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[54] **FUEL SUPPLY SYSTEM FOR REDUCED EXHAUST EMISSION**

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[58] **Field of Search** 123/127

[56] **References Cited**

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1,559,214	10/1925	Woolson	123/127
1,559,216	10/1925	Woolson	123/127
1,744,953	1/1930	Dienner	123/127

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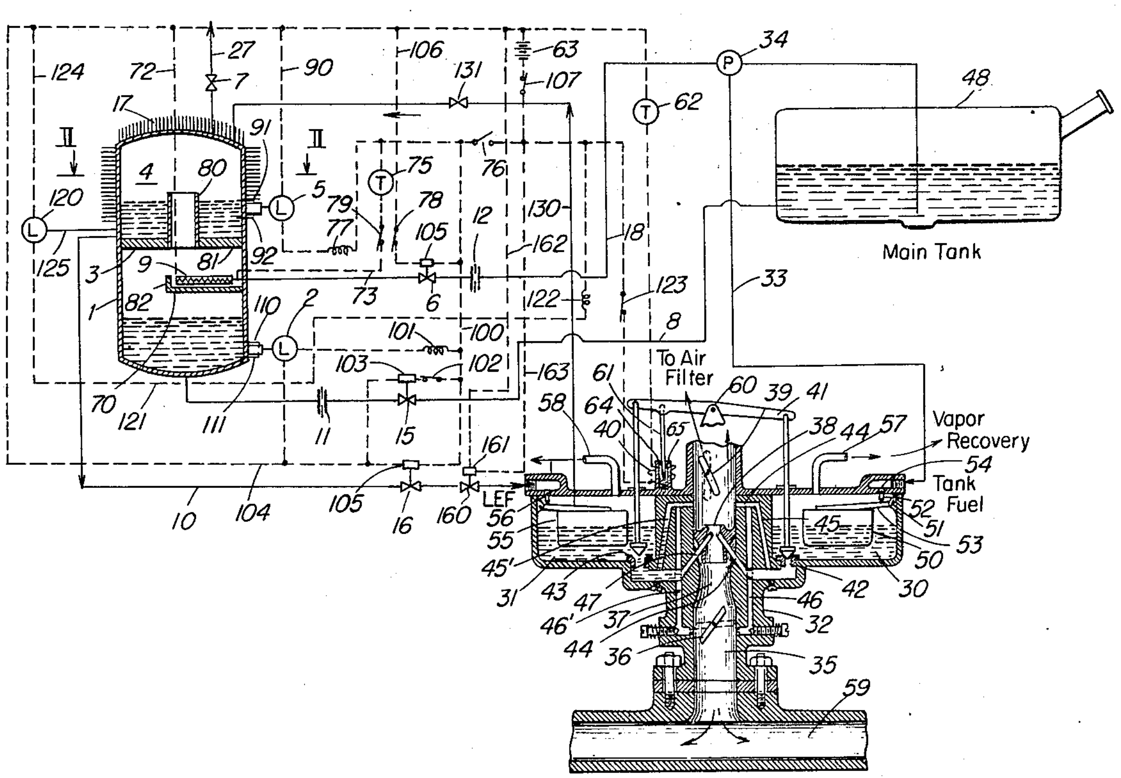
[57] **ABSTRACT**

Exhaust emissions from internal combustion engines of automotive vehicles are reduced in content of CO and unburned hydrocarbons by a modified fuel induction system. Light ends of normal motor fuel are separated by a flash distillation and stored in the vehicle for supply to the cylinders during low temperature operating conditions such as cold start and warm-up. The cut point for light ends separated is automatically adjusted in response to ambient temperature to supply fuel of greater volatility during cold start when operating under conditions of lower climatic temperature. Automatic control is also imposed on supply of the more volatile fuel to the cylinders responsive to engine temperature, e.g. responsive to a sensor of engine coolant temperature. Conventional operation on full range fuel, e.g. gasoline, is automatically established at engine temperature close to normal operating temperature, at which unburned hydrocarbon and carbon monoxide emissions are low. The evaporation of light ends to provide a volatile fuel component may be induced by reduced pressure (such as may be derived from pump suction or modified vacuum) or by heating the full range from engine coolant exhaust heat, or electric heating elements. Storage of the volatile fuel component may be as liquid condensate, absorbate on solid absorbent, or the like. Alternatively, chromatographic separation technique may be utilized.

