02d 33/00
[58] **Field of Search**.... 123/119 R, 32 EA, 139 AW, 123/100, 106

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*Primary Examiner*—Charles J. Myhre
*Assistant Examiner*—Tony Argenbright

[57] **ABSTRACT**

An electronic system for controlling a carburetor to supply an air-fuel mixture to an internal combustion engine at an optimum air-fuel ratio under all continuously variably conditions of engine speed, engine temperature, throttle opening and atmospheric pressure.

**24 Claims, 13 Drawing Figures**

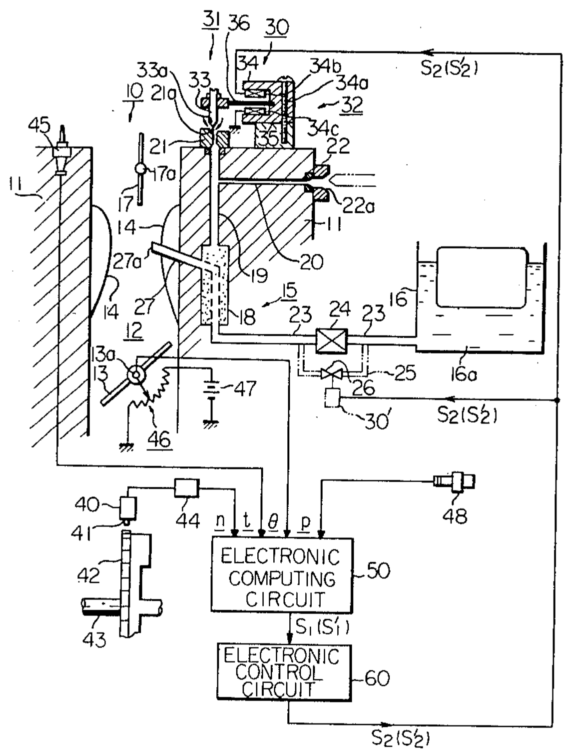
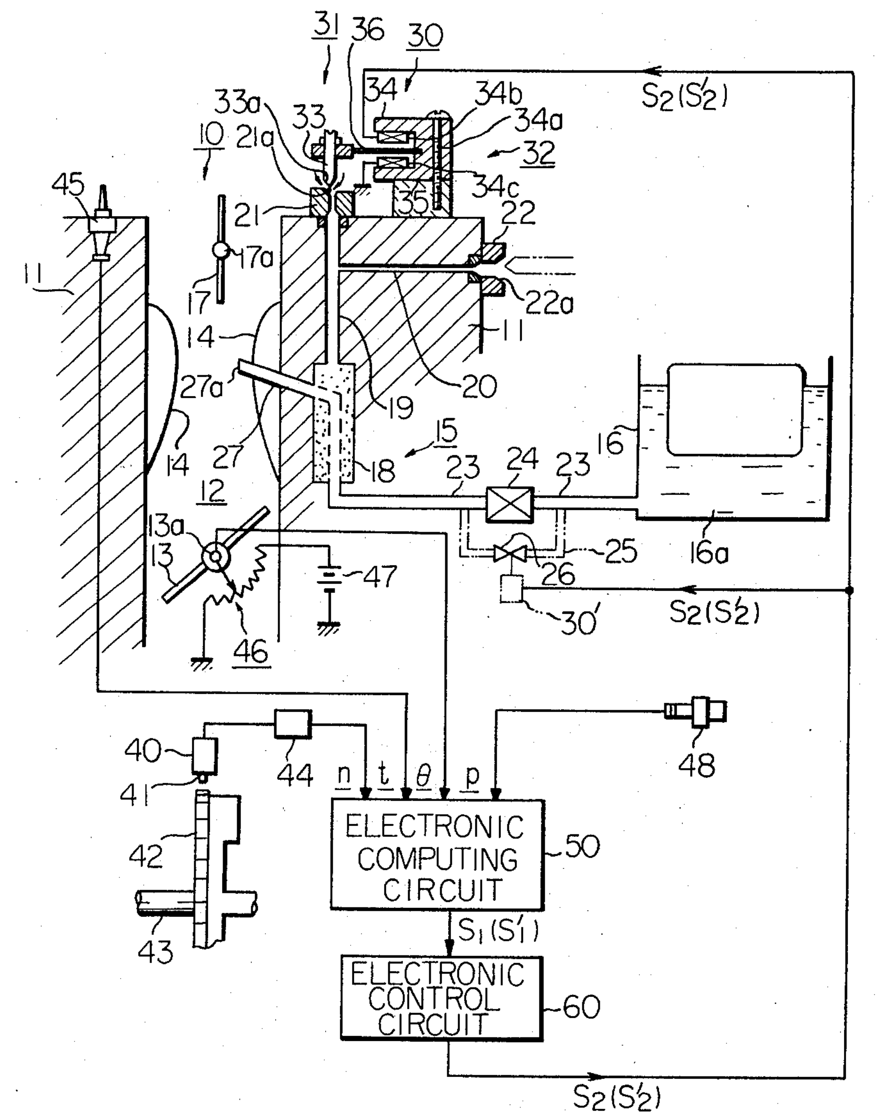


Fig. 1


31
36
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34
34b
34a
32
33a
33
10
21a
35
34c
45
21
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17
22a
14
27a
19
20
15
16
14
27
18
24
23
23
12
13a
13
25
26
16a
47
30'
46
S2(S'2)
S2(S'2)
40
44
48
n
t
θ
p
41
42
ELECTRONIC COMPUTING CIRCUIT
50
43
S1(S'1)
ELECTRONIC CONTROL CIRCUIT
60
S2(S'2)

