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Sata

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[54] **NON-POLLUTING COMBUSTION ENGINE HAVING ULTRASONIC FUEL ATOMIZER IN PLACE OF CARBURETOR**

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Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 187,950, Oct. 12, 1971, abandoned.

[30] **Foreign Application Priority Data**

Dec. 21, 1970 Japan 45-11410

[52] **U.S. Cl.** **239/102,** 239/338, 239/416.5

[51] **Int. Cl.** **B05b 17/06**

[58] **Field of Search** 239/102, 120, 121, 337, 239/338, 416.5, 424

[56] **References Cited**

UNITED STATES PATENTS

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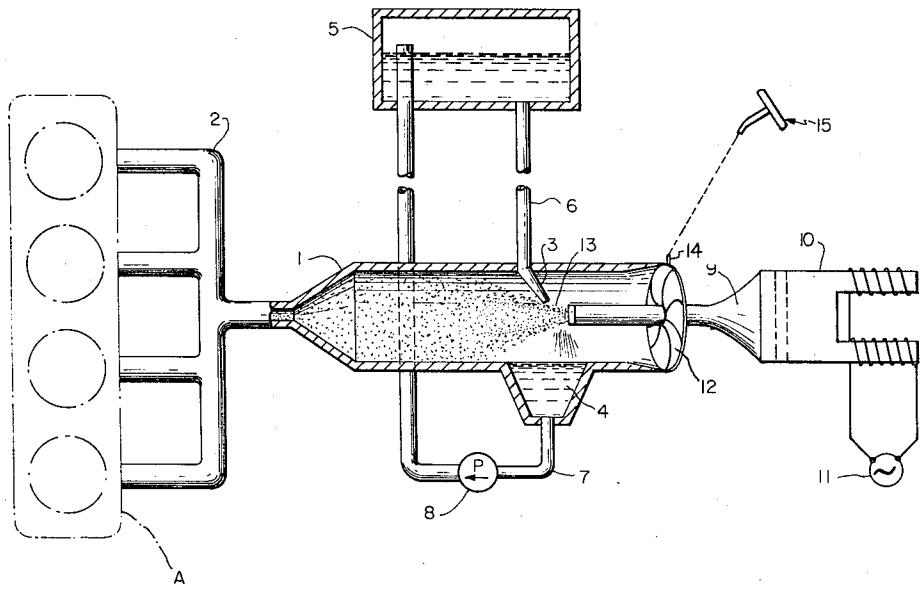
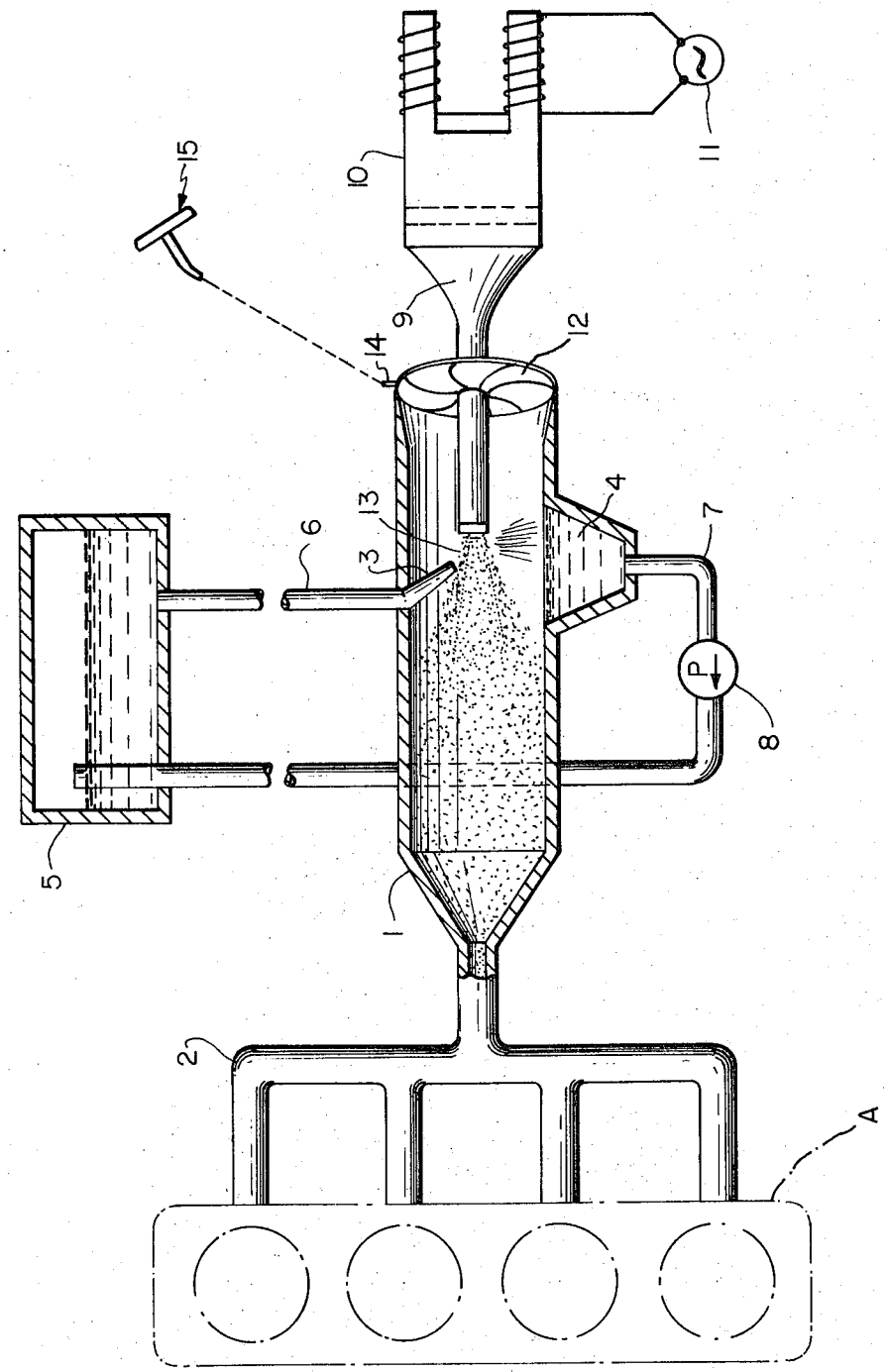
[57] **ABSTRACT**