10 Claims, 2 Drawing Figures



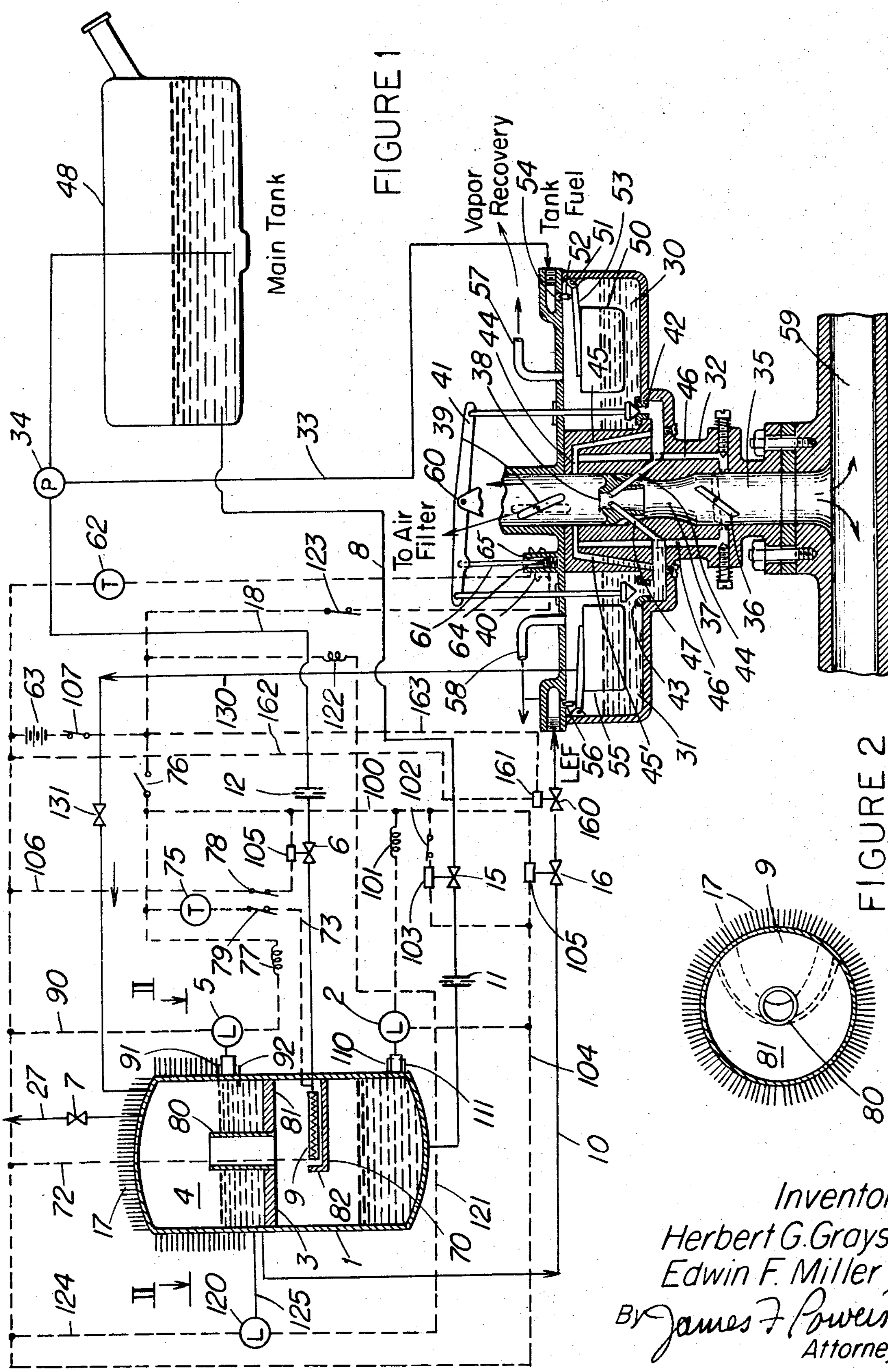


FIGURE 1

FIGURE 2

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FUEL SUPPLY SYSTEM FOR REDUCED EXHAUST EMISSION

BACKGROUND OF THE INVENTION

1. Field of the Invention

The invention is concerned with reduction in undesirable emissions in automotive exhaust and is particularly directed to reduction of unburned hydrocarbons and carbon monoxide in such exhaust.

