

[54] VAPOR INJECTION SYSTEM

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261/18 A; 261/DIG. 38[51] Int. Cl. **F02b 77/05**[58] Field of Search 123/25 R, 25 L, 198 A,
123/124, 119 D; 261/18 A, 18 R, DIG. 38[56] **References Cited****UNITED STATES PATENTS**

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3,077,341	2/1963	Schliehling	261/DIG. 38
3,346,244	10/1967	Bess	261/DIG. 38
3,348,823	10/1967	Roquene	261/DIG. 38
3,537,434	11/1970	Herbin	123/198
3,557,763	1/1971	Probst	123/198

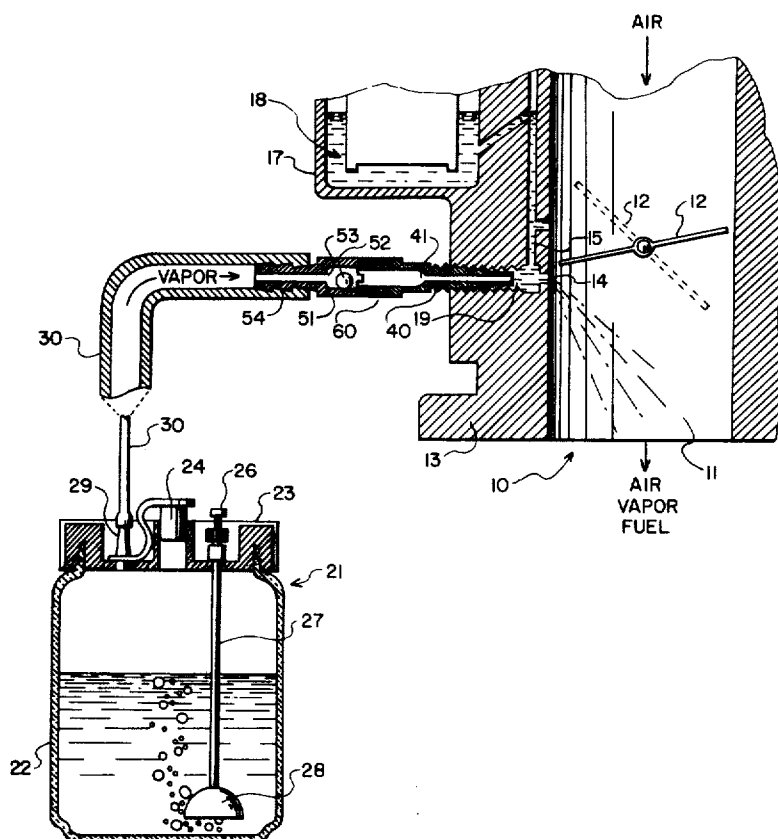
Primary Examiner—Charles J. Myhre

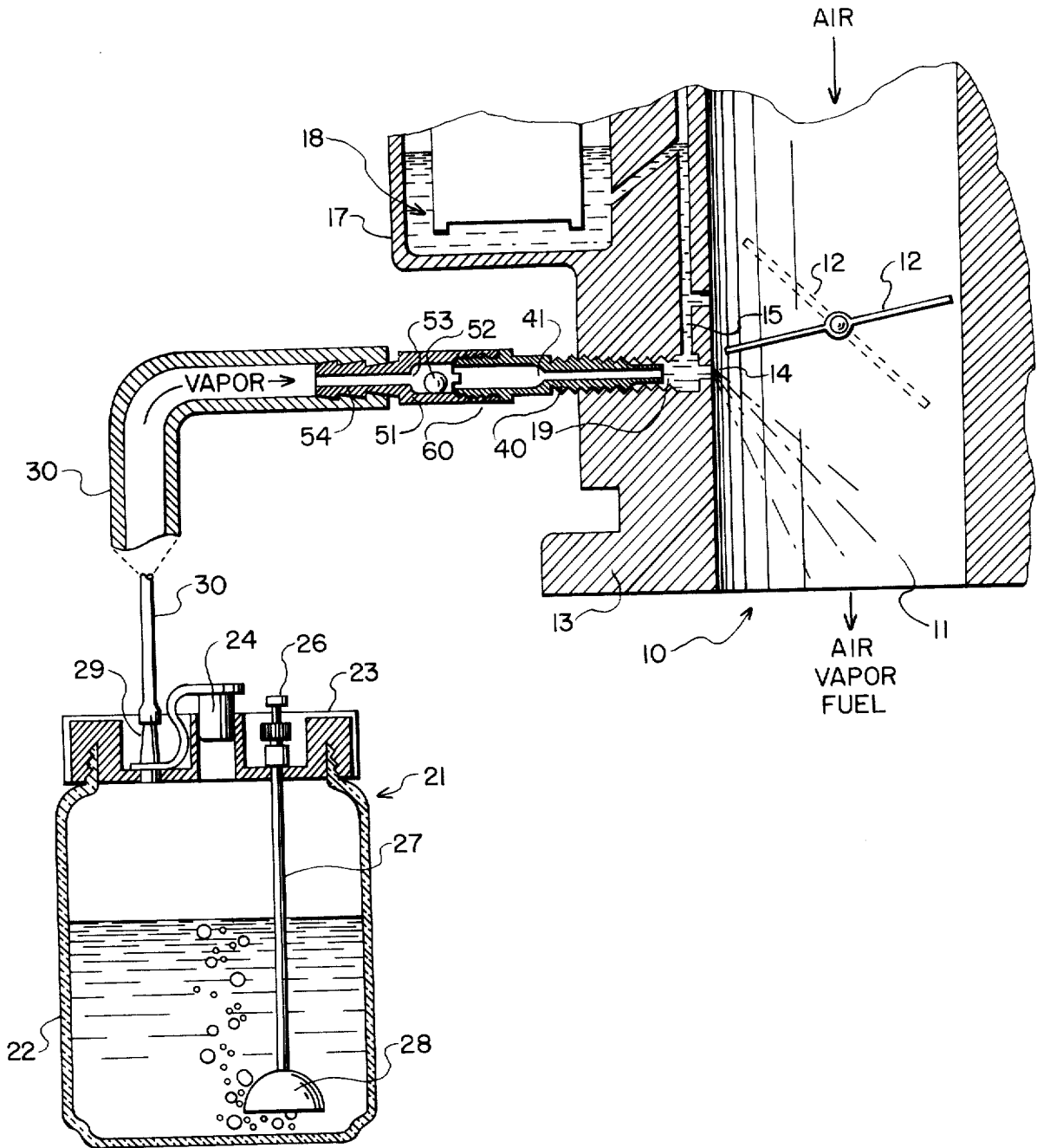
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[57] **ABSTRACT**

This disclosure describes apparatus for supplying a

vapor into the gasoline-air mixture of an internal combustion engine by means of the idle delivery orifice of a conventional carburetor and the vacuum thereat. The apparatus includes a reservoir for a liquid solution, preferably an aqueous solution of methanol and acetone. The reservoir is connected to the idle delivery orifice by a suction conduit which includes a flexible tube and a connector. The reservoir includes an adjusting valve and an octane increasing vapor conduit for bubbling a controlled amount of air through the solution to produce (air saturated with vapors of the solution) in the upper reservoir chamber, which is drawn into the fuel-air mixture through the suction conduit. The suction conduit connector includes a bored-out idle mixture screw which not only controls the amount of gasoline delivered through the idle delivery orifice, but delivers a stream of octane increasing vapor into gasoline in the delivery passageway. The amount of vapor delivered is a function of the fuel requirements of the engine, since the amount of vapor delivered is a function of the engine demand at the idle delivery orifice. A check valve in the idle mixture screw restricts back-flow from engine to reservoir.

12 Claims, 1 Drawing Figure



VAPOR INJECTION SYSTEM

BACKGROUND OF THE INVENTION

This invention relates to internal combustion engines with carburetor fuel metering. More particularly, it relates to apparatus for injecting an octane increasing vapor into the engine fuel distribution system and thereby reducing certain polluting emissions and improving the performance and efficiency of internal combustion engines.

It is well known that smog is formed by the uniting of hydrocarbons and oxides of nitrogen in the presence of sunlight. It is also well known that the internal combustion engine is inefficient and is presently the most prolific source of hydrocarbons (HC), oxides of nitrogen (NOX), and carbon monoxide (CO). Within recent years, Congress has imposed Federal controls which define certain standards governing and limiting emission of substances from vehicles or engines.

