

[54] FUEL SYSTEM FOR AN INTERNAL COMBUSTION ENGINE

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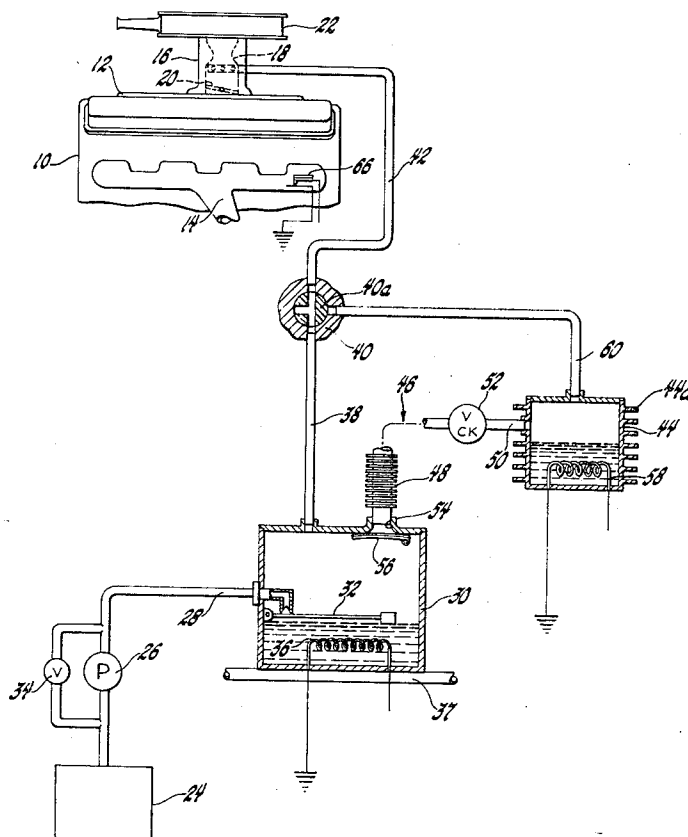
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