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APPARATUS FOR MIXING AIR AND FUEL FOR INTERNAL COMBUSTION ENGINES

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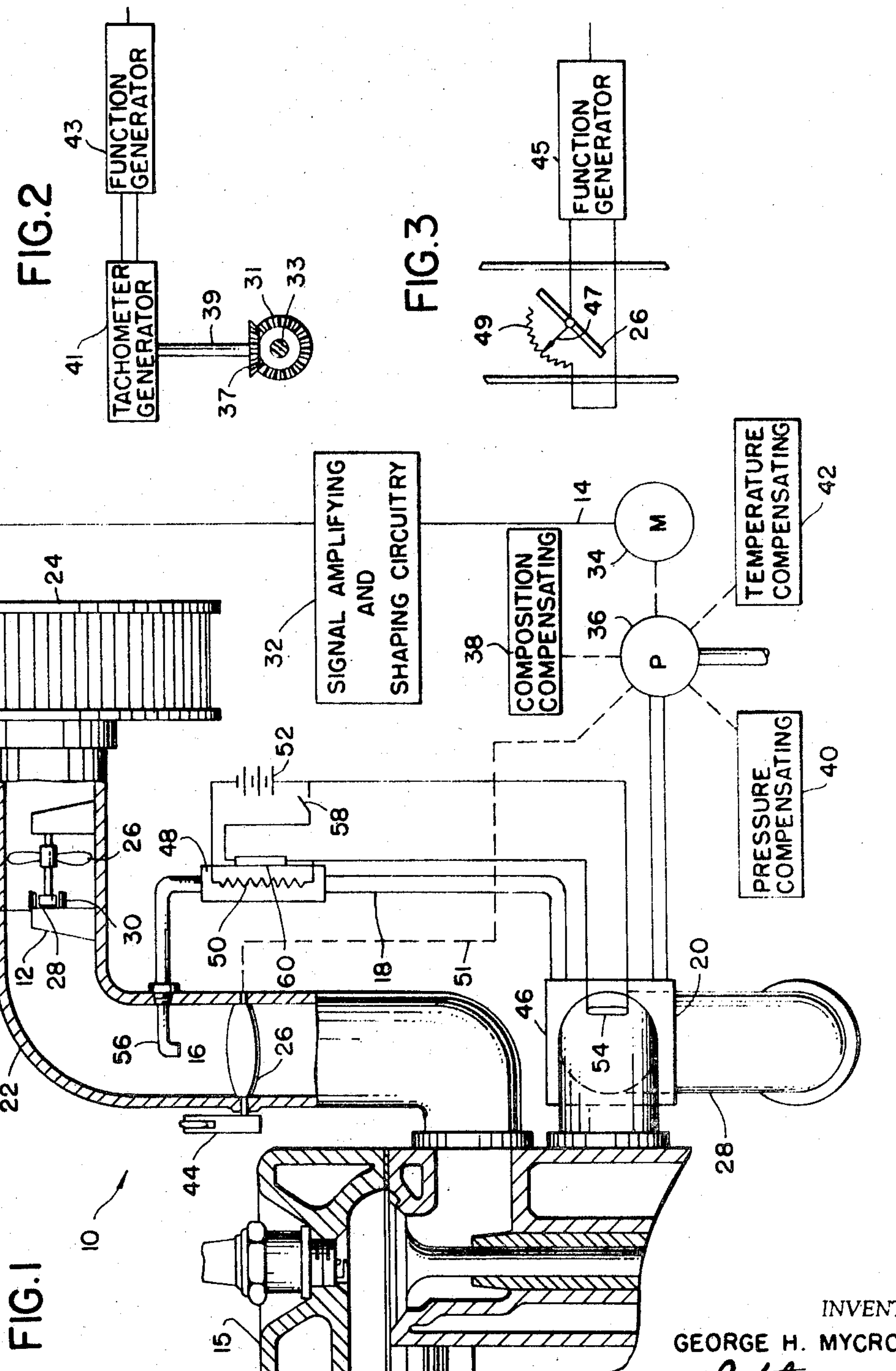

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APPARATUS FOR MIXING AIR AND FUEL FOR INTERNAL COMBUSTION ENGINES

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ABSTRACT OF THE DISCLOSURE

Apparatus for providing fuel for an internal combustion engine or the like in proportion to the air fed thereto to maintain a stoichiometric air fuel ratio over a wide range of fuels including structure for developing an electrical signal proportional to the air flow to the engine, a fuel pump, synchronous motor means for driving the fuel pump at a rate determined by the signal developed to provide fuel proportional to the signal developed and means for evaporating the fuel and subsequently mixing it with the air fed to the engine. The exhaust heat is used to evaporate the fuel after the engine has been running a short period in conjunction with a thermostatically controlled electrical heater for evaporating the fuel during initial engine operation.

