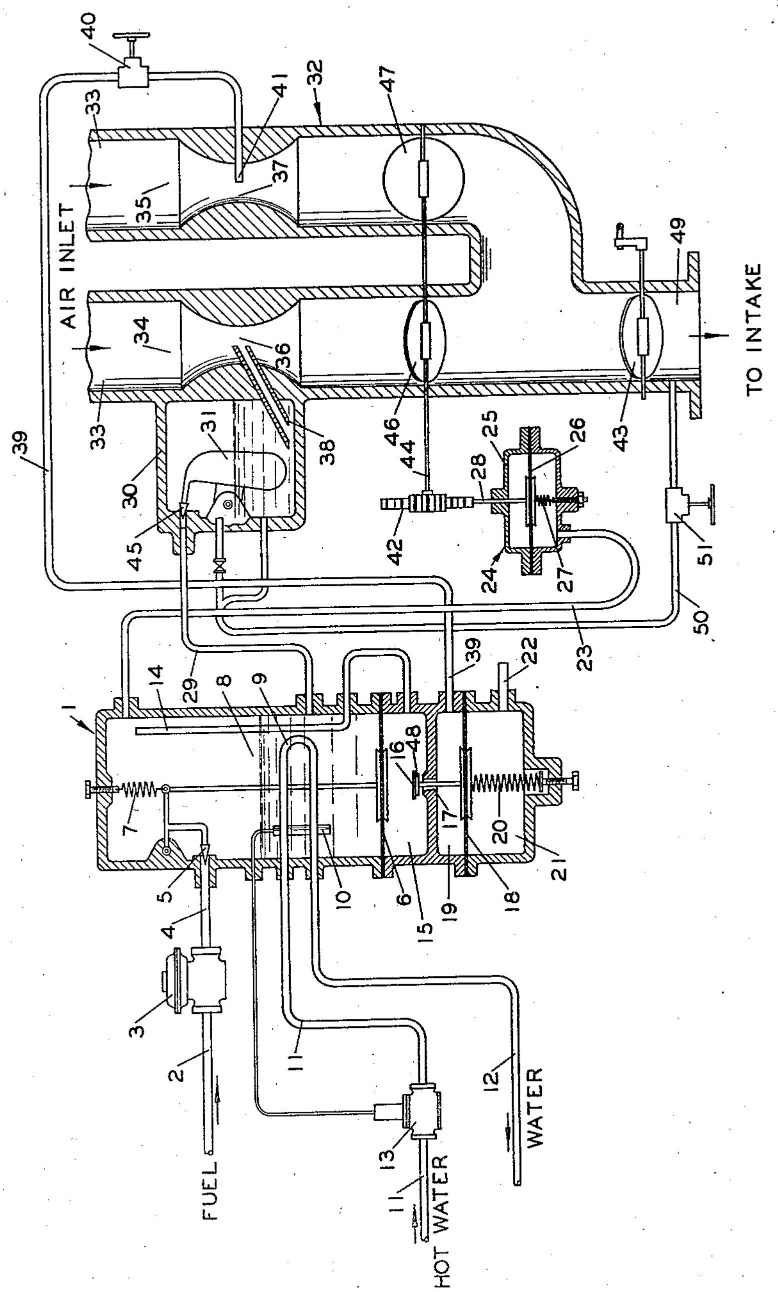
March 7, 1944. O. L. GARRETSON 2,343,765

FUEL PROPORTIONING ARRANGEMENT

Filed Oct. 3, 1941



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Patented Mar. 7, 1944 2,343,765

UNITED STATES PATENT OFFICE

2,343,765

FUEL PROPORTIONING ARRANGEMENT

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Application October 3, 1941, Serial No. 413,507

3 Claims. (Cl. 261—16)

This invention relates to carburetors and more particularly it relates to a type of carburetor especially adapted for use with high vapor pressure gasoline, in which the normally gaseous hydrocarbons are separated from the normally liquid hydrocarbons, and the two phases carbureted separately but in the same ratio as they occur in the original high vapor pressure fuel.

For automotive uses the conventional carburetor is one in which liquid gasoline of from approximately nine to twelve pounds Reid vapor pressure is used as fuel. Some stationary internal combustion engines operate on natural or artificial gases, and in some regions trucks, busses and even motor cars are powered by internal combustion engines which use compressed gases as fuel. These latter engines are equipped with special carburetors which are adapted for mixing the gas with air to form the combustible fuel mixture.