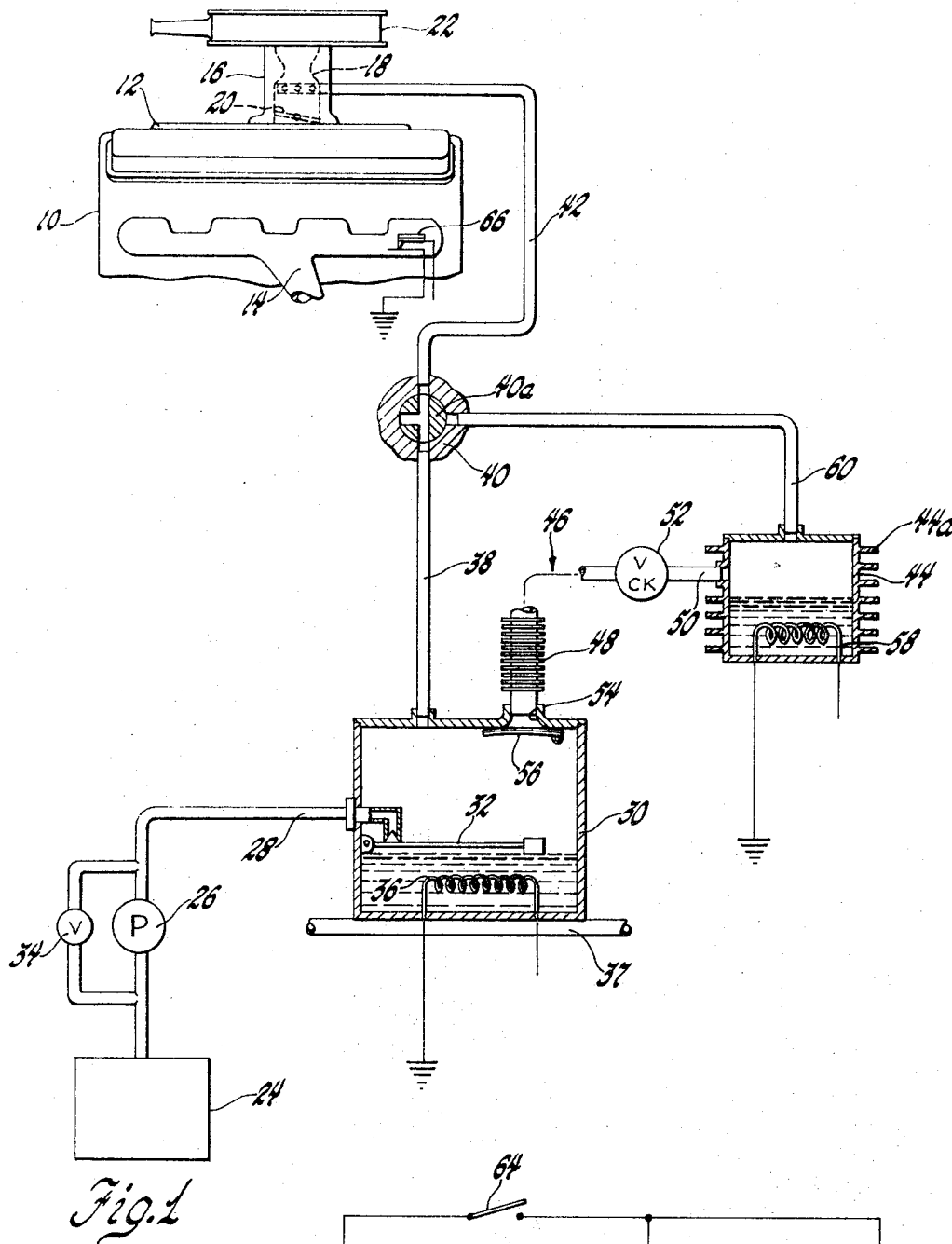
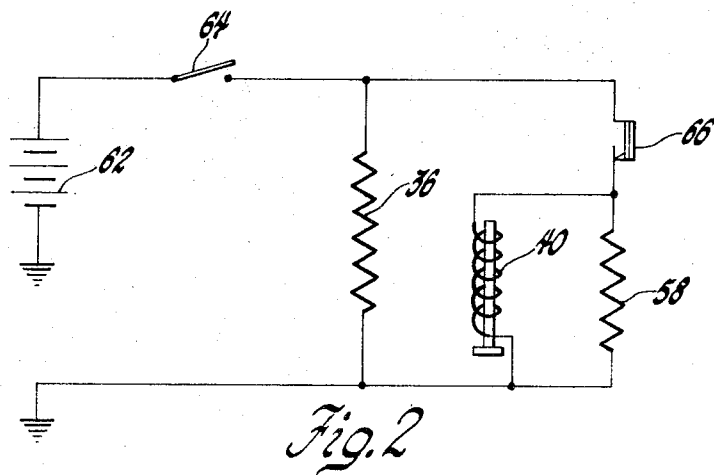
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[57] ABSTRACT