Fig. 2

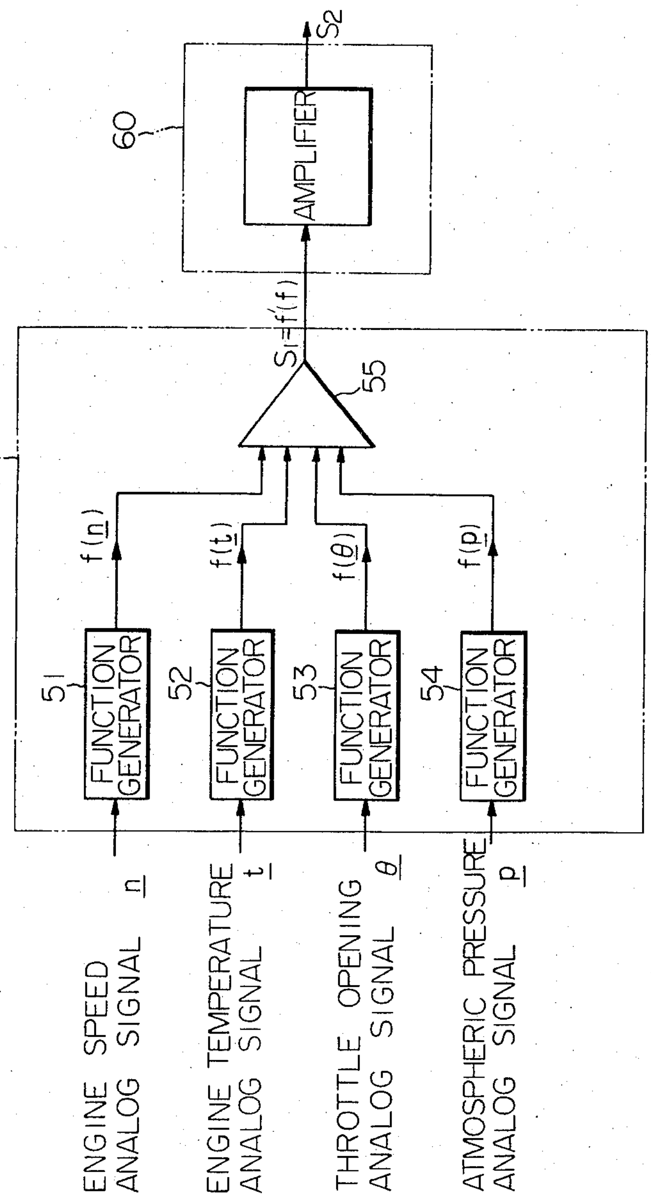

ENGINE SPEED ANALOG SIGNAL n
ENGINE TEMPERATURE ANALOG SIGNAL t
THROTTLE OPENING ANALOG SIGNAL θ
ATMOSPHERIC PRESSURE ANALOG SIGNAL p
50
51
52
53
54
FUNCTION GENERATOR
FUNCTION GENERATOR
FUNCTION GENERATOR
FUNCTION GENERATOR
f(n)
f(t)
f(θ)
f(p)
55
S1=f'(f)
60
AMPLIFIER
S2