Compensating means are provided for fuel composition and for the ambient pressure and temperature at which the engine operates to insure proper stoichiometric fuel air mixtures under different operating conditions and with a wide variety of fuels. Acceleration compensating and automatic evaporator cleaning structure is provided.

BACKGROUND OF THE INVENTION

Field of the invention

The invention relates to air and fuel mixing apparatus and refers more specifically to apparatus for mixing air fed to an internal combustion engine with an amount of evaporated fuel proportional to the volume of air fed to the internal combustion engine to provide a stoichiometric air fuel mixture with a wide range of fuels and under different operating conditions.

Description of the prior art

In the past, fuel has generally been metered to internal combustion engines and the like through carburetors which over the years have become quite complicated and expensive, requiring float systems, needle valves, metering jets, and the like.

In addition, prior carburetors have usually been functional over a very small range of fuels and have required major alterations to permit acceptance of fuels outside of the narrow range for which the carburetors have been constructed. The carburetors of the past have not therefore been sufficiently versatile to provide maximum efficiency in disaster areas, war zones and the like, wherein the available fuels may be outside of the normal carburetor fuel range.

Further, with prior carburetors fuel has normally been mechanically separated into small droplets or the like by passing it through metering jets, restricted openings and the like before delivery into an air fuel mixing area. Greater fuel efficiency would be obtained if the fuel were evaporated prior to introduction into an air fuel mixing area to provide more intimate mixing of the fuel and air.

SUMMARY OF THE INVENTION

The apparatus of the invention for mixing air and fuel includes means for metering evaporated fuel into an air fuel mixing area in proportion to the air passing

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through the air fuel mixing area. A stoichiometric air fuel ratio is thus possible. In addition, intimate mixing of the air and fuel is assured to provide most efficient fuel utilization.

The air fuel mixing apparatus of the invention further includes means for compensating the fuel pumped in proportion to air flow in accordance with the composition of the particular fuel and the pressure and temperature at which the engine is operated.

Self cleaning structure is included in the air fuel mixing apparatus of the invention whereby maintenance will be minimized. Acceleration compensation is also provided to improve efficiency of operation of the air fuel mixing apparatus disclosed.

In addition, the air fuel mixing apparatus disclosed is particularly simple in construction, whereby it is economical to manufacture and as indicated above is particularly efficient in operation.

BRIEF DESCRIPTION OF THE DRAWING

FIGURE 1 is a partly diagrammatic, partly block diagram of the air fuel mixing apparatus of the invention including structure for developing a signal proportional to air flow.

FIGURE 2 is a modification of the structure illustrated in FIGURE 1 for developing a signal proportional to air flow.

FIGURE 3 is still another modification of the structure illustrated in FIGURE 1 for developing a signal proportional to air flow.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

As shown best in FIGURE 1, the fuel and air mixing apparatus **10** includes structure **12** for developing an electrical signal proportional to air flow to the internal combustion engine **15**, structure **14** for receiving the electrical signal from the structure **12** for developing an electrical signal and passing fuel into the air fuel mixing area **16** in proportion to the electrical signal developed through the fuel line **18**. Structure **20** is provided to evaporate the fuel in the fuel line **18** before it is delivered to the air fuel mixing area **16**.

Only a portion of the engine **15** is illustrated in section as will be readiy understood by those in the art. The usual engine air intake passage **22** is connected to the engine and draws air through the air filter **24** in accordance with engine vacuum and the setting of the butterfiy valve **26** in the usual manner. An engine exhaust pipe **28** is illustrated diagrammatically connected to the engine **15**.

As shown in FIGURE 1, the structure **12** for developing an electrical signal proportional to air flow through the air intake passage **22** includes a turbine wheel **26** having a permanent magnet **28** mounted thereon for rotation therewith and the electrical coil **30** surrounding the magnet **28**. Thus, in operation, on rotation of the turbine **26** at a speed determined by the air flow in the air passage **22**, the lines of flux from the permanent magnet **28** cut the coil **30** and produce an alternating electrical signal in the coil **30** having a frequency depending on the speed of rotation of the turbine wheel **26**.

Alternate structure for developing an electrical signal proportional to air flow through the air intake passage **22** is illustrated in FIGURE 2 and includes a first bevel gear **31** secured to the cam shaft **33** of the engine **14** or other rotating shaft thereof in mesh with the bevel gear **37** connected to the drive shaft **39** a tachometer generator **41**. The variable electrical signal from the tachometer generator **41** varies in accordance with engine speed and thus in proportion to the air in the passage **22** and is used to vary the frequency of a function generator

43 to produce an electric signal having a frequency variable in accordance with the air flow through the passage **22** as will be understood by those in the art.