2. Description of the Prior Art

For brevity, the term "emissions" will be used sometimes hereinafter as meaning unburned hydrocarbon and carbon monoxide content of automotive exhaust. Such emissions have been regarded by many as a significant contributor to air pollution in that the hydrocarbons therein are subject to photo-chemical reaction in the atmosphere to compounds conducive of smog, many of which are lachrymators which induce more or less severe irritation of mucous membranes.

It has been demonstrated that emission of unburned hydrocarbons by an internal combustion engine during cold operation is many times that characteristic of operation at the stabilized conditions for the engine in a warmed up state. In operation, an internal combustion engine generates large amounts of heat by combustion of the charge of fuel (primarily hydrocarbons at this time) and air. Much of the heat energy is converted to useful work by expansion of the hot combustion gases against the piston head, but a substantial amount of the heat is diverted to raising temperature of the engine. To reach a stable operating condition, a coolant, primarily water in most cases, is circulated through a jacket about each cylinder and thence through a radiator to reduce temperature of the coolant and back to the jacket. After a few minutes of operation, the system reaches an equilibrium at which the radiator can dissipate to ambient atmosphere from coolant at the circulating temperature an amount of heat per unit time equal to the rate of heat input to the coolant from the operating cylinders.

It is apparent that the engine must be designed for operation at coolant temperatures well above ambient temperature if there is to be dissipation of heat to ambient atmosphere as a heat sink. It necessarily follows that an engine is operated during start-up at temperatures well below design temperature since the engine, while inoperative, has cooled to ambient temperature.

It has been common practice in automotive design over many decades to provide for "choking" the engine on cold starts. This is accomplished by impeding flow of air (throttling back or choking the air supply) to the carburetor to provide a very rich (in hydrocarbons) charge to the cylinders. Such rich mixtures necessarily result in less complete reaction of hydrocarbons in the charge with oxygen of air in the charge, and thus produce emissions higher in unburned hydrocarbons and CO than is characteristic of unchoked operation at design temperature for the engine.

It is a primary object of this invention to avoid the high emissions characteristic of cold starts without major departure from present principles of design for internal combustion engines.

Industrial research teams have sought for many years solutions to the problems of automotive engine operation. In addition to pollutant effects, rich fuel/air mixtures cause significant reductions in the thermal efficiency of internal combustion engines. During the recent several years, joint research by automotive manufacturers and petroleum refiners has been carried forward. The Government has imposed sanctions of law to limit emissions from new automotive engines and plans further restrictions in the future.

Setting of standards for design of automotive engines by industry or for imposing controls by governmental fiat must take into account the variation in emissions by a cold engine as compared with an engine which has achieved design operating temperature. Proposals have been advanced to limit volatility of the fuel for automotive equipment. Some fleet operations, particularly of automotive equipment operated by governmental agencies have converted certain of their vehicles to operate on liquified petroleum gas (LPG), primarily propane. The thick walled vessels needed to maintain the fuel liquid at ambient temperature add to the complexity and cost. Further, very limited distribution of LPG exists for automotive use.

It has also been proposed that automotive vehicles carry two fuels, one highly volatile (e.g. LPG) for starting and the other conventional gasoline for operation at design temperature. This again involves the problems of high pressure vessels for LPG, plus the need for dual refueling.

Some have suggested that maximum boiling point of motor gasoline be limited to some value much below present practice, perhaps 150°F. or more below the 400°–425° end point typical of gasolines now produced.