Fig. 3

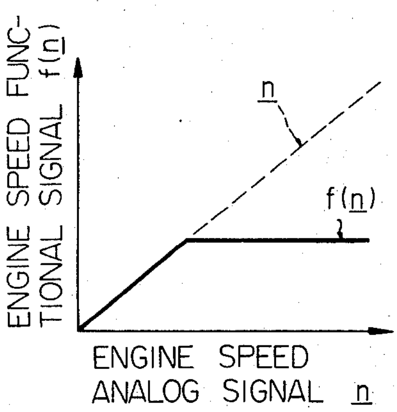



Fig. 4

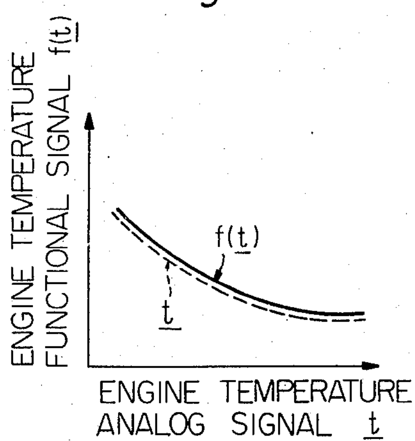



Fig. 5

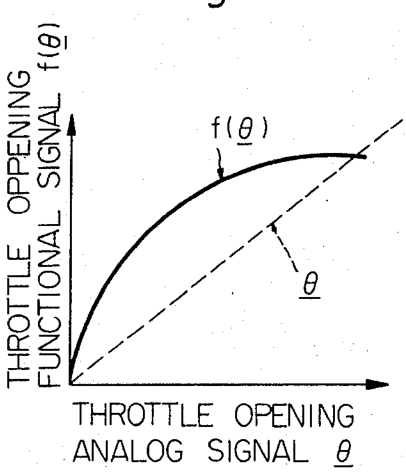



Fig. 6

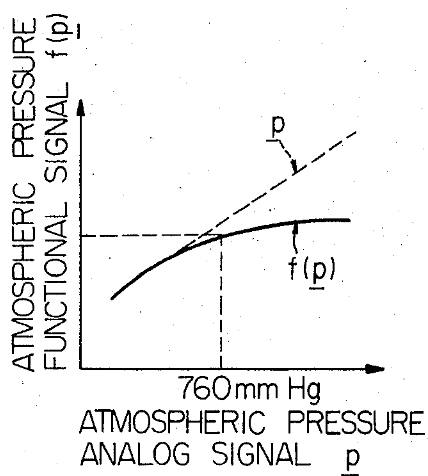


Fig. 7

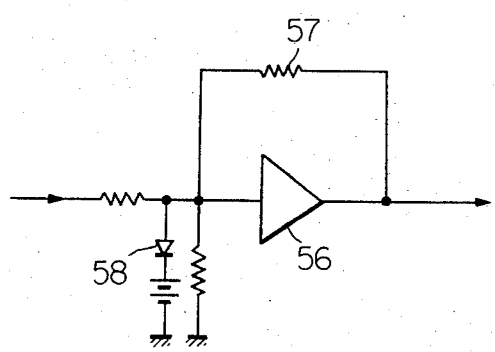



Fig. 8

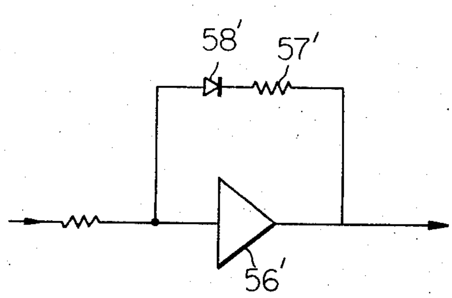


Fig. 9

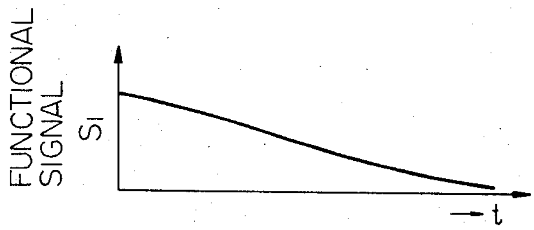



Fig. 11

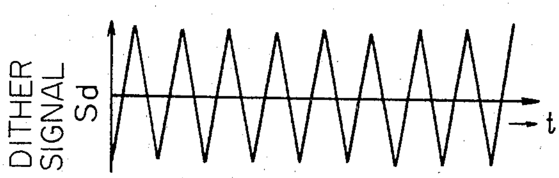
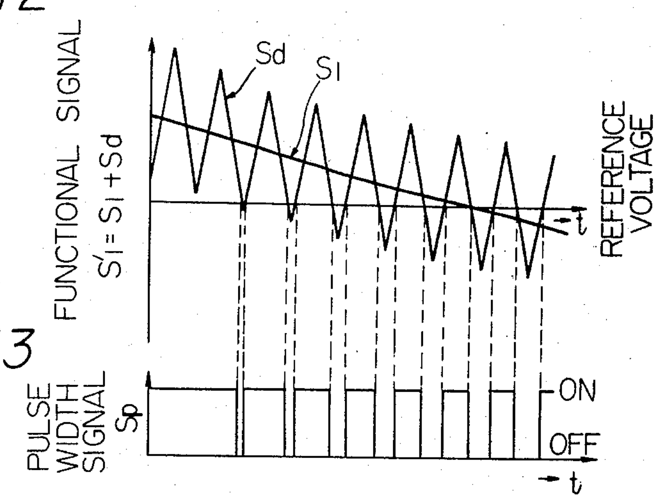



Fig. 12

Fig. 13



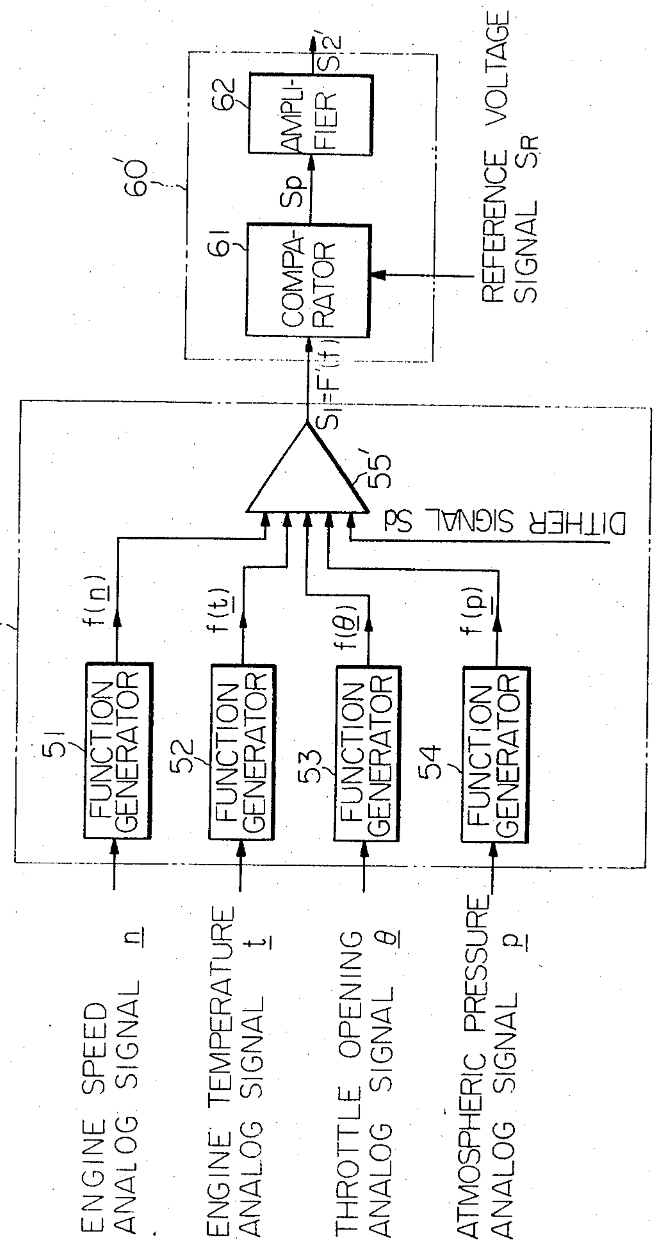

ENGINE SPEED ANALOG SIGNAL n
ENGINE TEMPERATURE ANALOG SIGNAL t
THROTTLE OPENING ANALOG SIGNAL θ
ATMOSPHERIC PRESSURE ANALOG SIGNAL p
FUNCTION GENERATOR
51
52
53
54
50
f(n)
f(t)
f(θ)
f(p)
DITHER SIGNAL Sd
55'
S1=F'(f)
COMPA-RATOR
61
60'
Sp
AMPLI-FIER
62
S2'
REFERENCE VOLTAGE SIGNAL SR

Fig. 10

# AIR-FUEL MIXTURE SUPPLY CONTROL SYSTEM FOR USE WITH CARBURETORS FOR INTERNAL COMBUSTION ENGINES

The present invention relates generally to carburetors for internal combustion engines of motor vehicles and, more particularly, to an air-fuel mixture supply control system for electronically controlling a carburetor to supply an air-fuel mixture to an internal combustion engine at an optimum air-fuel ratio under variable engine operating conditions.

Unburned hydrocarbons in engine exhaust gases are significant for two major reasons: they are causes of air pollution, and they indicate poor fuel burning efficiency. For the purpose of eliminating or minimizing unburned hydrocarbons in exhaust gases, many attempts have been made to optimize the air-fuel ratio of the air-fuel mixture being supplied to an internal combustion engine. However, many difficulties have been encountered in prior art methods in maintaining the air-fuel mixture at an optimum air-fuel ratio under the widely varying operating conditions of a motor vehicle.

As is well known in the art, it has been customary to incorporate into a carburetor an automatic choke mechanism which meters intake air in response to variations in engine temperature. However, since an automatic choke is responsive to variations in engine temperature only, it has also been customary to incorporate into a carburetor a system of fuel jets and air bleeds of fixed cross-sectional areas, in a further attempt to provide a proper air-fuel ratio corresponding to varying engine operating conditions such as idling, acceleration, deceleration and cruising. However, it is to be appreciated that these prior art devices are only approximately effective in adjusting the air-fuel ratio to an optimum value in response to subtle variations in engine speed, engine temperature, throttle opening and atmospheric pressure.