The structure illustrated in FIGURE 3 for developing an electrical signal the frequency of which varies in accordance with the air flow through the passage **22** comprises a function generator **45** for generating an electrical signal having a frequency variable in accordance with the value of a resistance connected in circuit therewith and a potentiometer including a wiper arm **47** and a resistance **49** connected, as shown in FIGURE 3. The resistance **49** in the circuit of the function generator **45** is varied in accordance with the angular position of the butterfly valve **26**. Again the output from the function generator is fed to the means **14** for passing fuel into the air fuel mixing area **16**.

The structure **14** for passing fuel into the air fuel mixing area **16** includes the signal amplifying and shaping circuitry **32** for receiving the variable frequency alternating electrical signal and providing a control signal for the synchronous motor **34** therefrom. Structure **14** further includes the pump **36** driven by the synchronous motor **34** for pumping fuel from a fuel reservoir (not shown) through the fuel line **18** into the air and fuel mixing area **16**.

The signal amplifying and shaping circuitry **32** may be, for example, a cathode follower stage, a purality of amplifier stages and wave shaping circuitry to provide a square wave signal to the synchronous motor **34**, the frequency of which is proportional to the quantity of air flowing in the air intake conduit **2**.

The pump **36** may be driven by a gear reduction system from the motor **34** and is a positive displacement fuel pump. The pump **36** may be compensated to vary the output therefrom for a given motor speed. Thus, for a given quantity of air passing through the air intake pasage **22**, the amount of fuel pumped may be varied by the composition compensating means **38**, pressure compensating means **40** and temperature compensating means **42** to provide a stoichiometric air fuel ratio for the fuel pumped at existing conditions.

As shown, an additional mechanical linkage **51** may be provided connected through the butterfly valve **26** to the throttle linkage **44** from the pump **36** to provide acceleration compensating by increasing the fuel pumped to the engine **15** during periods of acceleration. Compensated positive displacement pumps suitable for pump **36** are known in the art and will not therefore be considered in further detail herein.

The structure **20** for evaporating fuel in the fuel line **18** may be a single element. However as shown, the structure **20** includes a first evaporator chamber **46** positioned around the exhaust manifold **28** of the engine **15** so that when the exhaust manifold **28** is hot due to the escape of hot exhaust gases therethrough in the usual opeartion of the internal combustion engine **15**, gasses passing through the chamber **46** positioned in the fuel line **18** will be evaporated. A second evaporator chamber **48** is provided in the fuel line **18** and is heated through the electrical resistance element **50** by the battery **52** when the thermal electrical switch **54** is closed.

Thus, when the exhaust manifold **28** of the engine **15** is cool, as during starting so that evaporation of the gas in the fuel line **18** will not occur in the evaporator chamber **46**, the chamber **48** will be heated to evaporate the fuel before it is passed into the air and fuel mixing areas **16** through the nozzle **54**. On the exhaust manifold **28** becoming hot, the thermal switch **54** opens to remove the heat from the chamber **48**.

Since gum like residues may collect in the evaporator chamber **48**, the heating element **50** may be heated on closing of the switch **58**. With the switch **58** closed the element **50** will heat the evaporator chamber **48** to a temperature determined by the thermostatic switch **60** at which the gum residue in the evaporator chamber **48** will be evaporated. Should the need arise, a parallel heating element for cleaning evaporator chamber **46** on closing of switch **58** or a similar switch may be provided.

It will be understood that while evaporator chambers **46** and **48** are disclosed separately for clarity they could be a single evaporator chamber as previously indicated.

Thus, in overall operation of the fuel and air mixing apparatus **10**, the engine **15** is started or turned over by conventional means for starting internal combustion engines. Air is thus drawn through the air intake passage **22** through the air cleaner **24**. Air passing through the air passage **22** will cause the turbine wheel **26** to rotate to produce an electrical signal having a frequency proportional to the quantity of air passing through the air passage **22**.

The electrical signal having a varying frequency is amplified and shaped in the signal amplifying and shaping circuitry **32** without loading the turbine **26** in any manner. The amplified and shaped electrical signal is then used to control the speed of the synchronous motor **34** so that the pump **36** is driven at a speed proportional to the qauntity of air passing through the air passage **22**.

The pump **36** is initially compensated for the type of fuel to be used by means of the composition compensating structure **38**. The pressure and temperature compensating structures **40** and **42** may be continuously operable to compensate the pump **36** for the particular pressure and temperature at the engine **14**.

The fuel pumped by the pump **36** is passed through the evaporator chamber **46** and into the evaporator chamber **48** where it is heated and evaporated before passing through the nozzle **56** into the air fuel mixing area **16**. After the engine **14** has been operating for a period sufficient to heat the exhaust manifold **28**, the thermostatic switch **54** will open so that the evaporator chamber **48** is no longer heated by battery **52** through the heating element **50**. Fuel pumped from the pump **36** is then evaporated in the evaporator chamber **46** which is heated by the exhaust manifold **28**.