To meet these standards, numerous methods and apparatus have been tried, but have achieved only limited success. General techniques have included burning or chemically modifying unwanted emissions in the exhaust system after they leave the engine; more precisely controlling the air-fuel mixture and ignition advance curves; employing thermostatically controlled, heated air induction systems; setting higher idle speeds; retarding ignition timing at idle; providing greater slip in the torque converter. Many of these approaches have serious drawbacks; e.g., some of them cause a significant reduction in vehicle and engine performance and efficiency. Other devices are complex, expensive, difficult to install and maintain, and are a major source of unreliability. In addition, some approaches reduce one type of emission yet simultaneously increase another unwanted emission. This is now unacceptable. Other approaches, such as turbocharging, have improved engine performance, but have not significantly reduced the pollution problem.

Two additional devices which are well-known in the prior art are especially pertinent here. One type device is an internally vented screw which replaces the standard idling fuel adjustment screw in a carburetor. Examples of such devices are those shown in U.S. Pat. Nos. 3,348,823, 3,346,244, 3,166,611, 2,970,822 and 2,816,573. It provides more air at the carburetor idle delivery orifice, leans out the air/fuel mixture, provides better air-fuel mixing, and thus provides more complete and efficient burning of the fuel in the engine. However, since any device which introduces extra air into the combustion chamber raises the temperature in the presence of nitrogen, use of such a device results in increased emission of oxides of nitrogen. This is a most undesired result.

In addition HC emissions occur any time gasoline is allowed to evaporate into the air. This evaporation occurs from an automobile's gas tank and out of the carburetor as well. All current automobiles are designed with sealed fuel systems including sealed gasoline tanks and a return line, from the carburetor to the sealed gasoline tank to prevent evaporation of gasoline from the gasoline tank and carburetor. All the above cited devices suffer from the fact that they permit HC emissions resulting from gasoline evaporation to the atmosphere because they have an opening directly to the atmosphere. This, in effect, completely destroys the entire purpose of the sealed fuel system.

The second specially relevant device injects vapor into the intake manifold of an engine. The benefits of such systems have long been known. U.S. Pat. No. 3,557,763 illustrates a specific embodiment of one such device. Therein the manifold vacuum source is used to draw vapors from a reservoir into the engine cylinders. The positive crankcase ventilation line from the valve cover to the base of the carburetor is tapped by means of a T-connector. Two of the connector legs maintain the previous connection and the third permits communication between the vapor source and the intake manifold. Such a system causes a significantly higher percentage of the fuel to be burned, thereby improving performance and reducing hydrocarbon emission.

However the amount of vapor injected depends on intake manifold vacuum, and at increased engine rpm or during acceleration, intake manifold vacuum decreases. Thus the benefits of the vapor injection system are slightly less at higher speeds and during acceleration due to decreased suction.

The disadvantages of the prior art are overcome by the present invention which provides apparatus whereby HC and CO emissions are substantially reduced while also improving engine performance and combustion efficiencies. The invention will not increase NOX emission and will actually decrease emitted NOX on some engines. Moreover, the invention is simple, inexpensive, easily installed, requires virtually no maintenance, enhances vehicle reliability, and provides improved gasoline mileage. Additionally, the benefits are provided over a broader range of engine operating conditions.

The advantages of the present invention are preferably attained by channeling an octane increasing vapor through an internally ducted idling fuel adjustment screw and thereby introducing a ratio-controlled and homogenous mixture of vapor, gasoline, and air into the engine fuel distribution system. The tandem arrangement of a conventional vapor injection system and a hollow idle screw provides results not possible with either acting alone or both acting together but separately installed in the same engine carburetor.

The basic object of this invention is to overcome the above-described disadvantages of the prior art by providing simple, reliable and inexpensive apparatus which significantly reduces certain exhaust emissions and prevents increases in others while improving engine performance and efficiency.

A further object is to provide these benefits throughout a broader range of engine operation.

Additionally, it should be noted that since a vast number of older model vehicles are still on the road, the present invention provides a very simple and inexpensive means of retro-fitting these vehicles to reduce emissions from these vehicles.

Thus it is still a further object of this invention to provide apparatus with which both new and old vehicles may be easily and inexpensively fitted and thus reap the benefits herein of significantly reduced emissions while simultaneously improving performance, efficiency and reliability.

SUMMARY OF THE INVENTION

The above objects are accomplished by apparatus providing a source of octane increasing vapor and establishing a flow path for the vapor from its source

through a carburetor idle orifice to the fuel distribution system of an internal combustion engine. The invention utilizes the vacuum at the idle delivery orifice to deliver vapor and gasoline through the orifice, much like a spray gun, and thereby introduce a ratio-controlled and well homogenized mixture of air, gasoline and vapor into the fuel distribution system. The preferred embodiment further includes a check valve in the flow path to prevent back-flow from the engine to the vapor source.