The lack of precision and efficiency of prior art air-fuel mixture supply control systems is a direct cause of not only poor fuel economy, but also air pollution caused by unburned hydrocarbons contained in exhaust gases emitted from internal combustion engines. Thus, there is a pressing need for an air-fuel mixture supply control system which will supply an air-fuel mixture to an internal combustion engine at an optimum air-fuel ratio under all operating conditions of the engine, and thus reduce to a minimum the undesirable effects of poor fuel economy and air pollution.

It is accordingly a principal object of the present invention to provide an air-fuel mixture supply control system for a carburetor of a motor vehicle, which system is capable of electronically controlling the carburetor to supply an air-fuel mixture to an internal combustion engine at an optimum air-fuel ratio under all engine operating conditions.

It is another object of the present invention to provide an air-fuel mixture supply control system which is capable of eliminating or minimizing air pollution caused by the presence of unburned hydrocarbons in engine exhaust gases, and simultaneously provide increased fuel economy in operating an internal combustion engine due to increased combustion efficiency.

It is still another object of the present invention to provide an air-fuel mixture supply control system which is highly reliable in operation and can easily be installed on an existing carburetor.



It is a further object of the present invention to provide an air-fuel mixture supply control system which is capable of improving the driveability of the motor vehicle.

It is still a further object of the present invention to provide an air-fuel mixture supply control system which is capable of prolonging the expected life span of an exhaust gas cleaner incorporated in a motor vehicle.

An air-fuel mixture supply control system in accordance with the present invention controls a carburetor of an internal combustion engine to supply an air-fuel mixture to the engine at an optimum air-fuel ratio under all engine operating conditions by sensing the engine speed, engine temperature, throttle opening and atmospheric pressure by means of appropriate sensors, producing an electronic functional signal representing an optimum mixture air-fuel ratio corresponding to the above mentioned sensed conditions in an electronic computing circuit, transforming the electronic functional signal into an electronic operating signal in an electronic control circuit, and applying the electronic operating signal to an actuating mechanism which either adjusts the flow of air entering the carburetor or adjusts the flow of fuel passing through a metering section of the carburetor in response to the received electronic operating signal.

These and other objects and advantages of the present invention wil become apparent from the following detailed description taken in conjunction with the accompanying drawings in which like reference numerals designate corresponding parts in all figures and in which:

FIG. 1 is a schematic sectional view of an overall configuration of an air-fuel mixture supply control system according to the present invention and a carburetor controlled thereby;

FIG. 2 is a schematic block diagram of a preferred embodiment of an electronic computing circuit and an electronic control circuit shown in FIG. 1;

FIG. 3 shows the relationship between an engine speed analog signal and an electronic functional signal produced therefrom;

FIG. 4 shows the relationship between an engine temperature analog signal and an electronic functional signal produced therefrom;

FIG. 5 shows the relationship between a throttle opening analog signal and an electronic functional signal produced therefrom;

FIG. 6 shows the relationship between an atmospheric pressure analog signal and an electronic functional signal produced therefrom;

FIG. 7 shows an example of a function generator shown in FIG. 2;

FIG. 8 shows another example of a function generator shown in FIG. 2;

FIG. 9 shows an example of an electronic functional signal representing an optimum air-fuel ratio of an air-fuel mixture being supplied to an internal combustion engine as a function of time;

FIG. 10 is a schematic block diagram of another preferred embodiment of an electronic computing circuit and an electronic control circuit shown in FIG. 1;

FIG. 11 shows an example of an electric dither signal to be fed into a summing circuit shown in FIG. 10;

FIG. 12 shows an example of an electronic signal in which an electric dither signal shown in FIG. 11 is combined with an electronic functional signal shown in FIG. 9; and

FIG. 13 shows an example of an electric pulse width signal produced from the electronic signal shown in FIG. 12 by the comparator shown in FIG. 10.

Referring more particularly to FIG. 1, there is shown an air-fuel mixture supply control system of the present invention and a carburetor controlled thereby, the carburetor being generally indicated by a reference numeral 10. The carburetor 10 comprises a carburetor body 11, the inner surface of which defines a carburetor induction passage 12 communicating with an intake manifold of an internal combustion engine (not shown). The carburetor 10 is also provided with a throttle valve 13 which is fixedly mounted on a rotatable shaft 13*a* for rotation in the carburetor induction passage 12, a venturi 14, a fuel mixing system generally designated by a numeral 15, a float chamber 16 containing and supplying fuel 16*a* into the fuel mixing system 15 therefrom, and a choke valve 17 which is fixedly mounted on a rotatable shaft 17*a* for rotation in the carburetor induction passage 12. The carburetor body 11 has further formed therein an air-fuel mixing chamber 18 which is disposed in the fuel mixing system 15, a main air supply passage 19 and an auxiliary air supply passage 20 for supplying air into the air-fuel mixing chamber 18 from the ambient atmosphere through air bleed jets 21 and 22 respectively which are mounted on the carburetor body 11 and have openings 21*a* and 22*a* respectively, and a main fuel supply passage 23 for supplying fuel into the air-fuel mixing chamber 18 from the float chamber 16 through a main fuel jet 24 which is disposed therein. The main fuel jet 24 of the main fuel supply passage 23 is bypassed by an auxiliary fuel supply passage 25 which is provided with an auxiliary fuel jet 26 therein. The fuel mixing system 15 opens into the venturi 14 through a nozzle 27 having an opening or port 27*a* so as to introduce air-fuel mixture from the air-fuel mixing chamber 18 into the carburetor induction passage 12.

The air bleed jets 21 and 22 are so designed that the effective cross-sectional areas of their openings 21*a* and 22*a* have predetermined fixed values for effective operation. The fuel jets 24 and 26 also have cross-sectional areas which are predetermined fixed values for effective operation, and fuel introduced through the fuel jets 24 and 26 into the air-fuel mixing chamber 18 is mixed with air introduced therein through the air bleed jets 21 and 22. Air-fuel mixture from the air-fuel mixing chamber 18 is sucked into the venturi 14 through the nozzle 27 by vacuum produced in the venturi 14 by normal operation of the engine. Thus, it is to be appreciated that the amount and air-fuel ratio of air-fuel mixture sucked into the venturi 14 and accordingly into the carburetor induction passage 12 is determined by the effective cross-sectional areas of the openings 21*a* and 22*a* of the air bleed jets 21 and 22, the effective cross-sectional areas of the fuel jets 24 and 26, the level of vacuum in the venturi 14, and the difference in height between the port 27*a* of the nozzle 27 and the surface of the fuel 16*a* in the float chamber 16 (normally maintained as constant). Accordingly, it may be appreciated that control of the air-fuel ratio of the air-fuel mixture being supplied into the carburetor induction passage 12 can be accomplished by varying at least one of the cross-sectional areas of the openings 21*a* and 22*a* of the air-bleed jets 21 and 22 respectively, and the fuel jets 24 and 26.