In each of these aforementioned types of carburetor, the apparatus is used to carburet fuel from one phase, that is, from an all liquid phase, or from an all gaseous phase. I have devised a carburetor which is designed to carburet a two phase fuel, that is, a fuel which is composed of liquid and vapor under pressure. Fuels of this class may be such as high vapor pressure natural gasoline or even liquefied petroleum gases or mixtures thereof.

An object of this invention is to devise a carburetor for carbureting high vapor pressure fuels.

Another object of this invention is to devise a carbureting device for use with a high vapor pressure fuel, which upon reduction to approximately atmospheric pressure is separated into a liquid phase and a vapor phase, and carbureting these two phases in the ratio in which they are present in the original high vapor pressure fuel.

A further object is the provision of a proportioning means for vapor and liquid intake tubes rigidly connected and inversely controlling flow of the respective fuels in response to the supply of the gaseous phase.

Still another object of this invention is to devise a carburetor for use with a high vapor pressure fuel, which upon reduction to approximately atmospheric pressure is separated into a liquid phase and vapor phase, and furnishing a control device for carbureting these two separated fuel phases in the ratio in which they are present in the original fuel.

Another object is the provision of means in combination with the foregoing for reducing pressure of gaseous feed to the carburetor to approximately atmospheric.

Still other objects and advantages will be realized by those skilled in the art by a careful study of the following disclosure.

The figure illustrates one modification of my invention showing my carburetor for use with high vapor pressure fuel.

Referring to the figure, numeral 1 represents a vaporizing chamber in which the normally gaseous components of the fuel are separated from the normally liquid components. Liquid fuel is conducted from the fuel pressure tank, not shown, through line 2, through pressure regulator 3 and line 4 into vaporizing chamber 1. Valve 5 operated by diaphragm 6 and tension spring 7 controls the flow of fuel from line 4 into the vaporizing chamber. The vaporizing chamber 1 is equipped with heating coil 9 and thermo-regulator 10. Heating fluid enters heating coil 9 through tube 11 and leaves through tube 12, the flow being controlled by the thermally regulated valve 13. Vapor tube 14 connects vaporizing chamber 1 with vapor compartment 15, the bottom wall of which is equipped with a zero pressure regulating valve 16. The valve stem passes through opening 17 in the bottom of chamber 15 and terminates in a rigid connection with daphragm 18. Gas feed chamber 19 receives gas through the regulating valve opening 17. A spring 20 is adjusted to allow valve 16 to open under a slightly subatmospheric pressure on said diaphragm 18, air chamber 21 being open to the atmosphere through opening 22 or connected to air inlet 33. Tube 23 connects vaporizing chamber 1 with the throttle regulating apparatus 24. The said throttle regulating apparatus is essentially a diaphragm regulator and is composed of a housing 25, diaphragm 26, tension spring 27, push pin 28 and rack and pinion 42. The pinion wheel is fixed rigidly to throttle valve shaft 44 which extends through the walls of the throttle valve portion 32 of my carburetor. Upon the throttle valve shaft and within the liquid carbureting side is mounted butterfly valve 46, and within the gas carbureting side the butterfly valve 47 is mounted on the said valve shaft extended. These butterfly valves 46 and 47 are positioned about 60° to 80° apart on the shaft 44 so that when one valve is open, the other is not entirely closed, or when one is closed the other will not be fully open.

Tube 29 connects the liquid containing portion of the vaporizing chamber 1 with the float chamber 30, the flow of liquid fuel being controlled by the float mechanism 31 and valve 45. The float chamber is vented to the air inlet by a passage, not shown.

The throttle valve portion 32 of the carburetor comprises the air-fuel mixing apparatus. Air enters this apparatus through the two air inlet tubes 33, or preferably the air may enter through one tube, not shown, then divide into the two tubes as shown. Tube 34 is the liquid carbureting side and tube 35 is the gas carbureting side of the device. These carbureting parts are equipped with Venturi sections 36 and 37, the former or liquid carbureting venturi contains the jet 38 through which liquid fuel passes from float chamber 30 to venturi 36, the latter or gas carbureting venturi contains the jet 41 which conducts gas from tube 39 into the venturi 37. This tube 39 leads gas from the gas feed chamber 19 to the said jet 41, the flow being restricted and controlled by valve 40.

