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Laessig

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[54] **VAPOR GENERATOR**

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[52] **U.S. Cl.**..... **122/250 R**; 122/367 R; 431/328

[51] **Int. Cl.**[2] **F22B 27/08**

[58] **Field of Search** ..... 122/250 R, 367 R, 367 C; 431/328, 329

[56] **References Cited**

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[57] **ABSTRACT**

A vapor generator for vaporizing a liquid by burning a combustible mixture which has low pollutant emissions. A porous burner having a cooling liquid tube within it divides the interior of a housing into a combustion chamber and a plenum into which the combustible mixture is blown. The vaporized mixture passes through the wall and burns on its outer surface. In a coiled tube surrounding the porous burner the liquid from the cooling liquid tube is vaporized.

4 Claims, 2 Drawing Figures

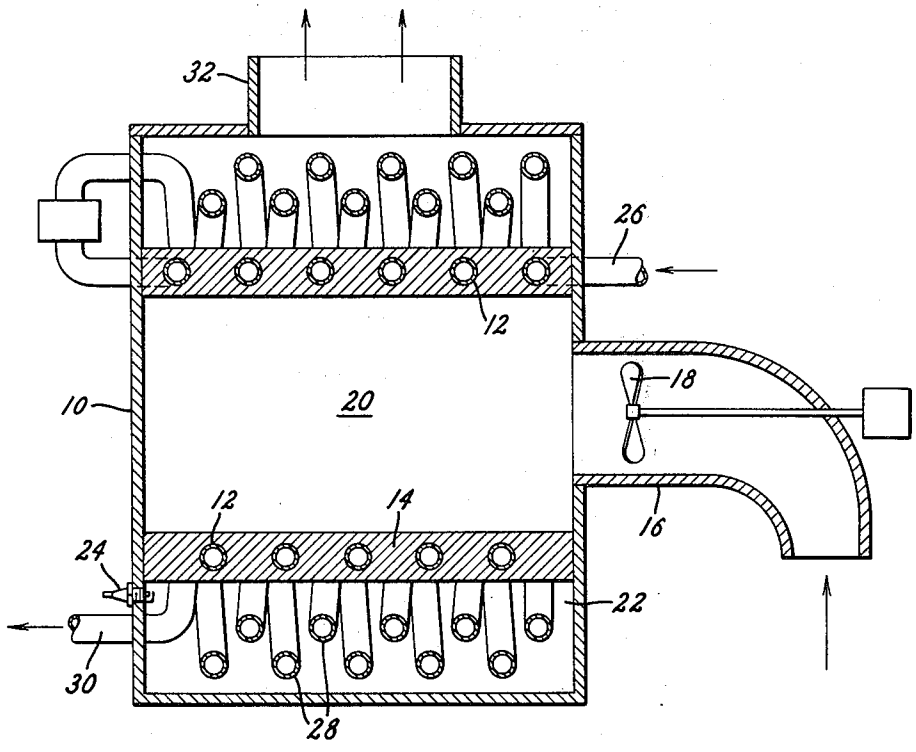


Fig. 1.