An air-fuel ratio control mechanism of the present invention will be hereinafter be described for the purpose of example as comprising an air supply metering device 30 shown in FIG. 1, which controls the amount of air entering the air bleed jet 21 from the ambient atmosphere by varying the effective cross-sectional area at the opening 21*a* of the air bleed jet 21.

The air supply metering device 30 generally comprises an air flow control valve assembly 31 which is operatively disposed over the opening 21*a* of the air bleed jet 21 for controlling the amount of air entering the main air supply passage 19, and an electric actuating device 32 for actuating the air flow control valve assembly 31. The air flow control valve assembly 31 comprises a needle valve 33 which has a tapered tip 33*a* projecting into the opening 21*a*. The tapered tip 33*a* is operative to move into the opening 21a to a full or partial extent, and thereby vary the effective cross-sectional area at the opening 21*a* and accordingly the amount of air passing therethrough into the main air supply passage 19. The electric actuating device 32 comprises a stationary core 34 forming a housing 35 which is mounted on the carburetor body 11 by a suitable fastening means such as at least one screw 34*a* and is provided therein with a pair of solenoid coils 34*b* and 34*c* which are positioned as facing each other and a movable core 36 which rockably connected at one end thereof to the housing 35. The movable core 36 is connected at its other end to the needle valve 33 so as to rockably move the tapered tip 33*a* of the needle valve 33 into the opening 21*a* of the air bleed jet 21 in response to a magnetic force induced in the solenoid coils 34*b* and 34*c*.

It is to be appreciated that, although the air supply metering device 30 is mounted on the carburetor body 11 so as to vary the effective cross-sectional area at the opening 21*a* of the air bleed jet 21 which opens into the main air supply passage 19, it may be mounted on the carburetor body 11 so as to vary the effective cross-sectional area at the opening 22*a* of the air bleed jet 22 which opens into the auxiliary air supply passage 20, such that the amount of air entering the air-fuel mixing chamber 18 is effectively metered in response to varying operating conditions of the engine.

It is further to be appreciated that an air supply metering device 30 of this invention as described above may alternatively be embodied as a fuel supply metering device 30′ which in this case is so arranged as to be operable to vary the effective cross-sectional area of the auxiliary fuel jet 26 which is located in the auxiliary fuel supply passage 25, such that the fuel supply metering device 30′ shown in FIG. 1 varies the amount of fuel supplied into the air-fuel mixing chamber 18 in response to varying engine operating conditions.

Moreover, it is to be appreciated that a fuel supply metering device 30′ may be alternatively adapted to control the main fuel jet 24 in an essentially similar manner as described above in relation to the auxiliary fuel jet 26.

The fuel supply metering device 30′ described above operates and functions in an essentially similar manner with the air supply metering mechanism 30 also previously described so that a detailed explanation of the operation of the fuel supply metering device 30′ can be dispensed with.

In order to effectively control the air supply metering device **30** and/or the fuel supply metering device **30'** in response to all operating conditions of the engine, an air-fuel mixture supply control system of this invention is provided with at least one of an engine speed sensor **40** having a gear **41** engaging with a gear **42** which is fixably mounted on an engine driven shaft **43** to produce an electric engine speed pulse signal which is covered by a converter **44** into an electric engine speed analog signal $n$, an engine temperature sensor **45** comprising, for example, a thermistor which is mounted on the carburetor body **11** to produce an electric engine temperature analog signal $t$, a throttle opening sensor **46** comprising, for example, a potentiometer to produce an electric throttle opening analog signal $\theta$, and an atmospheric pressure sensor **48** comprising, for example, a pressure sensitive element to produce an atmospheric pressure analog signal $p$. The electric analog signals $n$, $t$, $\theta$ and $p$ are fed into an electronic computing circuit **50** which modifies and combines the analog signals $n$, $t$, $\theta$ and $p$ and produces an electronic functional signal $S_1$ representing an optimum air-fuel ratio for an air-fuel mixture being supplied into the engine as a function of the above mentioned sensed conditions. The electronic functional signal $S_1$ is fed into an electronic control circuit **60** which produces an electronic operating signal $S_2$ which is fed into the solenoid coils **34***b* and **34***c* of the air supply metering device **30** and/or the fuel supply metering device **30'** for actuation thereof.

FIG. **2** illustrates an embodiment of an electronic computing circuit **50** and an electronic control circuit **60** shown in FIG. **1.** The computing circuit **50** generally comprises four function generators **51, 52, 53** and **54,** and a summing circuit **55.** When, in operation, the function generator **51** receives an engine speed analog signal $n$ from the engine speed sensor **40** through the converter **44,** it produces an electronic functional signal $f(n)$ which is then fed into the summing circuit **55.** Similarly, when the function generator **52** receives an engine temperature analog signal $t$ from the engine temperature sensor **45,** it produces an electronic functional signal $f(t)$ which is then fed into the summing circuit **55**; when the function generator **53** receives a throttle opening analog signal $\theta$ from the throttle opening sensor **46,** it produces an electronic functional signal $f(\theta)$ which is then fed into the summing circuit **55**; and when the function generator **54** receives an atmospheric pressure analog signal $p$ from the atmospheric pressure sensor **48,** it produces an electronic functional signal $f(p)$ which is then fed into the summing circuit **55.** The summing circuit **55** upon receiving the functional signals $f(n)$, $f(t)$, $f(\theta)$ and $f(p)$ from the respective function generators **51, 52, 53** and **54** produces an electronic functional signal $S_1$ which represents optimum air-fuel ratio of an air-fuel mixture being supplied into the internal combustion engine. The electronic functional signal $S_1$ is equal to an electronic functional signal $f'(f)$ which is obtained from the following relation:

$$S_1 = f'(f) = f(n) + f(t) + f(\theta) + f(p)$$

The electronic functional signal $S_1$ is then fed into the electronic control circuit **60** which produces an electronic operating signal $S_2$ which is then fed into the air supply metering device **30** and/or the fuel supply metering mechanism **30'**, as shown in FIG. **1.**