A fuel supply system for an internal combustion engine having a vapor carburetor wherein liquid fuel is vaporized in a fuel vaporizing chamber to supply fuel vapor to the engine with a portion of the lighter end of the fuel thus vaporized being stored in a holding fuel vaporizing chamber for a fuel system of an internal combustion engine used in starting the engine.

6 Claims, 2 Drawing Figures





FUEL SYSTEM FOR AN INTERNAL COMBUSTION ENGINE

This invention relates to a fuel system for internal combustion engines and, in particular, to a fuel system for supplying dual fuel vapors to an automotive vehicle engine.

It is well known to use a fuel vapor mixed with air by means of a vapor carburetor, such as a conventional liquid petroleum gas (LP gas) carburetor to effect operation of an internal combustion engine. If the fuel used is a liquid fuel, such as gasoline, means are provided to heat the liquid fuel to generate the necessary fuel vapors for engine operation before the fuel is injected into the induction passage of the engine. With gasoline, both light end and heavy end fuel vapors are generated since gasoline vaporizes within the approximate range of 95°F to 450°F because of the wide variation in components making up gasoline, such as Pentane, Hexane, Heptane, Octane, Nonane, Decane and Hendecane.

However, in these prior art systems in which gasoline is used as the fuel, electrical heat elements must normally be used when starting the vehicle engine to vaporize the liquid gasoline in a suitable fuel vaporizing chamber which has been supplied with gasoline from a fuel reservoir. The vehicle's electrical power is normally used to vaporize the liquid fuel, both light and heavy end fuel vapors being generated for delivery to the engine induction system to effect engine starting and subsequent engine operation. Since the raw liquid gasoline is being vaporized, considerable electrical energy is used to effect this vaporization during engine starting.

It is therefore the principal object of this invention to provide a fuel system for an internal combustion engine in which liquid fuel is partially distilled to provide a dual fuel supply of vapors for engine starting and operation.

Another object of this invention is to provide a fuel system for an internal combustion engine wherein the more volatile fuel vapors are stored and then used during engine starting and initial operation of the engine until less volatile fuel vapors are generated for use in subsequent engine operation.

These and other objects of the invention are attained by means of a fuel supply system for an internal combustion engine wherein liquid fuel is vaporized in a first fuel vaporizing chamber to supply fuel vapor to the engine during engine operation with the light end of the fuel vapors thus generated being stored in a second fuel vaporizing chamber for use during initial engine starting.

For a better understanding of the invention, as well as other objects and further features thereof, reference is had to the following detailed description of the invention to be read in connection with the accompanying drawings, wherein:

FIG. 1 is a schematic illustration of a fuel system for an internal combustion engine in accordance with the invention and,

FIG. 2 is a schematic electrical wiring diagram of the fuel system of FIG. 1.

Referring now to FIG. 1, a conventional internal combustion engine 10 includes an intake manifold 12 and an exhaust manifold 14, with a conventional vapor carburetor 16 mounted over the inlet of the intake

manifold. The vapor carburetor 16 is provided with an induction passage including a venturi 18, flow through which is controlled by a throttle valve 20, air being supplied through an air cleaner 22 mounted on top of the vapor carburetor.

The fuel system for the internal combustion engine 10, in accordance with the invention, includes a fuel reservoir or tank 24 with a fuel pump 26 supplying liquid fuel, such as gasoline, therefrom via a conduit 28 to a vaporizing chamber 30. As shown, the pump delivers liquid fuel to the vaporizing chamber 30 which contains a float controlled valve 32 so as to maintain a constant level of fuel available for vaporizing within the vaporizing chamber 30. As is common practice, a pressure valve controlled fuel bypass 34 is provided around pump 26.

Liquid fuel entering the vaporizing chamber 30 is vaporized by a heat source, such as electrical heating coil 36, suitably mounted in heat transfer relationship to the fuel within the vaporizing chamber and may also include additional heating means receiving heat as an incident to engine operation, such as, for example, a conduit 37 receiving hot exhaust gases from the exhaust manifold 14 and also being positioned to be in heat transfer relationship to the vaporizing chamber 30.

Fuel vapors generated within the vaporizing chamber 30 are delivered via a conduit 38, a solenoid controlled valve 40 and conduit 42 to the vapor carburetor 16 for induction into the combustion chambers, not shown, of the internal combustion engine 10.

The solenoid controlled valve 40 is provided with a rotatable valve element 40a, normally positioned as shown in FIG. 1 when de-energized, to place conduit 38 in fluid communication with conduit 42 but which, when energized, will rotate clockwise to block the flow from conduit 38.

In addition, part of the vapors generated within the vaporizing chamber 30 are supplied to a fuel vaporizing and holding chamber 44 through a vapor separator, generally designated 46. The vapor separator 46 includes a finned condenser conduit 48 and conduit 50 joined together, with the latter having a one-way check valve 52 therein so that fuel vapors can flow from the vaporizing chamber 30 to the chamber 44 but reverse flow of fuel vapors is prevented.

The flow of fuel vapors from the vaporizing chamber 30 through the discharge port 54 therein into the finned condenser conduit 48 is controlled by a suitable thermostat valve, such as bimetallic valve 56, which at low temperature uncovers the port 54 but at a predetermined temperature covers this port. Bimetallic valve 56 is used to block the flow of fuel vapors into vapor separator 46 at a predetermined elevated temperature, depending on the cooling capability of the finned condenser conduit 48. Otherwise, if heavy end fuel vapors above this predetermined temperature were permitted to enter the vapor separator 46, they would not condense in the finned condenser conduit 48 for return to the vaporizing chamber 30 as a liquid but instead would enter the chamber 44 to condense therein and mix with the more volatile fuel stored in chamber 44.