All these schemes entail wasting of the world's supply of petroleum in the sense that far greater quantities of crude petroleum will be consumed to produce an equivalent amount of automotive fuel and also would require vast capital expenditure to erect the added refinery facilities. The petroleum industry as presently equipped is incapable of meeting demand for automotive fuel if a substantial portion of the present automotive vehicles were converted according to any of the schemes outlined above.

We have now found that the objective of low emissions on cold start may be attained by adaptation of systems proposed fifty years ago for facilitating cold starts of internal combustion engines used in automotive vehicles. Patents granted on applications filed in 1920 and years immediately thereafter describe automotive fuel induction systems in which the more volatile components of a normal gasoline are separated and held for use as engine fuel during cold start and warm-up. When light ends only are employed as the fuel, charge mixtures can be prepared in the comburetor which have dew points approximating or below ambient temperatures. The charge is therefore homogeneous and can be fired in the cylinder without undue enrichment.

Typical of such prior patents is U.S. Pat. No. 1,744,953, granted Jan. 28, 1930 to Dienner on an application filed in 1923. Dienner disclosed a system wherein fuel is drawn from a storage tank by suction from the intake engine manifold to a vacuum feed tank. Fuel enters the vacuum feed tank and is applied to a bracket to cause the fuel to be sprayed out into a pumping chamber and thereby expose a relatively large surface of the fuel to the action of suction which carries off air and vapor through a vent to a condenser. The condenser condenses light end fuel which is stored in a trap. The fuel may be preheated by passing the fuel through or in the vicinity of an exhaust manifold. When the engine is initially started, a rod is pulled to open a valve and thus supply air to the trap. The air entering the trap carries vapors from the lighter constituents in the trap to the intake manifold of the engine. When the engine is started, the operator releases the rod which retracts by spring action to cause the engine to operate under normal fuel supplied to a carburetor. This patent mentions that the liquid fuel should contain some light ends which may be distilled off and trapped as a source of priming fuel. The disclosure thereby permits the use of heavier liquid fuel than previously used.

Woolson U.S. Pat. Nos. 1,559,214 and 1,559,216, granted Oct. 27, 1925 on applications of effective 1920 filing date are to like effect. These disclosures also are concerned with systems which permit use of heavy fuel and are thus pertinent to the comparison here between continuing use of present automotive fuel and change over to more volatile fuels. These patents provide for utilizing heat from a combustion heater to distill a fractional part of the heavy fuel for use in starting, and in operating the combustion heater. The system provides for pumping fuel from a storage tank to a still wherein the fuel is heated by a heater. Lighter fractions of the fuel are distilled off to a condenser and auxiliary storage tank. There are two float chambers which are fed by fuel from the auxiliary storage tank and from the fuel tank via the still, respectively. Operation of a manual switch determines which of the float chambers supplies fuel to the carburetor. It is stated that the system permits the engine to be started on a lighter fuel from a condenser and operated on the fuel until the engine is warm enough to run on kerosene or other heavier fuel. The system also provides for continuously supplying fuel from the float chamber to the heater.

See also Kloepper, U.S. Pat. No. 1,576,766, granted Mar. 16, 1926 on an application filed July 2, 1921.

SUMMARY OF THE INVENTION

In accordance with an aspect of the present invention, there is provided a system for supplying hydrocarbon fuel to an internal combustion engine comprising means for storing a main supply of hydrocarbon fuel, and means for separating volatile fuel components from the hydrocarbon fuel. The system also includes means for storing separated volatile components, and means for supplying fuel to the engine from the volatile fuel components storing means when the engine is below a predetermined temperature and for supplying fuel to the engine and to the separating means from the hydrocarbon fuel storing means when the temperature of the engine is at or above the predetermined temperature. In accordance with a specific aspect of the invention, the system further includes means responsive to ambient temperature for controlling the volatility level above which volatile fuel components are separated in the separating means.