Reference is now made to FIGS. **3** to **6** in which the relationships between the electric analog signals $n$, $t$, $\theta$ and $p$ fed into the respective function generator **51, 52, 53** and **54,** and the respective electronic functional signals $f(n)$, $f(t)$, $f(\theta)$ and $f(p)$ produced by the respective function generators is clearly shown. FIG. **3** shows the relationship between an engine speed analog signal $n$ and an electronic functional signal $f(n)$ produced by the function generator **51** in response thereto. The engine speed analog signal $n$ as represented by a broken line is a signal produced by the converter **44** in response to a received engine speed pulse signal generated by the engine speed sensor **40** and represents the engine speed. The function generator modifies the engine speed analog signal $n$ to produce an electronic functional signal $f(n)$, an example of which is represented by a solid line.

FIG. **4** shows the relationship between an engine temperature analog signal $t$ and an electronic functional signal $f(t)$ produced therefrom. The engine temperature analog signal $t$ represented by a broken line is fed from the engine temperature sensor **45** into the function generator **52** which then produces the electronic functional signal $f(t)$, an example of which is represented by a solid line. The functional signal $f(t)$ represents an optimum air-fuel ratio of an air-fuel mixture being supplied into the engine in response to the sensed engine temperature.

FIG. **5** shows the relationship between a throttle opening analog signal $\theta$ and an electronic functional signal $f(\theta)$ produced therefrom. The throttle opening analog signal $\theta$ as represented by a broken line is fed from the throttle opening sensor **46** into the function generator **53** which then produces an electronic functional signal $f(\theta)$ an example of which is represented by a solid line. The functional signal $f(\theta)$ represents an optimum air-fuel ratio of an air-fuel mixture being supplied into the engine in response to the sensed throttle opening.

FIG. **6** shows the relationship between an atmospheric pressure analog signal $p$ as represented by a broken line which is fed from the atmospheric pressure sensor **48** into the function generator **54** which then produces an electronic functional signal $f(p)$, an example of which is represented by a solid line. The functional signal $f(p)$ represents an optimum air-fuel ratio of an air-fuel mixture being supplied into the engine at the sensed atmospheric pressure.

Examples of circuit arrangements of the function generators employed in the invention are shown in FIGS. **7** and **8.** In FIG. **7,** the function generator generally comprises a functional amplifier **56,** a resistor **57** connected between the input and output terminals of the functional amplifier **56,** and a diode **58.** A function generator of this configuration may be utilized for producing an electronic functional signal in response to a received engine speed analog signal $n$, an engine temperature analog signal $t$, or a throttle opening analog signal $\theta$. In FIG. **8,** a function generator comprises an functional amplifier **56'** and a resistor **57'** and diode **58'** connected in electrical series with each other between the input and output terminals of the functional amplifier **56'**. A function generator of this configuration may be utilized for producing an electronic functional signal in response to a received atmospheric pressure analog signal $p$.

As mentioned above, the electronic functional signals $f(n)$, $f(t)$, $f(\theta)$ and $f(p)$ generated by the function generators **51, 52, 53** and **54** respectively are fed into the summing circuit **55** in which the functional signals are combined. The summing circuit **55** then produces an electronic functional signal $S_1 = f'(f)$ as shown in FIG. **9.** The functional signal $S_1$ is then fed into the electronic control circuit **60** in which the signal is transformed into an electronic operating signal $S_2$. The operating signal $S_2$ is supplied to the air supply metering device **30** and/or the fuel supply metering device **30'** for actuation thereof, such that the air-fuel ratio of the air-fuel mixture being supplied to the engine is continuously adjusted to an optimum value in response to the sensed combination of engine operating conditions.

FIG. **10** illustrates another embodiment of an electronic computing circuit **50** and an electronic control circuit **60** shown in FIG. **1.** In this embodiment, a summing circuit **55'** receives an electric dither signal $Sd$ such as triangular signal which is produced by a dither signal generator (not shown) as illustrated in FIG. **11** in addition to the functional signals $f(n)$, $f(t)$, $f(\theta)$ and $f(p)$, and produces an electronic functional signal $S_1'$ which is equal to an electronic functional signal $F'(f)$, an example of which is shown in FIG. **12.** The functional signal $F'(f)$ is produced by combining the dither signal $Sd$ and the functional signal $S_1$ as shown in FIG. **9.** The functional signal $F'(f)$ is fed into an electronic control circuit **60'** comprising a comparator **61** to which a reference voltage signal $S_R$ as shown in FIG. **12** is supplied from a reference voltage signal generator (not shown), and an amplifier **62.** The comparator **61** produces an electric pulse width signal $S_p$ in response to the reference voltage signal $S_R$ and the input functional signal $F'(f)$, an example of which is shown in FIG. **13.** This pulse width signal $S_p$ is fed into the amplifier **62** in which it is amplified. The output signal from the amplifier **62** is an electronic operating signal $S'_2$, and is fed into the air supply metering device **30** and/or the fuel supply metering device **30'**. The air supply metering device **30,** for example, is actuated by the operating signal $S'_2$ in such a way that the tapered tip **33**$a$ of the needle valve **33** is moved into the opening **21**$a$ of the air bleed jet **21,** for example, so as to completely or partially close the opening **21**$a$ when the operating signal $S'_2$ has an instantaneous positive polarity or "ON" state, and is moved out of the opening **21**$a$ when the operating signal $S'_2$ has an instantaneous negative polarity or "OFF" state, as shown in FIG. **13.** Thus, it can be seen that the proportion of time the opening **21**$a$ is closed by the tapered tip **33**$a$ of the needle valve **33** is determined by the proportion of time the operating signal $S'_2$ has a positive polarity or "ON" state, and that the proportion of time the opening **21**$a$ is covered and consequently the amount of air passing into the main air supply passage **19** can be continuously varied by varying the pulse widths of the pulses of the operating signal $S'_2$.

Since the widths of the pulses of the operating signal $S'_2$ are determined by the reference voltage signal $S_R$ and the functional signal $S'_1$ which is in turn determined by the sensed engine operating conditions, it can be appreciated that this embodiment of the present invention effectively controls a carburetor of an internal combustion engine to provide an optimum air-fuel mixture under all engine operating conditions by alternately opening and closing an air bleed intake port of the carburetor at a ratio determined by sensed operating conditions of the engine.