The throttle valves 46 and 47 are controlled by the throttle regulating apparatus 24, heretofore explained. The said valves 46 and 47 are fixed rigidly on shaft 44 and in fixed relation to one another, as for example, 60° to 80° apart or even at an angle of 90° and serve to assist in the control of the ratio of liquid fuel to gaseous fuel carbureted. Butterfly valve 43 is the control throttle for the manual operation of the motor and is positioned within the fuel air outlet 49. This latter is connected to the intake manifold of the motor, not shown. The air inlet tube or tubes 33 may or may not be connected to an air cleaner, not shown, as desired.

The gas metering valve 16 is faced with a synthetic rubber or other material 48 which is resistant to gasoline or gasoline vapors, will make a tight seal when the valve is closed and will allow fine adjustments or regulation during operation.

Idling tube 50 connects the float chamber 30 to the carbureting portion of the carburetor on the downstream side of the throttle valve 43 and carries control valve 51. A branch tube connects idling tube 50 with the vapor compartment of the float bowl to prevent liquid draining into the manifold at rest.

In the operation of my carburetor hydrocarbon fuel comprising natural gasoline, high vapor pressure natural gasoline containing substantial quantities of normally gaseous hydrocarbons, under pressure, flows from the fuel storage tank, not shown, through line 2, pressure regulator 3 and line 4 into the vaporizing chamber 1. Pressure regulator 3 reduces the pressure of the incoming fuel from that of the storage tank to from 1 to 4 pounds. Fuel at this lower pressure enters vaporizing chamber 1 through valve 5, which valve is operated by diaphragm 6 and tension spring 7. The liquid fuel upon entrance into vaporizing chamber 1 evolves as vapor some of the normally gaseous hydrocarbons, and the amount of vapors formed is dependent upon the specific hydrocarbons present in the fuel, and upon the pressure and temperature maintained within said chamber. I have found that by maintaining a temperature of approximately 120° F. at between 1 and 4 pounds pressure, excellent gas-liquid separation was obtained when using natural gasoline of 26 to 40 pounds Reid vapor pressure. Provision for warming of the liquid fuel in the vaporizing chamber is made in the form of the water heating coil 9. Hot water from the motor's cooling system, not shown, passes through line 11, into the above-mentioned coil 9, and passes therefrom through water outlet tube 12 and reenters the said cooling system. The rate of flow of the heating water through the coil is thermostatically controlled by the action of temperature bulb or thermo-regulator 10 on control valve 13 in said hot water line.

The separated vapor from the upper portion of the vaporizing chamber 1 passes downwardly through tube 14 into the vapor compartment 15, the gas pressure being essentially the same in these two compartments. The diaphragm 6 serves as the bottom of the vaporizing chamber 1 and the top of the vapor compartment 15, and since the gas pressures in these chambers are essentially equal, the operating force on said diaphragm is the weight of the accumulated liquid fuel as modified by the active tension in the tension spring 7. Thus, when the weight of the residual liquid reaches a certain predetermined maximum valve, the said diaphragm closes valve 5. The spring 7 is so adjusted that the valve 5 remains closed until at least a small portion of the residual liquid fuel from the vaporizing chamber has passed therefrom through tube 29 thereby lessening the weight of the liquid upon the diaphragm and causing valve 5 to open to admit more fuel. In ordinary operation due to the normal sensitivity of the diaphragm and adjusting spring, the level of the liquid remains essentially constant or varies only within very narrow limits.

The bottom of vapor compartment 15 carries a gas or vapor metering valve 16, the stem of which passes through opening 17 in the bottom of said chamber. Air chamber 21 is separated from the gas feed chamber 19 by diaphragm 18 which is adjusted by spring 20. Opening 22 serves as a vent or pressure equalizer to insure that air chamber 21 always remains at atmospheric pressure. When the gas pressure in gas feed chamber 19 becomes less than atmospheric as occasioned by the suction of gas from chamber 19 through tube 39 to the gas carbureting jet 41, the diaphragm 18 rises, thereby opening the gas metering valve 16 allowing gas to pass through the valve opening 17 into the gas feed chamber 19. In gas feed tubing 39 is inserted a valve 40 for the restriction or control of rate of gas flow. When valve 16 is open, the gas pressure in chamber 19 and in tube 39 tends to build up due to the presence of the restricting valve 40 and when the pressure becomes greater than atmospheric the diaphragm functions to close valve 16, thereby closing off the flow of gas. In actual operation when the amount of gas issuing from gas carbureting jet 41 is constant, a pressure equilibrium results which tends to hold the metering valve 16 open an amount necessary to furnish the proper flow of gas.