In accordance with another aspect of the invention, there is provided a system for supplying fuel to an internal combustion engine comprising means for storing a main supply of hydrocarbon fuel, means for separating volatile fuel components from a portion of the hydrocarbon fuel, and means for controlling the volatility level above which volatile fuel components are separated in the separating means. The system also includes means for storing the separated volatile fuel components, and means for selectively supplying fuel to the engine from one of the hydrocarbon fuel storing means and the volatile fuel components storing means. In accordance with another specific aspect of the invention, the supplying means supplies fuel to the engine from the volatile fuel components storing means when the engine is below a predetermined temperature, and supplies fuel to the engine and to the separating means from the hydrocarbon fuel storing means when the temperature of the engine is at or above the predetermined temperature.

Thus, the invention provides for supplying a relatively volatile fuel to the engine during start-up and warm-up phases of engine operation.

The use of a relatively more volatile fuel during these phases of engine operation provides for more complete combustion to thereby reduce engine emissions such as hydrocarbons and carbon monoxide. Further, the invention provides for reduction of engine emissions without necessitating a change in the volatility of fuels as presently marketed.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows a fuel supply system including a carburetor as a specific embodiment of the present invention; and

FIG. 2 is a sectional view taken along line II—II of a volatile fuel accumulator used in the system.

DESCRIPTION OF SPECIFIC EMBODIMENTS

With reference to FIG. 1, there is shown a carburetor **32** having a main fuel reservoir **30** which is supplied with fuel from a main hydrocarbon fuel tank **48** by a pump **34** through a line **33**. The carburetor **32** also includes a volatile fuel reservoir **31** to which fuel is fed by a line **10** from a volatile fuel accumulator **4**.

The main reservoir **30** has a float **50** therein which is vertically movable in response to the level of fuel in the reservoir **30**. The float **50** is connected to an extension arm **53** which is pivoted at a point **51**. A valve **52** extends upwardly from the arm **53** and is movable with respect to a valve seat **54** in response to vertical movement of the float **50**. When the fuel in the reservoir **30** reaches a predetermined maximum level, the float **50** causes the valve **52** to enter the seat **54** to thereby cutoff fuel flow from the main storage tank **48** to the main reservoir **30**.

The volatile fuel reservoir **31** also includes a float **55** and valve **56** arrangement to control the maximum level of volatile fuel therein in the same manner as that described with reference to the main fuel reservoir **30**.

Each of the reservoirs **30, 31** is connected to a conventional boost venturi **38** by a discharge nozzle **44; 44'** through a valve-orifice arrangement **42; 43**. Each of the valve-orifice arrangements **42; 43** is also in fluid communication with a first idling passage **45; 45'** which in turn is connected to a second idling passage **46; 46'**. The second idling passages also provide fluid communication between the carburetor passage at a point intermediate a conventional choke mechanism for fuel/air enrichment and a point in the carburetor throat **35** downstream of a conventional throttle plate **36**. A typical main venturi 37 is formed between the boost venturi 38 and the throttle plate 36. The carburetor throat 35 is in fluid communication with a manifold 59 which provides a combustible fuel/air mixture to the cylinders of an internal combustion engine (not shown).

When an engine is idling, the throttle plate 36 is in a nearly closed position as indicated by the dashed lines to thereby substantially reduce the pressure differential through the boost and main venturis. To permit sufficient fuel for idling, fuel is drawn upwardly through one of the first idling passages 45; 45' by action of air flowing downwardly in one of the second idling passages 46; 46'.

Each of reservoirs 30, 31 has a conduit 57, 58 at the upper part thereof through which vapors flow through a standard evaporative emissions canister (not shown) which is a standard anti-pollution device well-known in the art.

Fuel is supplied to the cylinders from one of the reservoirs 30, 31 in accordance with the position of a linkage 41. The linkage 41 is actuatable to one of two positions about a pivot 60. In the position shown, the linkage 41 maintains the valve-orifice arrangement 42 in a closed relationship to prevent fuel from passing through the orifice 42 from the main fuel reservoir 30. In the position shown, the linkage 41 also maintains the valve-orifice arrangement 43 in an open position to thereby permit the passage of fuel from the volatile fuel reservoir 31 to the discharge nozzle 44' and to the idling passages 45', 46'.