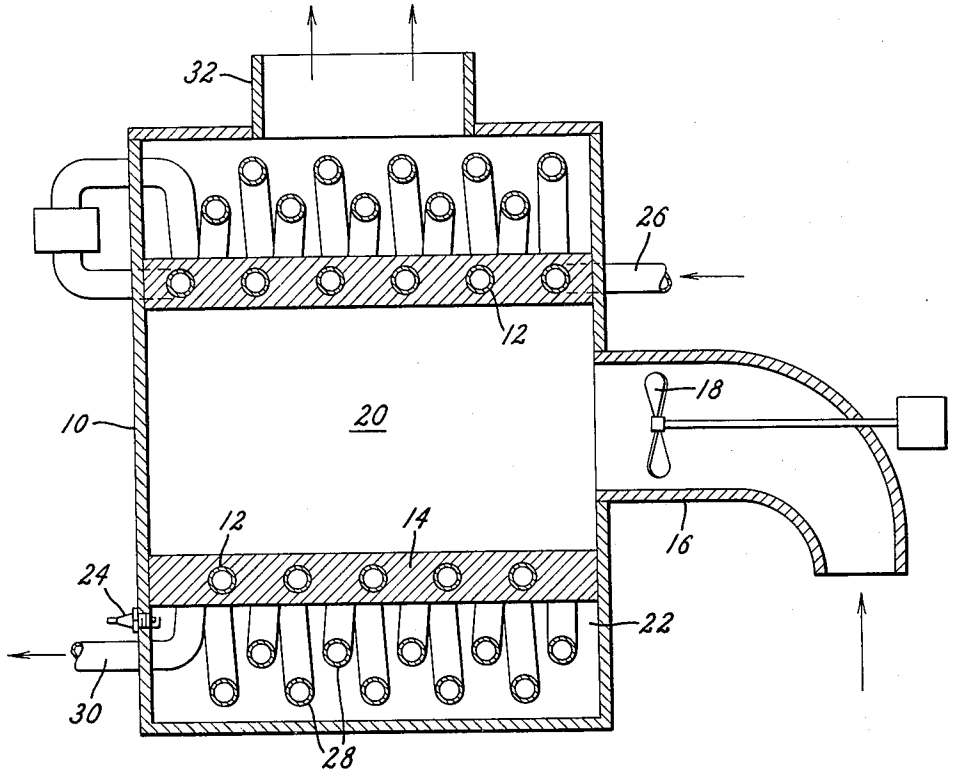
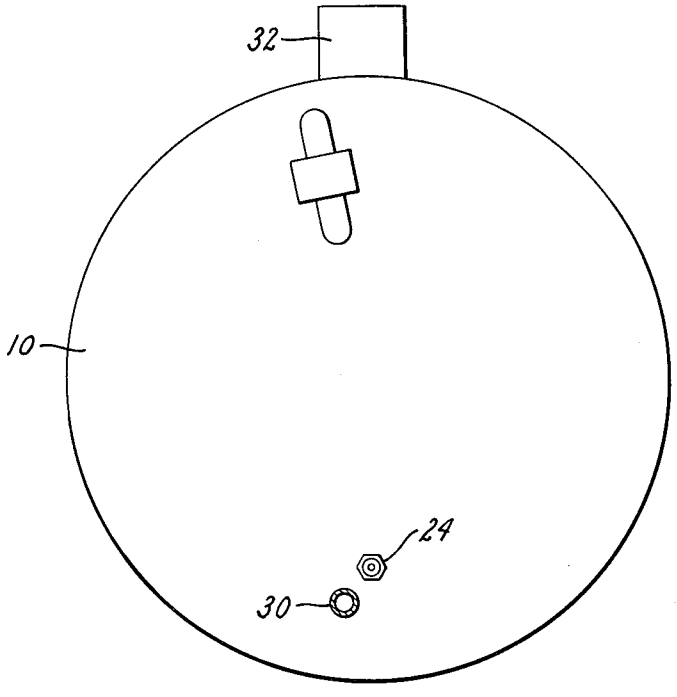


Fig. 2.



VAPOR GENERATOR

BACKGROUND OF THE INVENTION

This invention relates generally to vapor generators and more particularly to an improved vapor generator having low pollutant emission characteristics.

As widely publicized, one drawback of contemporary piston type internal combustion engines is the excessive amounts of air pollutants which result from their operation. Although efforts are being made to reduce the pollutants emitted by these engines, alternate power generating means are also being explored. One such alternate is the external combustion engine. In such an engine, a fuel (generally liquid) is burned in a combustor and the resulting hot gases are used to vaporize a liquid which in turn drives a prime mover such as an expander, turbine, etc.

External combustion generally results in more complete consumption of the hydrocarbons than the intermittant combustion in an internal combustion, piston type engine. Excessive production of nitrogen oxides and carbon monoxides still remain a problem, particularly in units small enough to be mobile. The rate of nitrogen oxides formation decreases rapidly as the temperature of the reaction gases is reduced (see for example U.S. Pat. No. **3,675,629**).

One approach to a compact combustor-boiler with low nitrogen oxides emissions employs a porous burner constructed of sintered metal particles with cooling tubes encased within the burner (see U.S. Pat. No. **3,750,399**). This device, while accomplishing the desired results, is somewhat complicated in structure, and, since it is intended for use in powering a motor vehicle, has a greater capacity than required for other purposes. For other purposes such as small electric generating units a simpler, more economical and more compact vapor generator is desirable.