As previously indicated during acceleration, when the butterfly valve **26** is opened wide, the pump **36** is compensated to provide more fuel than usual to air the engine **15**.

Periodically when it is desired to burn the gum or other volatile residue from the evaporator chamber **48**, the switch **58** is closed to provide a current path to the heater **50**. At this time, the evaporator chamber **48** is heated to a temperature determined by the thermostatic control **60** at which the gum residues of fuel are burned out of the evaporator chamber **48**.

Thus, it will be seen that there has been provided in accordance with the disclosure air fuel mixing apparatus **10** which is substantially maintenance free, which will accept a particularly wide range of fuel, and which will provide particularly efficient combustion since the apparatus **10** is compensated to provide a stoichiometric air fuel ratio with evaporated fuel at all times.

What I claim as my invention is:

1. Structure for mixing air and fuel for an internal combustion engine or the like having air intake means, an air fuel mixing area and exhaust means comprising means for producing a signal proportional to air intake, including a turbine wheel within the air intake means, a permanent magnet secured to the turbine wheel for rotation therewith and a pickup coil positioned adjacent the magnet for developing an electrical signal proportional to the rate of rotation of the magnet, means connected to the signal producing means for pumping fuel proportional to the signal produced by the signal producing means and passing the fuel into the area for mixing air and fuel and means for evaporating the pumped fuel before it is fed into the air fuel mixing area.

2. Structure as set forth in claim **1** wherein the signal producing means comprises a tachometer generator, gear means for driving a tachometer generator from a rotatable portion of the engine at a speed proportional to engine speed and a function generator connected to the tachometer generator receiving the electrical signal produced thereby.

3. Structure as set forth in claim **1** and further including a throttle valve in the air intake means and wherein the signal producing means comprises a function generator, a potentiometer connected to the function generator for regulating the signal output therefrom and means connecting said potentiometer to the throttle valve in the air intake means for providing a variable resistance in accordance with the angular position of the throttle valve.

4. Structure as set forth in claim **1** wherein the means for pumping fuel proportional to the developed signal and passing the fuel into the air fuel mixing area comprises signal amplifying and shaping circuitry connected to receive the signal proportional to air intake, a synchronous motor driven by the signal from the signal amplifying and shaping circuitry and a constant displacement fuel pump connected to be driven by the motor.

5. Structure as set forth in claim **4** wherein the means for evaporating fuel comprises a section of fuel line extending from the pump to the area for mixing air and fuel in heat exchange relation with the exhaust means of the engine and thermostatically controlled heating means in the fuel line for heating the fuel in the fuel line prior to the exhaust system reaching a predetermined temperature.

6. Structure as set forth in claim **4** and further including heating structure for periodically heating the means for evaporating fuel to boil out residues therein.

7. Structure as set forth in claim **4** and further including means for compensating the pump for one or more of fuel composition, pressure of operation and temperature of operation of the engine.

8. Structure as set forth in claim **4** and further including means for compensating the pump for engine acceleration to provide additional fuel during acceleration.

9. Structure for mixing air and fuel for an internal combustion engine or the like having air intake means, an air fuel mixing area and exhaust structure comprising means for producing a signal proportional to air intake, a motor, means for driving the motor in response to and in proportion to the signal produced proportional to air intake, a pump for pumping fuel to the air fuel mixing area connected to the motor for driving thereby, a first fuel evaporation chamber positioned around the exhaust structure, means for passing the fuel from the pump around the exhaust structure in the first evaporation chamber, a second evaporation chamber positioned between the first evaporator chamber and the air fuel mixing area for receiving fuel from the first evaporation chamber and passing it to the air fuel mixing area and separate means for heating the second evaporation chamber to evaporate fuel therein.

10. Structure as set forth in claim **9** and further including a thermostat control responsive to the temperature in the first evaporation chamber to produce heating of the second evaporation chamber through the heating means therefor when the exhaust structure is below a predetermined temperature and for removing the heat from the heating means for the second evaporation chamber when the temperature of the exhaust structure is above the predetermined temperature.

11. Structure as set forth in claim **9** and further including means for selectively turning on the separate heating means for the second evaporation chamber to heat the second evaporation chamber to a temperature sufficient to boil out fuel residue in the second evaporation chamber without regard to the temperature in the exhaust structure.

12. Structure as set forth in claim **9** wherein the motor is a synchronous motor, the pump is a constant displacement fuel pump and means are provided for compensating the constant displacement fuel pump for one or more of fuel composition, pressure of operation, temperature of operation and engine acceleration.

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