The linkage 41 is maintained in the position shown by action of a solenoid 40 which acts to drive a rod 61 upwardly against a bias of a spring 64 within a boss 65. The solenoid 40 is actuatable by a temperature sensing device 62 such as a bimetallic switch connected in circuit with a battery 63 and the solenoid 64. The temperature sensing device 62 is positioned to sense the temperature of the coolant in the cooling system of the engine. When the temperature of the coolant is below a predetermined valve, for example 150° F., the device 62 closes to supply power to the solenoid 40 to actuate the linkage 41 to the position shown. When the temperature of the coolant is at or above the predetermined value, power is removed from the solenoid 40, and the linkage 41 pivots about the pivot point 60 by action of the spring 64 which drives the rod 61 downwardly in the boss 65. When the linkage is in position not shown, the main fuel valve-orifice arrangement 42 is opened and the volatile fuel valve-orifice arrangement 43 is closed such that fuel is supplied to the cylinders through the discharge nozzle 44 and the idling passages 45, 46 from the main fuel reservoir 30.

In a typical cold engine starting sequence, a valve 16 in the line 10 is opened, as will be described hereinafter, to provide relatively high volatile fuel gravity flow from the accumulator 4 through the valve 16 to the volatile fuel reservoir 31. The choke 39 is thermostatically controlled to move to the position shown to provide fuel enrichment during a cold engine start. Since the fuel supplied to the volatile fuel reservoir 31 has a relatively high volatility, the amount of choking required is greatly reduced and may be eliminated. As the engine warms up from either idling operation or operation under power, the temperature sensing device 62 in the engine coolant system operates the solenoid 40 at its predetermined temperature to move the linkage 41 to the position not shown and thereby shut off high volatility fuel flow through the valve-orifice arrangement 43 and supply fuel from the main fuel reservoir 30 through the now opened valve-orifice arrangement 42. The valve 16 is also closed, as will be described hereinafter, at the predetermined temperature to stop further flow of high volatility fuel to the reservoir 31.

It is contemplated that the switch over from relatively high volatile fuel to normal fuel occurs at a coolant temperature such that further choking or other fuel enrichment will not be required for engine operation on normal fuel.

Further, the use of a high volatile fuel permits the choke mechanism 39 to be moved to the fully opened position as indicated by the dash lines in response to a fast-acting release mechanism without adversely affecting the drivability rating of the vehicle. Fast acting releases include the use of exhaust gas circulating about the thermostat control on the choke, operation in response to manifold pressure, engine speed, or a timed released mechanism.

When the linkage 41 is moved to the position not shown, a switch 76 is actuated to the closed position by any moving part of the linkage. Closure of the switch 76 completes a circuit including the battery 63, a switch 107 closed in response to turning of the ignition switch, a solenoid 109, a line 106 to supply power to the solenoid 109 which moves a valve 6 to the open position. When the valve 6 is opened, fuel flows from the main fuel tank 48 by action of the pump 34 through a line 18, a flow control orifice 12, to a flash separator 1.

Closure of the switch 107 completes a circuit including the battery 63, a line 162, a solenoid 161 and a line 163 to supply power to the solenoid 161 to open a valve 160 in a line 10. When the switch 107 is opened by removal of an ignition key (not shown), the solenoid 161 is deenergized to close the valve 160.

Closure of the switch 76 also completes a circuit including the battery 63, the switch 107, an ambient temperature sensor 75, a solenoid contact arm 79, a line 73, a heater 9, and a line 72 to provide power to the heater 9 within the flash separator 1.

Closure of the switch 76 also completes a circuit including the battery 63, the switch 107, a line 100, a parallel arrangement of solenoids 103, 105, and a line 104 to a supply power to the solenoids 103, 105. When power is applied to the solenoid 103, it actuates a valve 15 to an open position to permit flow by gravity from the bottom of the flash separator through a flow control orifice 11 and a line 8 to the main fuel tank 48. When power is applied to the solenoid 105, it actuates the valve 16 to the closed position to thereby prevent further flow of high volatile fuel from the accumulator 4 through the line 10 to the volatile fuel reservoir 31.