SUMMARY OF THE INVENTION

In a preferred form of the invention, a cylindrical housing is divided into a central plenum and a generally annular combustion chamber by a porous wall. A combustible mixture is introduced into the plenum at a pressure higher than ambient. This mixture passes through the porous wall and burns on its outer surface. Contained within the wall is a coil of tubing through which a liquid is passed to remove heat from the wall. The liquid then passes to a tube coil in the combustion chamber where it is vaporized.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a cross-sectional schematic of the vapor generator of this invention; and

FIG. **2** is a side view of the same vapor generator.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIGS. **1** and **2**, housing **10** of the vapor generator of this invention encloses helical tubular coil **12** which is contained in wall **14**. Wall **14** is porous and may be formed of bonded particles of metal such as copper or aluminum shot. In the alternative, wall **14** may be formed of spaced parallel plates with metal wool provided within to improve heat conduction to coil **12**. Pores may be formed in the plates by drilling, laser beams or other means.

A combustible mixture is admitted through inlet **16**, impelled by blower **18**, into plenum **20**. Plenum **20**, formed by wall **14** and housing **10**, is of a generally cylindrical configuration, although in the bonded particle structure mentioned above, which is formed in a mold, it has been found desirable to make it slightly frustoconical to enhance separation from the mold.

The combustible mixture, because of its higher pressure, passes through the pores of wall **14** into combustion chamber **22** where it burns on the surface of wall **14** after being ignited by ignitor **24**. The flow of liquid through coil **12** which is admitted at inlet **26** keeps porous wall **14** cool. The flame temperature is reduced below the adiabatic value due to heat transfer from the flame to the wall. After passing through coil **12**, the liquid flows into coil **28** where it is vaporized. The vapor is removed at outlet **30** to be used as desired, for example as the motive fluid of a prime mover. The products of combustion exit via exhaust **32**.

In a vapor generator built in accordance with this invention, wall **14** was about ½ inch thick with a pressure drop of about **25** mm of water. The overall dimensions of housing **10** were: diameter **14** inches and length **12** inches.

At maximum design conditions, fuel (in this case low lead gasoline) is consumed at a rate of **17.6** pounds per hour. (It should be recognized that the numbers given are nominal and some variations will occur.) With **60** cubic feet per minute of air delivered at **70°F**, **330,000** BTU's per hour are generated. Of these, **65,000** BTU's per hour are exhausted, about **65,000** BTU's per hour go to heat the coolant in helical coil **12** and the remainder vaporizes the liquid in coil **28**.

As a coolant/vapor, a mixture of trifluoroethanol and water was used with the water comprising **14.8%** by weight. The flow rate of the coolant was **620** ± 50 pounds per hour at an inlet temperature of **175°F** and an inlet pressure of **700** psia. The vapor at the outlet was at a pressure of **500** ± 40 psia and a temperature of **480** ± 25°F.

Only about **10** ppm of unburned hydrocarbons are found in the exhaust together with approximately **10** ppm of nitrogen oxides and **0.075%** carbon monoxide.

Of course, insulation about housing **10** may be provided and other changes and modifications can be made without departing from the spirit of the invention and the scope of the appended claims.

I claim:

1. A vapor generator for vaporizing a liquid by burning a combustible mixture while minimizing the production of carbon monoxide, unburned hydrocarbons and nitrogen oxides comprising:

a housing having a central inlet for receiving the combustible mixture and an exhaust port in the housing wall;

a first coil of tubing for carrying the liquid contained in a porous wall;

said porous wall dividing the interior of said housing into a central plenum and a combustion chamber;

a second coil of tubing in said combustion chamber spaced from said porous wall wherein said liquid is vaporized;

the outlet of said first tube being connected to the inlet of said second tube;

means for introducing a combustible mixture into said plenum at a pressure higher than atmospheric; and

means for igniting said combustible mixture in said combustion chamber.

2. A vapor generator in accordance with claim **1** wherein:

said housing is cylindrical; and

said exhaust port is in the cylindrical wall.

3. A vapor generator in accordance with claim **1** wherein:

said porous wall is formed of bonded metal particles.

4. A vapor generator according to claim **1** wherein:

said first and second coils of tubing are concentric helixes.

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