BRIEF DESCRIPTION OF THE DRAWING

A complete understanding of the present invention and of the above and other objects and advantages thereof may be gained from a consideration of the following detailed description presented in connection with the accompanying drawing which is described as follows:

The FIGURE is diagrammatic and illustrates a sectional view of a carburetor to which the vapor injector apparatus of the invention has been installed. The view of the carburetor is fragmentary and carburetor plus connector is drawn at scale different from the scale of the vapor reservoir.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The FIGURE illustrates the pertinent portion of a carburetor 10, including the main inlet throat 11 and throttle valve 12 through which air flows from an air filter into the intake manifold of the engine, gasoline being mixed with air in the carburetor to provide a combustible gasoline-air mixture. A threaded hole 19 provides communication from the exterior of the carburetor body 13 to the throat 11 and terminates with an idle delivery orifice 14 at a point adjacent the edge of engine-idle-positioned throttle valve 12. The threaded hole 19 serves as a seat for the conventional carburetor idling fuel adjustment screw and additionally serves as a cavity to which gasoline 18 is delivered from a float bowl 17 via idle delivery channel 15 within the carburetor body 13.

In accordance with the present invention, octane increasing vapor is drawn from a reservoir 21 through a duct-plus-valve system by the carburetor throat vacuum into the idle delivery channel 15 at a point adjacent the idle delivery orifice 14 and a combination of vapor and gasoline is forced by the pressure differential through the orifice into the air stream.

The preferred embodiment of the apparatus includes a connector 60, one end of which comprises an internally ducted screw 40 which theadedly engages hole 19. Ducted screw 40 additionally serves the purpose of a conventional idle adjustment screw which is omitted from the carburetor in accordance with the invention; that is, it controls the size of the gasoline delivery passageway by its depth of insertion into hole 19. The screw acts as a valve limiting the amount of gasoline delivered to the idle port.

The other end of connector 60 comprises a valve seat portion 51 which, when engaged with the projecting end of ducted screw 40, defines a check valve housing enclosing a ball closure member 52 coacting with valve seat 53. The valve seat portion includes a nipple 54 having external annular serrations.

The FIGURE also illustrates the vapor source apparatus. Said source includes a reservoir 21 consisting of

an open topped vessel 22, fabricated of high silica glass, for example, and a closure cap 23, preferably fabricated of cast aluminum, for example. The closure cap 23 is sealed by epoxy-bonding but may be threaded on to the container in a conventional manner and sealed thereto with a suitable gasket that insures a positive seal. The closure cap is provided with a filler opening, closed by means of a suitable plug 24.

The closure cap 23 is provided with an inlet conduit 27 and an associated control valve 26, such as an adjustable needle valve, for controlling the flow of air into the reservoir 21. The inlet conduit 27 communicates with the inlet control valve and extends to a point adjacent the bottom of the reservoir, terminating in an aerator device 28 for breaking up the air into numerous bubbles which pass upward through the solution in the reservoir to the upper reservoir chamber defined above the liquid level.

The closure cap 23 is provided with a suitable boss 29 having a passage therethrough, to which is conveniently connected a suction conduit 30 for communicating the upper reservoir chamber with the carburetor throat 11. For this purpose, in the preferred form of the invention, the suction conduit 30, which may be a hose of rubber of similar material, is connected to serrated nipple end of connector 60.

Various solutions for vapor formation have been tried, and understandably varying results have been obtained. The preferred embodiment of this invention utilizes an aqueous solution which includes methanol and acetone as principal ingredients. The particular solution used does not constitute a part of the invention so long as it is one which will provide an octane increasing vapor without damage to the engine.

During normal flow conditions, when the vapor flows from the nipple 54 through the check valve into the screw duct 41, the ball closure 52 permits flow around itself. Should there be any reversing of the pressure differential, whereby the pressure on the reservoir side of the check valve should be less than that on the engine side, the check valve is dimensioned so that this reverse flow will effect an immediate seating of the ball closure member 52 on seat 53 to prevent such reverse flow. For example, the reservoir is protected from increased pressure due to backfire.