The heater 9 can operate at a constant current flow. However, the ambient temperature sensor 75 can be included in the circuit to control current flow through the heater 9 in response to ambient temperature. The use of the ambient temperature sensor 75 provides a means for varying the volatility level of the separated fuel to thus provide for varying weather conditions. For example, it is preferable to use a fuel having a higher volatility for cold engine starts in the winter than that used for cold engine starts in the summer. Accordingly, the ambient temperature sensor **75** provides a means for varying the current flow to compensate for the prevailing ambient temperature.

A portion of the fuel flowing over the heater **9** is vaporized and rises through a vapor riser **80** which extends upwardly from a base **81** of an accumulator **4**. The vapors enter the accumulator **4** and are condensed after contact with the walls of the accumulator **4**. A plurality of fins **17** are formed about the outer portion of the accumulator **4** wall to transmit heat from the interior of the accumulator **4**. The fuel that is condensed in the accumulator **4** is collected in an annular shaped portion of the accumulator **4** formed by the outer walls of the riser **80**, the upper surface of the base **81** and the interior wall of the accumulator **4**.

A relief valve **7** is connected to the upper part of the accumulator **4** to provide a relief path through a line **27** to the evaporative emissions canister (not shown) in the event of abnormal vapor pressure in the accumulator **4**.

The unvaporized fuel that is flowed over the heater **9** flows into the tray **70** and over an upwardly extending lip **82** to the bottom of the flash separator **1**. This fuel flows from the bottom of the flash separator **1** by gravity through the flow restrictive orifice **11**, and the valve **15** to the main hydrocarbon storage tank **48**, by way of the line **8**.

A level sensor **5** is connected to the accumulator **4** to monitor the level of the relatively high volatile fuel therein. The level sensor **5** is connected by a line **90** to one terminal of the battery **63** and through a relay coil **77** and the switch **76** to the other terminal of the battery **63**. When the level of the relatively high volatile fuel in the accumulator **4** reaches a predetermined level such as that indicated by the probe **91**, the level sensor **5** provides electrical energy to the relay coil **77** which causes the relay contact arms **78** and **79** to move to the open position. When the relay contact arm **79** opens, power is removed from the heater **9**. Simultaneously, the opening of the relay contact arm **78** removes power from the solenoid **109** to thereby close the valve **6** to prevent further application of fuel to the flash separator **1**. When the level of fuel in the accumulator **4** thereafter falls to a predetermined level such as that indicated by the probe **92**, the level sensor **5** removes power from the relay coil **77** to thereby cause the relay contact arms **78** and **79** to close. At this time, power is again applied to the heater **9** and to the solenoid **109** to permit the supply of fuel to flow to the heater for further flash separation.

A level sensor **2** is situated at the lower part of the flash separator **1** and provides electrical energy to a relay coil **101** when the fuel in the flash separator **1** falls to a low point such as that indicated by the probe **111**. Application of electrical energy to the relay coil **101** acts to open the relay contact arm **102** to thereby remove power from the solenoid **103** and thus close the valve **15**. When the valve **15** closes, fuel is prevented from flowing by gravity from the flash separator **1** through the line **8** to the main fuel tank **48**. Thereafter, when the fuel level within the flash separator rises to a predetermined point such as that indicated by the probe **110** the level sensor **2** removes power from the relay coil **101** to thus close the relay contact arm **102** and thereby apply power to the solenoid **103** to open the valve **15**.

The circuit also includes a level indicator **120** which acts to close a circuit including the battery **63** a line **124**, a line **121**, a relay coil **122** and the switch **107** when the level of volatile fuel in the accumulator **4** falls below the predetermined level such as that indicated by a probe **125** to apply power to the coil **122**. When power is applied to the coil **122**, a relay contact arm **123** is opened to prevent the application of electrical energy to the solenoid **40** during a cold engine start as indicated by the predetermined temperature set in the temperature sensor **62**. Thus, when this low level condition occurs during cold engine start, the linkage **41** will be in the position not shown by action of the spring **64** to provide engine starting fuel from the main fuel reservoir **30**. Additional choking may also be required.

The system also includes a vent line **130** having a unidirectional valve **131** for providing a vent passage from the volatile fuel reservoir **31** to the accumulator **4**.