A combustion engine includes a powerful unltrasonic fuel atomizer connected to the intake manifold thereof instead of a carburetor. The ultrasonic fuel atomizer includes a horizontal atomizing chamber, having a fuel inlet at the top and a fuel tray at the bottom. A powerful ultrasonic ferrite vibrator has the large end of an exponential horn mounted thereon, the small end of the horn extending into the chamber to a position under the fuel inlet and above the tray. An air inlet is provided in the chamber around the small end of the exponential horn, and the end of the chamber toward which the small end of the horn faces is connected to the intake manifold of the internal combustion engine. A constant and excessive quantity of fuel fed to the fuel inlet streams down from the inlet and is fully atomized while pouring over the ultrasonically vibrating head of the exponential horn. Fuel not sucked into the engine through the intake manifold thereof is collected in the fuel tray and recirculated to be again fed to the fuel inlet.

6 Claims, 1 Drawing Figure

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NON-POLLUTING COMBUSTION ENGINE HAVING ULTRASONIC FUEL ATOMIZER IN PLACE OF CARBURETOR

This application is a continuation-in-part of copending application Ser. No. 187,950, filed Oct. 12, 1971 now abandoned.

BACKGROUND OF THE INVENTION

This invention relates to an internal combustion engine having a fuel atomizer in place of a carburetor, and more particularly to such a combination in which liquid fuel is atomized by ultrasonic energy.

Over forty years have elapsed since the introduction of high power ultrasonic vibrations produced by the piezoelectric effect from crystals such as quartz, and later from a ferrite core by the magneto-strictive effect. During this time it has been proposed to use ultrasonic vibrations for the breaking up of microbes such as colon bacilli and cancer cells, the dispersing of oil in liquids to make an emulsion and the dispersing or atomizing of liquid fuel oil in air. Such applications of the intensive ultrasonic waves by piezoelectric and magneto-strictive effects have been most intensively explored by the researchers in the many scientific fields all over the world.

The conventional carburetor, assumed to be indispensable in an internal combustion engine, employs the principle of an atomizer making use of the vacuum developed in a venturi tube by the suction stroke of a piston of the engine. In this orthodox type of carburetor the fuel is atomized to form small droplets in air and is expected to burn sufficiently well for good engine performance. However, sometimes the burning or combustion of the fuel creates noxious fumes which result in air pollution.

The ultrasonic vibrations described above are also useful for atomizing fuel, and when an ultrasonic atomizer is used it is theoretically and experimentally verified that the size of fuel droplets is very much finer than those produced by the venturi atomizer or carburetor. Thus an ultrasonic atomizer seems, from a qualitative standpoint, to be remarkably more efficient than an ordinary carburetor. However, until now the amount of fuel which can be atomized by such an ordinary ultrasonic vibrator was quantitatively not sufficient for use in an automobile replacing the carburetor.