In operation, the vacuum produced in the carburetor throat 11 withdraws vapor from the reservoir to reduce pressure therein. This results in air flow into the reservoir through the adjustable inlet control valve 26. The air flowing through the inlet conduit 27 and aerator 28 produces numerous air bubbles which flow upward through the solution in the reservoir. In doing this, the air becomes saturated with the constituents of the solution and forms an octane increasing vapor which collects in the upper chamber portion of the reservoir 21. This vapor is drawn from the reservoir through the suction conduit 30, the check valve and the connector 60 into the idle delivery passageway adjacent the idle delivery orifice 14. A stream of vapor and gasoline flows through the orifice into the air stream, thus introducing a well homogenized or misted mixture of air, gasoline, and vapor into the fuel distribution system. From the fuel distribution system the mixture of the air, gasoline, and vapor is drawn into the engine cylinders to be compressed and burned in a conventional manner.

It has been found that the introduction of the vapor into the air-gasoline mixture causes upwards of 85 per-

cent of the fuel in the mixture to be burned, whereas only about 50 - 65 percent of the gasoline in conventional gasoline-air mixtures is normally burned. Because of the more efficient burning of the fuel with the vapor additive, pollution problems are considerably reduced since substantially more of the fuel is burned and substantially less CO and unburned hydrocarbons remain to be discharged thru the engine exhaust into the atmosphere.

Additionally, the performance of the engine is improved, and the engine runs more smoothly and produces substantially more power than does the same engine when operated with conventional gasoline air mixtures. Furthermore, because of more efficient utilization of fuel, it is found that spark plug fouling and oil contamination are virtually eliminated resulting in longer life for the engine.

The present invention utilizes vapor injection at an optimum or near optimum location, i.e., the idle delivery orifice. At idle, the throttle valve 12 is closed and intake manifold vacuum is high. Thus the suction from the vapor source through the idle delivery orifice is adequately high to draw a good supply of vapor. As the throttle valve opens intake manifold suction decreases, a Venturi is formed by the edge of the throttle valve and the wall of the carburetor throat 11. The thus created Venturi vacuum adjacent the idle delivery orifice tends to compensate for the fall off in manifold vacuum, and tends to maintain the vacuum at the idle delivery orifice constant throughout the engine operating range.

As mentioned previously, the present invention enjoys the benefits of a conventional hollow idle screw while overcoming the normal and objectionable increase in NOX and HC emissions characteristic of such conventional needles. Both the conventional hollow idle screw and the present invention cause the delivery of gasoline into the air stream via the idle delivery orifice and thoroughly mix it with the gasoline. The conventional hollow idle screw delivers a stream of pure air, thus leaning the combustible mixture and resulting in increased NOX and HC emissions.

In contrast, the present invention delivers a stream of octane increasing vapor to the gasoline through the idle port. The vapor is itself a combustible mixture of air and a second fuel other than gasoline. Thus the invention adds no excess or unneeded air to the total air/total fuel mixture for which the vehicle or engine was designed. Any additional air being introduced to the fuel distribution system by the invention is air already mixed with fuel in vapor form from the reservoir. Although additional air goes to the fuel distribution system, an additional second fuel in a controlled and proportioned amount goes along with it, thus permitting the conventional or normal total air/total fuel ratio to be left practically unchanged.

New vehicle carburetors are adjusted to air/fuel ratios which minimize NOX or HC emissions. Therefore, for purposes of controlling NOX or HC, it is important to leave this design ratio virtually undisturbed. The present invention achieves this end, and thus does not cause increased NOX or HC emissions from new or old engines.

Control over the amount of vapor injected through the idle adjustment screw is achieved by setting the control valve 26 which determines the air flow through the reservoir 21. Control over the total air/total fuel

ratio is then had by positioning the ducted idle screw, which controls the quantity of gasoline delivered to the idle port, until the total air/total fuel ratio meets manufacturer's specification. Air/fuel ratio is indicated by an exhaust gas analyzer. This conventionally employed measurement method automatically takes into account the fuel component of the vapor and indicates when the proper total and/total fuel ratio is achieved.

An important drawback of hollow idle screws used alone is the venting to atmosphere of gasoline vapors from closed fuel systems now required on cars. It can readily be seen that in accordance with the present invention the only liquid surface from which evaporation to the atmosphere can occur is the liquid within conduit 27. Since the conduit 27 is of limited diameter, typically 1/8-inch I.D., evaporation is insignificant and does not include gasoline vapors.