The evaporation of light ends to provide a volatile cold start fuel may be induced by a reduced pressure system such as may be derived from pump suction or modified vacuum, or by using exhaust engine heat in place of the electrical heating element **9**. Further, the fuel may be alternatively stored as absorbate on solid absorbent or the like. Still further, chromatographic separation techniques may be used to separate a volatile fuel component from the main supply of fuel.

It is also contemplated that liquid petroleum gas or fuel injection metering principles may be utilized to apply the volatile fuel from the accumulator **4** to the cylinders such that no choking action is necessary.

The flash separator **1** and the accumulator **4** are sized to provide a sufficient amount of high volatile fuel to be used for starting, idling and engine warm-up for an adequate number of these modes before replenishment is required. For example, the accumulator **4** can have a capacity of approximately one gallon of condensed fuel. Further, the heater **9** can be a conventional emersion strip-type heater. A typical 10 psi RVP motor gasoline when subjected to a temperature of about 200° F. and 15 psig will separate to about 30 percent vapor and 70 percent liquid. The thus separated vapor when subjected to a temperature of about 125° F. and 15 psig will totally condense.

What is claimed is:

1. In a system for supplying hydrocarbon fuel to an internal combustion engine, the combination comprising:

means for storing a main supply of hydrocarbon fuel,

means for separating volatile fuel components from said hydrocarbon fuel,

means for storing said separated volatile fuel components, and

means for supplying fuel to said engine from said volatile fuel components storing means when said engine is below a predetermined temperature, and for supplying fuel to said engine and to said separating means from said hydrocarbon fuel storing means when the temperature of said engine is at or above said predetermined temperature.

2. The system of claim **1** further comprising means responsive to ambient temperature for controlling the volatility level above which volatile fuel components are separated in said separating means.

3. In a system for supplying fuel to an internal combustion engine, the combination comprising:

means for storing a main supply of hydrocarbon fuel,

means for separating volatile fuel components from a portion of said hydrocarbon fuel,

means responsive to ambient temperature for controlling the volatility level above which volatile fuel components are separated in said separating means,

means for storing said separated volatile fuel components, and

means for selectively supplying fuel to said engine from one of said hydrocarbon fuel storing means and said volatile fuel components storing means.

4. The system of claim 3 wherein said supplying means supplies fuel to said engine from said volatile fuel components storing means when said engine is below a predetermined temperature, and supplies fuel to said engine and to said separating means from said hydrocarbon fuel storing means when the temperature of said engine is at or above said predetermined temperature.

5. In a system for supplying hydrocarbon fuel to an internal combustion engine, the combination comprising; means for storing a supply of hydrocarbon fuel,

means for separating in a vapor phase volatile fuel components from a portion of said hydrocarbon fuel,

means in fluid communication with said separating means for condensing and storing the separated volatile fuel components,

means for supplying fuel to said engine from said condensing and storing means when an engine temperature is below a predetermined value, and for supplying fuel to said engine from said hydrocarbon fuel storing means when said engine temperature is at or above said predetermined value, and

means responsive to a predetermined minimum liquid level in said condensing and storing means for causing said fuel supplying means to supply fuel to said engine only from said hydrocarbon fuel storing means irrespective of said engine temperature.

6. The system of claim 5 further comprising means responsive to a predetermined maximum level of volatile fuel in said condensing and storing means for preventing further separation of volatile fuel components in said separating means.

7. The system of claim 5 wherein said separating means comprises means for heating the portion of hydrocarbon fuel.

8. The system of claim 5 wherein said engine fuel supplying means comprises means for combining fuel from one of said condensing and storing means and said hydrocarbon fuel storing means with air prior to application of the fuel to said engine.

9. The system of claim 8 further comprising:

a first reservoir for storing fuel from said hydrocarbon fuel storing means,

a second reservoir for storing fuel from said condensing and storing means,

means for feeding fuel to said combining means from said second reservoir when said engine temperature is below said predetermined value and for supplying fuel to said combining means from said first reservoir when said engine temperature is at or above said predetermined value.

10. The system of claim 5 further comprising means responsive to ambient temperature for controlling the volatility level above which volatile fuel components are separated in said separating means.

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