In this embodiment, any problems which might be encountered due to friction or hysteres is in the air supply metering device **30** and/or the fuel supply metering device **30'** respectively are effectively eliminated by controlling the air supply metering device **30** and/or the fuel supply metering device **30'** respectively in an on-off manner.

The herein presented detailed descriptions of preferred embodiments of the present invention are for the purpose of explaining the principles thereof only, and are not to be considered as limiting or restricting the present invention, since many modifications may be made by exercise of skill in the art without departing from the scope of the present invention.

What is claimed is:

**1.** In a carburetor for an internal combustion engine having air and fuel supplying means which include mixing means for mixing air and fuel, at least one air supply passageway and a main fuel supply passageway for supplying air and fuel respectively into said mixing means, said at least one air supply passageway being in communication with the ambient atmosphere, a fuel supply reservoir for supplying fuel into said main fuel supply passageway, a flow control means operatively disposed in said main fuel supply passageway, an air-fuel mixture supply passageway for supplying air-fuel mixture from said mixing means into an induction passage of said carburetor, throttling means operatively disposed in said induction passage for controlling the amount of said air-fuel mixture being supplied into said engine, an auxiliary fuel supply passageway bypassing said flow control means of said main fuel supply passageway, flow control means operatively disposed in said auxiliary fuel supply passageway, and an air bleed jet mounted on said carburetor and communicating between the ambient atmosphere and said air and fuel supplying means; an air-fuel mixture supply control system which comprises:

electronic computing means responsive to at least one of electric signals representing prevailing values of engine operating conditions including engine speed, engine temperature, throttle opening and atmospheric pressure to produce an electric output signal representing an optimum air-fuel ratio of said air-fuel mixture and corresponding at all times to prevailing engine operating conditions;

electronic control means responsive to said output signal from said electronic computing means to produce an electric operating signal; and

an air supply metering device which is actuated by said operating signal from said electronic control means to meter a flow of air being passed through said air supply passageway from the ambient atmosphere.

**2.** In a carburetor as claimed in claim **1,** said electronic computing means comprising at least one function generator responsive to at least one of said electric signals representing said engine operating conditions to produce at least one electronic functional signal therefrom, and summing means responsive to said at least one functional signal to produce said electric output signal representing said optimum value of the air-fuel ratio of said air-fuel mixture.

**3.** In a carburetor as claimed in claim **2,** said electronic control means comprising an amplifier for amplifying said electric output signal from said summing means to produce said electric operating signal to be fed into said air-fuel mixture supply control system.

**4.** In a carburetor as claimed in claim **1**, said air supplying metering device comprising an air flow control valve assembly which is operatively disposed over an opening of said air bleed jet for metering the amount of air being passed into said air supply passageway, and an electric actuating device for actuating said air flow control valve assembly in response to said operating signal from said electronic control means.

**5.** In a carburetor as claimed in claim **4**, said electric actuating device comprising a stationary core forming a housing which is mounted on said carburetor and is provided with a pair of solenoid coils therein, and a rockable movable core which is rockably connected at one end to said housing and the other end of which is rockably moved in or out of said opening of said air bleed jet in response to a magnetic force induced in said solenoid coils.

**6.** In a carburetor as claimed in claim **5**, said air flow control valve assembly comprising a valve needle with a tapered end which projects into said opening of said air bleed jet and is fixedly attached to said other end of said movable core, said tapered end being capable of varying the effective cross-sectional area of said opening of said air bleed jet to thereby meter the amount of air being supplied into said air supply passageway from the ambient atmosphere.

**7.** In a carburetor for an internal combustion engine having air and fuel supplying means which include mixing means for mixing air and fuel, at least one air supply passageway and a main fuel supply passageway for supplying air and fuel respectively into said mixing means, said at least one air supply passageway being in communication with the ambient atmosphere, a fuel supply reservoir for supplying fuel into said main fuel passageway, flow control means operatively disposed in said main fuel supply passageway, an air-fuel mixture supply passageway for supplying air-fuel mixture from said mixing means into an induction passage of said carburetor, throttling means operatively disposed in said induction passageway for controlling the amount of said air-fuel mixture being supplied into said engine, an auxiliary fuel supply passageway bypassing said flow control means of said main fuel supply passageway, flow control means operatively disposed in said auxiliary fuel supply passageway, and an air bleed jet mounted on said carburetor and communicating between the ambient atmosphere and said air and fuel supplying means; an air-fuel mixture supply control system which comprises:

electronic computing means responsive to at least one of electric signals representing prevailing values of engine operating conditions including engine speed, engine temperature, throttle opening and atmospheric pressure to produce an electric output signal representing an optimum air-fuel ratio of said air-fuel mixture corresponding at all times to prevailing engine operating conditions;

electronic control means responsive to said output signal from said electronic computing means to produce an electric operating signal; and

a fuel supply metering device which is actuated by said operating signal from said electronic control means to meter a flow of fuel being supplied into said air and fuel mixing means through said auxiliary fuel supply passageway from said fuel supply reservoir.

**8.** In a carburetor as claimed in claim **7**, said electronic computing means comprising at least one function generator responsive to at least one of said electric signals representing said engine operating conditions to produce at least one electronic functional signal therefrom, and summing means responsive to said at least one functional signal to produce said electric output signal representing said optimum value of the air-fuel ratio of said air-fuel mixture.

**9.** In a carburetor as claimed in claim **8**, said electronic control means comprising an amplifier for amplifying said electric output signal from said summing means to produce electric operating signal to be fed into said air-fuel mixture supply control system.

**10.** In a carburetor as claimed in claim **8**, said fuel supply metering device comprising a fuel flow control valve assembly which is operatively disposed in said auxiliary fuel supply passageway, and an electric actuating device for a actuating said fuel flow control valve assembly in response to said operating signal from said electronic control means for metering the amount of fuel being supplied into said air and fuel mixing means through said auxiliary fuel supply passageway from said fuel supply reservoir.

**11.** In a carburetor as claimed in claim **10**, said electric actuating device comprising a stationary core forming a housing which is provided with a pair of solenoid coils therein, and a rockable movable core which is rockably connected at one end to said housing and the other end of which is rockably actuated by a magnetic force induced in said solenoid coils by said electric operating signal from said electronic control means.