Old engines generally accumulate carbon deposits on the surfaces of the combustion chambers. This accumulated carbon tends to insulate the chambers from the cooling system and thus creates higher temperatures in the combustion chambers. The same deposits also increase the compression ratio which in turn increases chamber temperature. Any increase in temperature naturally produces additional NOX emissions. When installed on an old engine, the present invention will cause a decrease in these carbon deposits as a result of the solvent effect of the vapor on them, thus permitting the engine to run cooler and causing decreased NOX emissions. Control over the total air/total fuel ratio is again achieved as above described.

Additionally, it has been found that not only will combustion chamber temperature decrease over a period of time due to fewer carbon deposits, but the vapor injection causes an immediate decrease in chamber temperature as compared to conventional gasoline-only fueling. This additional cooling naturally contributes to preventing increases in NOX emissions.

It can readily be seen that the present invention achieves a synergism not possible with separate but simultaneous installation of an internally ducted idle adjustment screw and a conventional vapor injector. The present invention provides important benefits of increased power, efficiency and economy, removal of carbon deposits, increased octane rating of gasoline and reduction of harmful exhaust emissions without increasing either hydrocarbon or oxides or nitrogen emissions.

A hollow idle screw drawing air would still permit too much air and produce an overly lean mixture for which the vapor injection could not compensate. Furthermore, the conventional vapor injection introduces vapor at a non-optimum location for constant suction and the benefits thus substantially subside during acceleration or at increased rpm.

Although there has been described a specific preferred embodiment of this invention, it will be understood that it is intended to be illustrative only and that various changes and modifications that will be obvious to those skilled in the art may be made therein without departing from the invention defined in the claims.

What is claimed is:

1. Vapor injector apparatus for a carburetted internal combustion engine of the kind having a carburetor equipped with a throat, a movable throttle valve in the throat, and a gasoline passage leading to an idle port, said idle port being located downstream of the throttle

valve for introducing gasoline into a stream of air moving through said carburetor throat, said injector apparatus comprising:

- a hollow vapor delivery tube mountable in said carburetor gasoline passage, the output end of said tube being configured to establish with the walls of said passage flow-rate fixing means for gasoline flowing through said passage to the idle port, and vapor delivery means for delivering an octane increasing vapor to the input end of said tube including a closed reservoir for containing a supply of volatile liquid with a vapor chamber above the liquid, means for admitting air into said reservoir below the liquid level at a metered rate, and conduit means for providing communication between said vapor chamber and said input end of the vapor delivery tube.
2. Apparatus as defined in claim 1 wherein said hollow vapor delivery tube comprises:
 - an idle jet needle mountable in said gasoline passage, said needle having a generally axial bore there-through.
3. Apparatus as defined in claim 2 wherein said idle jet needle is adjustably mountable in said carburetor gasoline passage so as to adjustably regulate gasoline flow through said passage.
4. Apparatus as defined in claim 1 including check valve means permitting fluid flow toward said idle port only.
5. Apparatus as defined in claim 4 wherein said check valve means is integral with said vapor delivery tube.
6. Apparatus as defined in claim 5 wherein said vapor delivery means includes valve means for establishing a maximum vapor flow rate.
7. Apparatus as defined in claim 6 wherein said valve means is positioned at the input of said means for admitting air into said reservoir.

8. Apparatus as defined in claim 1 wherein the hollow vapor delivery tube is positionable in said gasoline passage such that the vapor from the output end of said tube mixes with the gasoline in said passage through said idle port, thereby atomizing said gasoline.

9. In combination:

- a. a carburetor of the type having a throat, a movable throttle plate in the throat, and a gasoline passage leading to an idle port, said idle port being located downstream of the throttle valve for introducing gasoline into a stream of air moving through said carburetor throat,
- b. a hollow vapor delivery tube mounted in said carburetor gasoline passage, the output end of said tube being configured to establish with the walls of said passage flowrate fixing means for gasoline flowing through said passage to the idle port, and
- c. means for delivering octane increasing vapor to the input end of said tube including a closed reservoir for containing a supply of volatile liquid with a vapor chamber above the liquid, means for admitting air into said reservoir below the liquid level at a metered rate, and conduit means for providing communication between said vapor chamber and said input end of the vapor delivery tube.

10. Apparatus as defined in claim 9 including check valve means permitting fluid flow toward said idle port only.

11. Apparatus as defined in claim 10 wherein said check valve means is integral with said vapor delivery tube.

12. Apparatus as defined in claim 11 wherein the hollow vapor delivery tube is positionable in said gasoline passage such that the vapor from the output end of said tube mixes with the gasoline in said passage through said idle port, thereby atomizing said gasoline.

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