

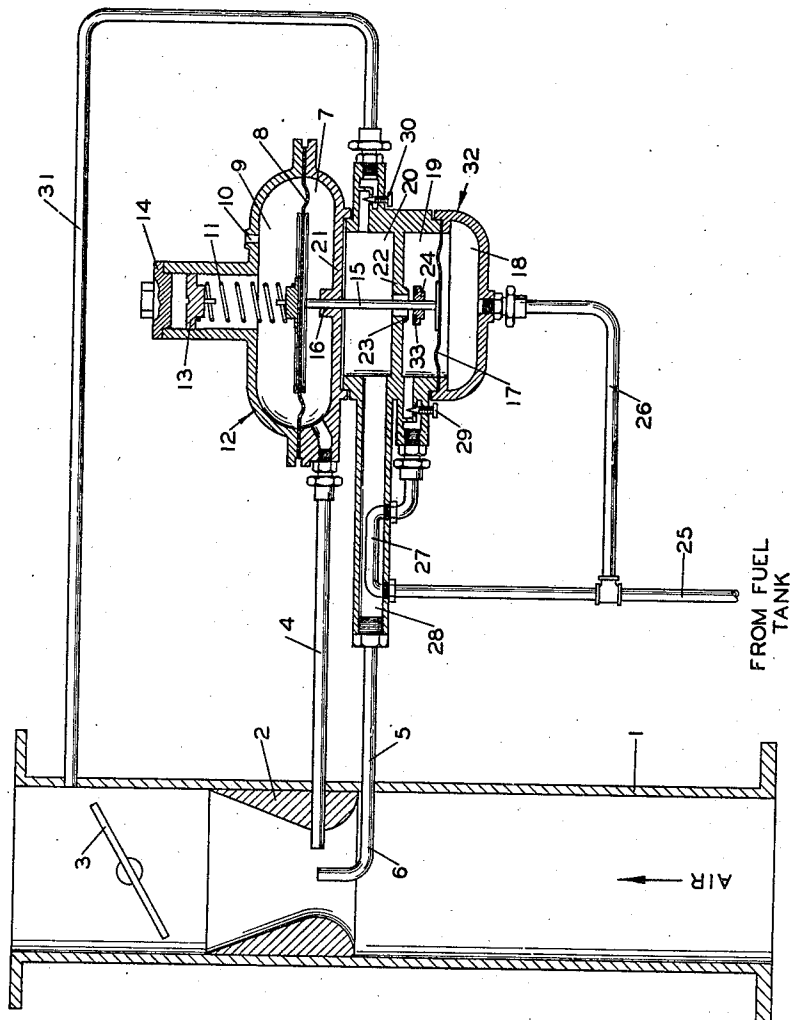
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O. L. GARRETSON

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CARBURETOR

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INVENTOR
OWEN L. GARRETSON

BY

Hulson, Young, Shambly & Fingers
ATTORNEY

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CARBURETOR

Owen L. Garretson, Detroit, Mich., assignor to
Phillips Petroleum Company, a corporation of
Delaware

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1 Claim. (Cl. 261—11)

This invention relates to a carbureting device. More particularly it relates to a carbureting device for use with internal combustion engines wherein very volatile, or high vapor pressure hydrocarbons or liquefied petroleum gases may be used as the fuel. The present invention is particularly adapted to the use of high pressure fuels such as natural gasoline or any other fuel which may contain a mixture of hydrocarbons which separate into gaseous and liquid phases at normal temperatures and pressures. In fuels of the aforementioned type the gaseous phase ordinarily contains a preponderance of propane, butane, or mixtures thereof which are known to possess high anti-knock value. The gasoline is ordinarily stored under pressure in tanks so that the lighter normally gaseous constituents are liquefied and in admixture with the relatively heavier and normally liquid constituents.

An object of this invention is to provide a method and apparatus for carbureting very volatile or high vapor pressure liquid fuels or even liquefied petroleum gases for internal combustion engines.

Another object of this invention is to provide a carburetor of simple design, with few adjustments for use with high vapor pressure liquid fuels.

Still another object of this invention is to provide a carburetor for use with high vapor pressure liquid fuels which will not permit undesirable evaporation or ebullition commonly called "vapor lock" within the normally liquid containing portions of the carburetor.

Yet another important object of the invention is to furnish a carburetor for use with high vapor pressure fuels for automotive and aircraft engines which will be sensitive and rapid in response to acceleration.

Still other objects and advantages will be apparent to those skilled in the art from a careful study of the following detailed description.