As fuel vapors are generated in the vaporizing chamber 30, with the bimetallic valve 56 open, the vapors will travel upward through the finned condenser conduit 48 toward chamber 44. Since the temperature at the top of this condenser conduit 48 will be lower because of heat loss, as compared to the bottom portion

of this condenser conduit directly adjacent to the vaporizing chamber 30, the heavy end fuel vapors of the gasoline will condense along the walls of this conduit and this liquid gas will then flow back into the vaporizing chamber 30. Only the light end fuel vapors will continue to travel through the vapor separator into the fuel vaporizing and holding chamber 44. Since the fuel vaporizing and holding chamber 44 is provided with suitable fins 44a on the exterior thereof for heat dissipation, these light end fuel vapors will also condense in the chamber 44.

Liquid fuel, consisting only of the light ends of the gasoline, thus stored within the chamber 44 are then vaporized, when desired, by a heat source, such as electrical heating coil 58 suitably mounted in heat transfer relationship to the fuel within the fuel vaporizing and holding chamber 44.

Fuel vapors generated within the fuel vaporizing and holding chamber 44 are delivered via a conduit 60 and the previously described solenoid controlled valve 40 and conduit 42 to the vapor carburetor 16 during engine starting in a manner to be described.

As seen in FIG. 2, the heating coils 36 and 58 are connectable to a source of electrical power, such as the vehicle battery 62, through the ignition switch 64, the heating coil 58 also being connected through a normally closed thermostatic control switch 66 positioned in thermal contact with, for example, a catalytic converter (not shown), or as shown to the engine exhaust manifold 14. In addition, the solenoid controlled valve 40 is connected in parallel with the heating coil 58.

With light end fuel of high volatility stored in the vaporizing and holding chamber 44 and with a cold engine so that the switch 66 is in its normally closed position, as the ignition switch 64 is closed to start the engine, the heating coils 36 and 58 and the solenoid controlled valve 40 are energized. As the solenoid controlled valve 40 is energized, the valve element 40a thereof is rotated in a clockwise direction from the position shown in FIG. 1 to place the conduit 60 in communication with conduit 42. Heat from the heating coil 58 will vaporize the light end fuel in chamber 44 in a few seconds and the thus generated vapors will then flow through conduit 60, valve 40 and conduit 42 to the vapor carburetor 16 for induction into the combustion chambers of the engine. With this arrangement, both the starting and initial operation of the engine are effected by the use of only the more volatile components of the original gasoline stored in the fuel tank, that is, the light end components of the gasoline. This permits the engine to be started with a leaner air-fuel mixture than is normal using regular gasoline and, the resulting combustion of this fuel is much cleaner during initial engine operation. Depending on the size of the engine, sufficient fuel is stored in the chamber 44 to permit engine operation for a predetermined period of time so as to allow the engine to reach a normal operating temperature.

When the temperature of the engine, as determined at the exhaust manifold 14, for example, reaches a predetermined temperature as sensed by the thermostatic control switch 66, the contact of this switch will open to de-energize the heating coil 58 and the solenoid controlled valve 40. As the solenoid controlled valve 40 is de-energized, the valve element 40a will then rotate counterclockwise back to the position shown in FIG. 1 to place conduit 38 in fluid communication with the

conduit 42 so that fuel vapors generated within the vaporizing chamber 30 are then used for further operation of the engine. During subsequent engine operation, the vaporizing and holding chamber 44 will then start to recharge until it is once again full of the low end fuel components of the gasoline being vaporized in the vaporizing chamber 30 in the manner previously described.

Although in the embodiment disclosed a thermostatic control switch 66 is used to determine when the engine operation should be switched from the fuel in chamber 44 to the fuel supply from the vaporizing chamber 30, it is to be realized that in lieu of this thermostatic control switch 66, a suitable timer, such as a thermal timer, not shown, can be used to effect de-energizing of the heating coil 58 and the solenoid controlled valve 40 a predetermined time interval after engine start-up.