Also, in previously known ultrasonic atomizers, in order to have an atomizing capacity sufficient for the fuel needs of an automobile engine, the ultrasonic wave generator to drive an ultrasonic transducer would weigh at least over 100 Kgs.

It has thus not heretofore been considered to be practicable to completely replace the standard carburetor with an ultrasonic atomizer. Consequently, many attempts have been made in recent years to use such an atomizer together with the known venturi atomizer in a carburetor in order to attain atomization of a sufficient quantity of fuel for automobile use.

It has now been found that a very powerful ultrasonic vibrator can be made by attaching an exponential horn to a ferrite ultrasonic transducer, which is a magneto-strictive type of ultrasonic vibrator, which greatly magnifies the vibration energy. This type of vibrator can atomize the great amount of fuel needed for an automobile. Also, the weight of such ultrasonic generator is decreased enormously by the recent invention of power transistor and other diode accessories.

SUMMARY OF THE INVENTION

It is the object of the present invention to provide an engine including a fuel atomizing device which utilizes ultrasonic vibrations to independently atomize sufficient fuel for an internal combustion engine and to completely replace the standard carburetor with such an atomizer.

It is a further object and fundamental principle of the present invention, and having succeeded in actual tests, to employ the recently developed light weight power transistor ultrasonic wave generator to drive the ferrite transducer of the atomizer, whereby the entire unit is sufficiently light in weight to be employable in standard vehicles.

It is also an important object of the present invention to provide such an ultrasonic atomizer engine whereby consumption of the fuel is greatly decreased over previous engines, thereby eliminating a serious source of air pollution.

To this end the present invention provides an engine and a fuel atomizer which comprises a horizontal atomizing chamber connected to the engine intake manifold with a fuel inlet at the top, a fuel tray at the bottom and in the middle a powerful ferrite or the like ultrasonic vibrator. Since all of the elements are arranged horizontally, the invention results in a low, compact unit which can easily be fitted into the limited space of the engine area of an automobile body. In the atomixing chamber liquid fuel streams down from the inlet and is atomized as it pours over the head of the vibrator, while the fuel which is not sucked into the intake manifold or not atomized is collected itself in the tray and pumped from the tray up to the fuel tank and is recirculated.

BRIEF DESCRIPTION OF THE DRAWING

One example of the invention will be described with reference to the attached drawing which is a schematic view, partly in section, of the fuel atomizer and engine according to the invention.

DETAILED DESCRIPTION OF THE INVENTION

In the drawing, a fuel atomizing chamber **1** is connected to the air intake manifold **2** of an internal combustion engine A, such as a **4**-cylinder automobile gasoline engine. A fuel inlet **3** is provided at the top of chamber **1** and fuel tray **4** for collecting excessive fuel is provided at the bottom beneath inlet **3.** The fuel inlet **3** is connected to a fuel tank **5** by a pipe **6** and fuel tray **4** opens into a pipe **7** which leads to the suction side of a fuel pump **8.** A pipe extends from the discharge side of pump **8** to the fuel tank **5.**

To a powerful ferrite ultrasonic vibrator **10** is attached the large end of an exponential horn **9** so as to emit ultrasonic vibration by an electric power source **11** which is tuned to a constant maximum output. The small end of horn **9** extends horizontally into the atomixing chamber **1,** with the free vibrating end facing toward the air intake manifold **2** of the engine. In the end of chamber **1** oipposite to the engine is fitted an iris-shaped vane-type air intake valve **12** around the exponential horn **9** by which the necessary amount of air sucked in and mixed with the atomized fuel in chamber **1** is controlled. Air valve **12** is controlled by lever **14** which is linked to accelerator pedal **15** of the engine **2** just as by the conventional carburetor throttle control. A nozzle **13** on the fuel inlet **3** directly faces the vibrat-

ing free end of horn 9, the angle between the two being easily adjustable for the highest fuel atomizing efficiency. Fuel pump 8 must have ample capacity to pump an amount of fuel in excess to recirculate the fuel from tray 4 to tank 5 through pipe 7.

The operation is as follows: when the fuel from nozzle 13 constantly pours on the vibrating free end of the horn 9, fuel is instantly atomized. Then, by pushing the starter button of the engine and at the same time slowly opening air inlet valve 12 by pushing the accelerator pedal 15, the gasoline mist in atomization chamber 1 is mixed with air and sucked through manifold 2 into the combustion chamber of the engine. Thus, the engine starts at once. By providing maximum output of the tuned vibration head of exponential horn 9, the atomization chamber 1 is always constantly filled with atomized gasoline. Therefore, the engine speed is regulated only by accelerating pedal 15, which is linked with air intake valve lever 14, just as in a carburator engine. Thus the ultrasonic atomizer totally replaces the conventional venturi type carburetor. Due to its ingenious but simple construction, the ultrasonic atomizer engine of the present invention can be operated quite simply, economically and without danger of failure. Furthermore, this ultrasonic atomizer is widely adjustable and yet accurate to all liquid fuel requirement conditions. The efficiency of fuel combustion of the engine employing this atomizer will be almost 100 percent because the fuel is atomized to an extremely fine mist, and this accordingly reduces hydrocarbons and carbon monoxide concentration in the exhaust gas, thus reducing pollution of the atmosphere. This advantage is very significant today in view of the severe MASKY-regulations.