The figure represents one embodiment of my invention directly applicable for use with internal combustion engines where high vapor pressure hydrocarbons or mixtures thereof are used as fuel.

Referring to the figure, numeral 1 represents the air inlet in which air flows in the direction as indicated by the arrow. The air may come directly from the atmosphere or through an air cleaner, not shown, the flow being caused by suction from the intake manifold of the engine. Venturi tube 2, hereafter called venturi, is installed in the air inlet pipe 1 just previous in terms of direction of air flow to the butterfly throttle

valve 3. Passing through the thickened side wall of venturi 2 is tube 4 for communication between air inlet 1 and chamber 7 of my carbureting device. Tube 5 enters the air inlet at 6 and the end of said tube 5 within the air inlet tube is open and said open end points in the direction of air flow.

Diaphragm 8 separates an upper diaphragm casing 12 into two chambers 7 and 9. Chamber 7 is a chamber of relatively small volume, while chamber 9 may be of essentially any relative volume, that is, smaller or equal to chamber 7, or even larger. Ordinarily I construct said chamber 9 somewhat larger in volume than chamber 7, though it need not necessarily be so. Vent 10 is a small opening or vent connecting chamber 9 with the atmosphere in order to maintain chamber 9 at atmospheric pressure at all times or it may be connected to the air tube on the upstream side of the venturi so as to maintain an equal pressure in chamber 9. Spring 11 is attached to the top center of diaphragm 8, and the tension or compression on said spring may be increased or decreased by turning the adjustment screw 13 in the proper direction. Cover 14 is for the purpose of excluding dirt, water or other foreign matter from the tension adjuster 13 and to give a pressure tight seal. To the underside of diaphragm 8 is attached in a conventional manner push pin 15, the bottom end of which is attached also in a conventional manner to diaphragm 17. The push pin need not be attached to the diaphragms but may be easily held therebetween. Compartment 18 is separated from compartment 19 in diaphragm casing 32 by the above mentioned diaphragm 17.

The lower plate portion 21 of the upper diaphragm casing 12 and the upper plate portion 22 of the lower diaphragm casing 32 form respectively the top plate and bottom plate of chamber or compartment 20. The plate 21 contains a bearing or guide 16 for push pin 15. The said bearing or guide is intended to permit free vertical movement of the push pin 15 and yet be sufficiently close fitting to prevent leakage of fluid from chamber 20 to chamber 7.

To the push pin 15 is attached valve 24, which when in contact with seat 23 prevents flow of liquid from chamber 19 to chamber 20.

Line 25 is the fuel line connecting the pressure fuel tank, not shown, and my carbureting device. The fuel line 25 divides and fuel passes through line 26 into the lower chamber 18 for maintenance of liquid pressure therein. The fuel for carburetion passes through tubing 27, which is within

pipe 28 for cooling purposes, needle valve 29 and thence into chamber 19. Pipe or tube 28 serves as an intermediate passageway between chamber 20 and tube 5. Needle valve 30 is located in an exit from fluid chamber 20, the fluid passing from chamber 20 through said needle valve 30 through line 31 and thence into the air inlet tube 1 on the downstream side of the butterfly valve 3.

A washer 33 on valve 24 permits a sealing engagement between the valve and the seat 23. A compression spring may be interposed between the end of valve stem 15 and diaphragm 17 to avoid pumping in the chamber 18 and increase of volume in chamber 19.

In the operation of my invention, I am able to use such hydrocarbon fuels as liquid butane, natural gasoline or fractions thereof or mixtures of butane with natural gasoline or fractions thereof as well as ordinary gasoline to yield relatively high vapor pressure fuels. By high vapor pressure fuels I intend to include the use of such fuels which have vapor pressures greater than that of ordinary automotive gasolines. Ordinary gasolines may be employed with the use of tank pressuring means. In the use of such hydrocarbon fuels, they will be contained in the gas tight fuel supply tank at least under their own vapor pressure, and under certain conditions may be held under pressures greater than their vapor pressure to insure a flow of liquid from the gas-tight fuel tank to the carburetor and to prevent premature vaporization or "vapor-lock" in the liquid fuel lines or liquid containing compartments of the carburetor during warm weather operation.