**12.** In a carburetor as clained in claim **11**, said fuel flow control valve assembly being operatively disposed in said auxiliary fuel supply passageway and operatively connected to and actuated by said other end of said movable core of said electric actuating device to meter the amount of fuel being supplied into said air and fuel mixing means through said auxiliary fuel supply passageway from said fuel supply reservoir in response to said electric operating signal from said electronic control means.

**13.** In a carburetor for an internal combustion engine having air and fuel supplying means which include mixing means for mixing air and fuel, at least one air supply passageway and a main fuel supply passageway for supplying air and fuel respectively into said mixing means, said at least one air supply passageway being in communication with the ambient atmosphere, a fuel supply reservoir for supplying fuel into said main fuel supply passageway, an air-fuel mixture supply passageway for supplying air-fuel mixture from said mixing means into an induction passage of said carburetor, throttling means operatively disposed in said induction passageway for controlling the amount of said air-fuel mixture being supplied into said engine, an air bleed jet communicating between the ambient atmosphere and said air and fuel supplying means, flow control means operatively disposed in said main fuel supply passageway, an auxiliary fuel supply passageway bypassing said flow control means of said main fuel supply passageway, and a flow control means operatively disposed in said auxiliary fuel supply passageway; an air-fuel mixture supply control system which comprises:

electronic computing means responsive to an electric dither signal and at least one of electric signals representing prevailing values of engine operating conditions including engine speed, engine temperature, throttle opening and atmospheric pressure to produce an electric output signal representing an optimum air-fuel ratio of said air-fuel mixture and corresponding at all times to prevailing engine operating conditions;

electronic control means responsive to said output signal from said electronic computing means to produce an electric operating pulse width signal; and

an air supply metering device which is actuated by said operating pulse width signal from said electronic control means to meter the flow of air passing through said at least one air supply passageway from the ambient atmosphere.

**14.** In a carburetor as claimed in claim **13,** said electronic computing means comprising at least one function generator responsive to at least one of said electric signals representing said engine operating conditions to produce at least one electronic functional signal therefrom, and summing means responsive to said at least one functional signal and said dither signal to produce said electric output signal representing said optimum air-fuel ratio of said air-fuel mixture.

**15.** In a carburetor as claimed in claim **14,** said electronic control means comprising a comparator responsive to said electric output signal from said summing means to produce an electric pulse width signal, and an amplifier for amplifying said pulse width signal to produce said operating pulse width signal to be fed into said air-fuel mixture supply control system.

**16.** In a carburetor as claimed in claim **13,** said air supply metering device comprising an air flow control valve assembly which is operatively disposed over an opening of said air bleed jet for metering the amount of air being passed into said air supply passageway, and an electric actuating device for actuating said air flow control valve assembly in response to said operating pulse width signal from said electronic control means.

**17.** In a carburetor as claimed in claim **16,** said electric actuating device comprising a stationary core forming a housing which is mounted on said carburetor and is provided with a pair of solenoid coils therein, and a rockable movable core which is rockably connected at one end to said housing and the other end of which is rockably moved in or out of said opening of said air bleed jet in response to a magnetic force induced in said solenoid coils.

**18.** In a carburetor as claimed in claim **17,** said air flow control valve assembly comprising a valve needle with a tapered end which projects into said opening of said air bleed jet and is fixedly attached to said other end of said movable core, said tapered end being capable of opening and closing said opening of said air bleed jet to meter the amount of air passing into said air supply passageway from the ambient atmosphere.

**19.** In a carburetor for an internal combustion engine having air and fuel supplying means which include mixing means for mixing air and fuel, at least one air supply passageway and a main fuel supply passageway for supplying air and fuel respectively into said mixing means, said at least one air supply passageway being in communication with the ambient atmosphere, a fuel supply reservoir for supplying fuel into said main fuel supply passageway, flow control means operatively disposed in said main fuel supply passageway, an air-fuel mixture supply passageway for supplying air-fuel mixture from said mixing means into an induction passage of said carburetor, throttling means operatively disposed in said induction passage for controlling the amount of said air-fuel mixture being supplied into said engine, an auxiliary fuel supply passageway bypassing said flow control means of said main fuel supply passageway, flow control means operatively disposed in said auxiliary fuel supply passageway, and an air bleed jet mounted on said carburetor and communicating between the ambient atmosphere and said air and fuel supplying means; an air-fuel mixture supply control system which comprises:

electronic computing means responsive to an electric dither signal and at least one of electric signal representing prevailing values of engine operating conditions including engine speed, engine temperature, throttle opening and atmospheric pressure to produce an electric output signal representing an optimum air-fuel ratio of said air-fuel mixture and corresponding at all times to prevailing engine operating conditions;

electronic control means responsive to said output signal from said electronic means to produce an electric operating pulse width signal; and

a fuel supply metering device which is actuated by said operating pulse width signal from said electronic control means to meter the flow of fuel being supplied into said mixing means through said auxiliary fuel supply passageway from said fuel supply reservoir.

**20.** In a carburetor as claimed in claim **19,** said electronic computing means comprising at least one function generator responsive to at least one of said electric signals representing said engine operating conditions to produce at least one electronic

**21.** In a carburetor as claimed in claim **20,** said electronic control means comprising a comparator responsive to said electric output signal from said summing means to produce an electric pulse width signal, and amplifier for amplifying said pulse width a signal to produce said operating pulse width signal to be fed into said air-fuel mixture supply control system.

**22.** In a carburetor as claimed in claim **19,** said fuel supply metering device comprising a fuel flow control valve assembly which is operatively disposed in said auxiliary fuel supply passageway for metering fuel passing therethrough, and an electric actuating device for actuating said fuel flow control valve assembly in response to said operating pulse width signal from said electronic means.

**23.** In a carburetor as claimed in claim **22,** said electric actuating device comprising a stationary core forming a housing which is provided with a pair of solenoid coils, and a rockably movable core which is connected at one end to said housing and the other end of which is rockably actuated by a magnetic force induced in said solenoid coils by said electric operating pulse width signal from said electronic control means.

**24.** In a carburetor as claimed in claim **23,** said flow control means operatively disposed in said auxiliary fuel supply passageway comprising a flow control valve assembly which is operatively connected to and actuated by said other end of said movable core of said electric actuating device to meter the amount of fuel being supplied into said mixing means through said auxiliary fuel supply passageway from said fuel supply reservoir in response to said operating pulse width signal from said electronic control means.

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