In carrying out the present invention, it has been possible to fabricate an atomizer including ultrasonic generator 11, vibrator 10 and horn 9 weighing less than 20 Kgs and haviong a gasoline atomizing capacity of over 20 Liters per hour.

Various specific features of the invention, such as power requirements of source 11, the specific frequency of vibration of horn 9, precise size of horn 9, size of chamber 1 and inlet 3 etc. have not been described in detail, but it will be apparent that those skilled in the art would readily be able to determine such features for any given size and type of engine. Such features may be very easily calculated and designed from the data published under the title "Liquid Atomization by Ultrasonic Vibration" by Hirose and Kimoto [Journ. Soc. Acoustic, Japan, Vol. 28, No. 7, p. 335.(1972)].

I claim:

1. A non-carburetor-type internal combustion engine system comprising:
- an intake manifold; and
- ultrasonic atomizer means for supplying atomized fuel to said intake manifold, said ultrasonic atomizer means comprising:
  - a horizontal atomizing chamber connected at one end thereof to said intake manifold;
  - an ultrasonic ferrite transducer;
  - an exponentially shaped resonator having the large end thereof attached to said transducer and the small end thereof having a vibrating head thereon and extending into said atomizing chamber and facing said one end of said atomizing chamber connected to said intake manifold;
  - a lightweight, power transistor ultrasonic wave generator means attached to said ultrasonic ferrite transducer for imparting vibrations thereto;
  - fuel inlet means extending through the top of said atomizing chamber to a position directly above said vibrating head for supplying a constant amount, greater than required by said engine, of fuel to said vibrating head, whereby the thus supplied fuel contacts said vibrating head and is fully atomized thereby;
  - air inlet means in said chamber for allowing passage therein of air to mix with said atomized fuel and to pass therewith into said intake manifold; and
  - fuel tray means in the bottom of said atomizing chamber at a position below said vibrating head for receiving fuel not sucked into said intake manifold.

2. An engine system as claimed in claim 1, further comprising a fuel supply tank connected to said fuel inlet means; conduit means connecting said fuel tray means with said fuel supply tank; and pump means in said conduit means for recirculating said fuel from said fuel tray means back to said fuel supply tank.

3. An engine system as claimed in claim 1, wherein said air inlet means extends into said atomizing chamber at an end thereof opposite said end thereof connected to said intake manifold, said air inlet means comprising adjustable valve means for controlling the amount of air entering said atomizing chamber.

4. In a non-carburetor-type internal combustion engine including an intake manifold and fuel supply means for supplying fuel to said intake manifold, the improvement wherein said fuel supply means comprises an ultrasonic atomizer means, in place of a conventional carburetor, for supplying atomized fuel to said intake manifold, said ultrasonic atomizer means comprising:
- a horizontal atomizing chamber connected at one end thereof to said intake manifold;
- an ultrasonic ferrite transducer;
- an exponentially shaped resonator having the large end thereof attached to said transducer and the small end thereof having a vibrating head thereon and extending into said atomizing chamber and facing said one end of said atomizing chamber connected to said intake manifold;
- fuel inlet means extending through the top of said atomizing chamber to a position directly above said vibrating head for supplying a constant amount, greater than required by said engine, of fuel to said vibrating head, whereby the thus supplied fuel contacts said vibrating head and is fully atomized thereby;
- air inlet means in said chamber for allowing passage therein of air to mix with said atomized fuel and to pass therewith into said intake manifold; and
- fuel tray means in the bottom of said atomizing chamber at a position below said vibrating head for receiving fuel not sucked into said intake manifold.

5. The improvement of claim 4, further comprising a fuel supply tank connected to said fuel inlet means; conduit means connecting said fuel tray means with said fuel supply tank; and pump means in said conduit means for recirculating said fuel from said fuel tray means back to said fuel supply tank.

6. The improvement of claim 4, wherein said air inlet means extends into said atomizing chamber at an end thereof opposite said end thereof connected to said intake manifold, said air inlet means comprising adjustable valve means for controlling the amount of air entering said atomizing chamber.

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