Fuel under pressure flows through line 25 and line 26 to enter compartment 18 and when filled no further flow of fuel through line 26 occurs since there is no opening or outlet to chamber 18 other than said line 26. Fuel for carburetion from line 25 passes on through line 27 through needle valve 29 and into the liquid feed chamber 19. When the engine is not operating, the tension spring 11 has been so previously adjusted by adjuster 13 that the valve 24 is seated permitting no flow or leakage of liquid from said feed chamber 19 into chamber 20. When the engine is turned for starting purposes a slight vacuum is created by the passage of air through the venturi 2 which vacuum is communicated through tube 4 and into vacuum chamber 7. This slight vacuum or reduction in pressure tends to pull diaphragm 8 downward since the upper surface of said diaphragm and chamber 9 are open to atmospheric pressure or pressure ahead of venturi. This very slight downward movement of diaphragm 8 opens valve 24 permitting flow of liquid fuel from liquid feed chamber 19 into chamber 20. The partial vacuum communicated through line 4 into compartment 7 is also communicated through line 5 and tube 28 into chamber 20. This slight vacuum together with the vaporizing tendency of the high vapor pressure fuel very quickly feeds hydrocarbon vapors through line 5 into the intake air current thereby forming a combustible gas mixture for passage through the intake manifold and into the cylinders. Obviously, as soon as a cylinder fires, the engine is turned over rapidly thereby creating a greater flow of air through the intake 1 and greatly magnifying the pressure differential on the diaphragm 8 and further opening valve 24. Where fuels of relatively low vapor pressure or two phase fuels having a normally liquid phase are employed, partial vaporization on pressure drop through valve 24 will entrain nor-

mally liquid constituents maintaining chamber 20 and tube 28 practically free of liquid.

As mentioned above, when the engine is not in operation, the liquid pressures in liquid feed chamber 19 and liquid pressure chamber 18 are equal. When valve 24 opens, liquid flows from chamber 19 into chamber 20, the liquid pressure in said liquid feed chamber 19 decreases, dependent upon degree of opening and rate of flow through valve 24 and the setting of valve 29 which produces a pressure differential between chambers 18 and 19. The decrease in pressure on the upper side of liquid operated diaphragm 17 causes said diaphragm to raise upward tending to offset the downward push from the diaphragm 8 and to close fuel valve 24. The surface areas or more specifically the sizes of these diaphragms are so chosen that an equilibrium is established between the downward tendency of diaphragm 8 and the upward tendency of diaphragm 17 so that the amount of opening of the valve 24 is a function of the amount of suction created within the Venturi in the air inlet line.

Needle valve 29 is inserted in the fuel line to restrict the flow of liquid fuel into liquid feed chamber 19, thereby maintaining a pressure differential between liquid pressure chamber 18 and liquid feed chamber 19, tending to oppose the opening of valve 24.

Line 31 enters air intake on the downstream side of butterfly throttle valve 3, carrying fuel and air for idling of the motor from chamber 20. The amount of fuel entering the motor intake for idling is controlled by manual adjustment or setting of the needle valve 30 in line 31.

Valve 24 and valve seat 23 should be of very small diameter since the amount of liquid fuel passing through this opening is very small. For example, a 95 horse-power engine uses a maximum of only about 0.6 cubic inch of liquid fuel per second, and the valve surface by being small may be easily opened even though it is opened against the pressure within the liquid fuel chamber. This arrangement permits the valve 24 to be quite sensitive to suction variations in vacuum chamber 7 and, therefore, responsive to the operation of throttle 3.

A more efficient design of my carburetor for making the same sensitive and responsive to load requirements requires that vacuum chamber 7 be made of as small volume as possible. The smaller the volume of chamber 7, the less is the lag of diaphragm 8 in response to vacuum changes in vacuum tube 4. In addition a better design pointing to utility is the size or clearance of push pin bearing or guide 16, which should be made as small as possible and yet allow free movement of push pin 15 to prevent leakage of vapor or liquid into chamber 7 from chamber 20.

Line 27, as seen in the figure, conducts liquid fuel through cooling zone 28 enroute to liquid feed chamber 19. This cooling is for the purpose of preventing premature vaporization or vapor lock by reduction of pressure on passage through the jet or adjustable valve 29. Partial vaporization of the liquid fuel in chamber 20 furnishes the cooling for this heat exchange. To avoid the possibility of excessive fuel feed through valve 24 on sudden change of pressure conditions, which might cause a slight pumping action to occur, a restriction or needle valve may be placed in the line 26 to lessen pressure surge on the diaphragm 17.