It is also to be realized that the fuel tank 24, vaporizing chamber 30 and the vaporizing and holding chamber 44 can also be connected in a suitable manner to an evaporative loss control device of the type disclosed, for example, in U.S. Pat. No. 3,093,124 issued on June 11, 1963 to Joseph T. Wentworth which device would also serve as a venting device for the subject fuel system. However, such an evaporative loss control device is not shown since it forms no part of the subject invention.

What is claimed is:

1. A fuel supply system for an internal combustion engine having an air induction passage provided with a venturi, a fuel reservoir for liquid fuel, a first fuel vaporizing chamber having a first heat source associated therewith, pump means connected to said fuel reservoir and to said first fuel vaporizing chamber for supplying fuel from said fuel reservoir to said first fuel vaporizing chamber, a second fuel vaporizing and storage chamber for light end fuel having a second heat source associated therewith, a vapor separator and valve controlled conduit means connecting said second fuel vaporizing chamber to said first fuel vaporizing chamber whereby only the light end fuel portion of the fuel vapor generated in said first fuel vaporizing chamber flows to said second fuel vaporizing and storage chamber and, valve controlled conduit means selectively connecting said first fuel vaporizing chamber and said second fuel vaporizing chamber to said venturi.

2. A fuel supply system according to claim 1 wherein said vapor separator and valve controlled conduit means includes a heat exchanger conduit connected to said first fuel vaporizing chamber for the flow of fuel vapors therefrom, a thermostat valve at one end thereof for controlling the flow of fuel vapor from said first fuel vaporizing chamber into said heat exchanger conduit and a one-way check valve at the opposite end of said heat exchanger conduit to prevent the flow of fuel vapor from said second fuel vaporizing and storage chamber to said first fuel vaporizing chamber.

3. A fuel supply system according to claim 2 wherein said first heat source includes an electrical heating coil connectable through a first switch to a source of electrical power and wherein said second heat source includes a second electrical heating coil connectable through said first switch and an engine operating temperature sensitive switch to said source of electrical power and wherein said valve controlled conduit means

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includes a solenoid controlled valve connected in parallel with said second electrical heating coil.

4. A fuel supply system for an internal combustion engine having an induction passage provided with a venturi, a fuel reservoir for liquid fuel, a first fuel vaporizing chamber having a first heat source associated therewith, energizing means connected to said first heat source for energizing said first heat source during engine operation, pump means connected to said fuel reservoir and to said first fuel vaporizing chamber for supplying fuel from said fuel reservoir to said first fuel vaporizing chamber, a second fuel vaporizing and storage chamber having a second heat source associated therewith, said energizing means including means connected to said second heat source for energizing said second heat source as a function of an engine operating condition, a vapor separator and valve controlled conduit means connecting said second fuel vaporizing chamber with said first fuel vaporizing chamber whereby fuel vapors flowing therein from said first fuel vaporizing chamber are separated so that only the light end fuel vapors flow to said second fuel vaporizing and storage chamber and, valve controlled conduit means operatively connecting said second fuel vaporizing chamber to said venturi when said second heat source is being energized and to connect said first fuel vaporiz-

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ing chamber to said venturi when said second heat source is not being energized.

5. A fuel supply system according to claim 4 wherein said vapor separator and valve controlled conduit means includes a heat exchanger conduit connected to said first fuel vaporizing chamber for the flow of fuel vapors therefrom, a thermostat valve at one end thereof for controlling the flow of fuel vapor from said first fuel vaporizing chamber into said heat exchanger conduit and a one-way check valve at the opposite end of said heat exchanger conduit to prevent the flow of fuel vapor from said second fuel vaporizing and storage chamber to said first fuel vaporizing chamber.

6. A fuel supply system according to claim 4 wherein said first heat source is a first electrical heating coil and said second heat source is a second electrical heating coil and wherein said energizing means includes a source of electrical power connectable through a first switch to said first electrical heating coil and to said second electrical heating coil and an engine operating temperature sensitive switch interposed between said first switch and said second electrical heating coil, and wherein said valve controlled conduit means includes a solenoid controlled valve connected in parallel with said second electrical heating coil.

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