For the selection of diaphragm sizes for use in my carburetor, the following illustration will

serve as a guide: Assume diaphragm 8 has an area of 60 square inches and diaphragm 17 has an area of 10 square inches. The air flow through venturi 2 at three-fourths motor load may produce a suction or vacuum of 25 inches of water column through suction tube 4, the pressure on the underside of said diaphragm 8 will be reduced to 25 inches of water column less than the pressure in air chamber 9, and the total downward force exerted on diaphragm 8 is

$$\frac{25 \text{ inches water column} \times 60 \text{ square inches}}{27.7}$$

53 pounds

The value 27.7 is the inches of water column pressure equivalent to one pound per square inch. This 53 pound force opens valve 24, thus permitting liquid fuel to flow into chamber 20 and thence through tubes 28 and 5 and into the air inlet.

The top and the bottom of diaphragm 17 are subjected to the same liquid pressure from line 25 before flow of liquid begins through valve 24. However, when the flow of liquid begins, the pressure in chamber 19 becomes less than pressure in chamber 18 due to the pressure drop through needle valve 29. This valve is so set as to obtain the correct mixture and for the above assumed conditions, it would be set so that the correct amount of fuel for three-fourths engine load would give 150 inches water pressure drop across said valve 29. This pressure drop is required as 150 inches water differential acting on diaphragm 17 will produce a force of

$$\frac{150 \text{ inches water} \times 10 \text{ square inches}}{27.7} = 53 \text{ pounds}$$

This 53 pound force acting upward on diaphragm 17 is transmitted to push pin 15 and exactly counterbalances the downward force from the diaphragm 8, thereby holding valve 24 in a position that will permit the liquid fuel flow to be such an amount as will give a pressure drop of 150 inches of water across valve 29. If the mixture flow is reduced by throttle 3 so that the suction produced by venturi 2 is only 5 inches water pressure, the force on push pin 15 will be $(5 \times 60) / 27.7 = 10.6$ pounds, and valve 24 will then close until the pressure drop across needle valve 29 is only 30 inches water pressure which will give an upward force on diaphragm 17 of $(30 \times 10) / 27.7 = 10.6$ pounds to balance the downward force from diaphragm 8. Thus, reduction of air flow to change the Venturi suction from 25 inches water pressure to 5 inches water pressure will reduce the quantity of air in the same proportions that a change from 150 inches to 30 inches of water pressure drop across valve 29 changes the fuel flow.

In case an air cleaner is used, vent 10 should preferably be connected to the carburetor air inlet on the down stream side from the air

cleaner in order to balance the air cleaner friction.

While the one embodiment of my invention, as represented by the drawing and fully described in the specifications, is a satisfactory and useful design, I do not wish to be limited to this one design. Many of the component parts may be altered as to size and shape and yet remain within the intended scope of my invention. Under certain conditions, one or two component parts may be entirely omitted, as heretofore explained, and my invention still serves its useful purpose, or it may even be more efficient and sensitive in its operation than the above described embodiment.

I claim:

In an internal combustion engine fuel supply system for utilizing hydrocarbon fuels, certain components of which possess a superatmospheric vapor pressure, an air inlet tube, a main throttle valve in the tube, a liquid fuel conduit, a vaporization chamber wherein, on pressure reduction, vaporization accompanied by cooling of the high pressure components of said fuel takes place and a vapor tube delivering fuel from said chamber to the air inlet tube, means for regulating the supply of fuel relative to air comprising a main liquid fuel chamber connected with the liquid fuel conduit, a second liquid fuel chamber connected with the liquid fuel conduit, said liquid fuel chambers being separated by a fuel diaphragm, a valve for controlling the flow of fuel from the main liquid fuel chamber to the vaporization chamber and reducing the pressure of said fuel, an air chamber communicating with the atmosphere, a second air chamber communicating with said air inlet tube, said air chambers being separated by an air diaphragm, force transmitting means connected with said air and fuel diaphragms and said fuel valve, a restriction in said liquid fuel conduit for establishing a pressure differential across the fuel diaphragm tending to reduce the degree of valve opening on increase in fuel flow through the conduit, a portion of said liquid fuel conduit upstream of said restriction being located within said vapor tube in heat exchange relationship with the vaporized high pressure components of said hydrocarbon fuel, means in the air inlet tube on the inlet side of said main throttle valve producing a pressure differential on said air diaphragm tending to increase the degree of opening of said fuel valve on increase of air flow through the air inlet tube, a tube connected with the vaporization chamber and communicating with the air inlet tube on the engine side of said main throttle valve for utilizing high pressure components of said hydrocarbon fuel during idling and a spring normally tending to hold said fuel valve closed but so adjusted as to allow the fuel valve to remain open during idling.

OWEN L. GARRETSON.