The vapor-free residual liquid fuel from the bottom of vaporizing chamber 1 passes through gasoline feed line 29 to the float chamber 30 under the 1 to 4 pounds pressure heretofore mentioned. When this liquid reaches a certain predetermined level in the float chamber, the float 31 rises and the attached valve 45 closes off the flow of liquid from the fuel line 29. A liquid carbureting jet 38 extends from the bottom of the said first chamber 30 through the wall of the venturi 36 on the liquid side of the dual carburetor.

Connected to the top of the vaporizing chamber 1, the diaphragm pressure regulating device 24 proportions the flow of air through the two venturis and the flow of air through each venturi controls the amount of residual liquid and separated gas entering the liquid and gas carbureting members 34 and 35, respectively, of the dual carburetor so that these two fractions of fuel may be used in the same ratio in which they are present in the original fuel. This regulating device operates by pressure variations communicated from the vaporizing chamber 1 through tube 23. When the pressure in chamber 1 increases, diaphragm 26 within housing 25 moves upward according to the drawing and this movement increases the tension on adjustable tension spring 27 and is transmitted by push pin 28 to the rack and pinion 42, which in turn rotates shaft 44, thereby opening throttle valve 47 on the gas side to utilize the gaseous fuel from the separating chamber. The suction exerted on gas jet 41 is not communicated directly to the vaporizing chamber 1 but passes to said chamber by way of gas feed chamber 19, valve opening 17, vapor compartment 15 and vapor tube 14. When the pressure builds up in vaporizing chamber 1 from incoming high vapor pressure fuel, diaphragm 26 operates to open butterfly valve 47 and at least partially close butterfly valve 46. When inlet air passes the said butterfly valve 47, the suction set up in jet 41 tends to evacuate the gas feed chamber 19 and when the pressure therein is reduced below that of the atmosphere in air chamber 21, the diaphragm 18 opens gas metering valve 16 permitting the higher pressure vapor to pass from the vaporizing chamber 1 into the gas feed chamber 19 and thence into the carbureting jet 41. When the vapor or gas pressure in the vaporizing chamber drops to a low level of say 1 pound per square inch, the tension spring 27 pulls diaphragm 26 downward according to the drawing operating the rack and pinion to open butterfly valve 46 on the liquid carbureting side and at least partially closing the butterfly valve 47 on the gas carbureting side. Under these conditions suction is formed in gasoline jet 38 by passage of inlet air through the venturi 36 causing residual vapor-free liquid fuel to be drawn from the float chamber 30 into the air stream passing through said venturi. This operation continues until the liquid level in the float chamber 30 decreases sufficiently to permit the opening of the float valve 45 thus permitting liquid to pass from the vaporizing chamber 1 through line 29 into the float chamber. When the liquid level in said float chamber reaches a predetermined height, the said float 31 rises to close valve 45 closing off the flow of incoming liquid fuel. Upon continued carburation of the liquid fuel, the level of said liquid fuel in the vaporizing chamber 1 decreases until the weight of liquid on the diaphragm 6 is sufficiently small that the diaphragm raises to open valve 5 admitting high vapor pressure fuel. Upon entrance of this high vapor pressure fuel into the vaporizer in the presence of the heating coil 9, the gas pressure increases rather rapidly to such a point that diaphragm 26 operates to open butterfly valve 47 for the carburation of the separated gas.

These above given operations are so interrelated and dependent upon one another that a general pressure equilibrium is established among these individual operations. For example, after the motor is warmed up and its temperature reasonably constant, the valve 5 is partially opened permitting a small flow of fuel into the separator. This small flow of fuel into the vaporizing chamber 1 increases the gas pressure somewhat, and this rather small pressure increase remains reasonably constant and holds the diaphragm 26 and rack and pinion 42 in such an intermediate position that the butterfly valves 46 and 47 are held partially open and both liquid fuel and gaseous fuel are carbureted. Upon a change in load or upon a further opening of the manual throttle control valve 43, the equilibrium adjusts itself to meet the newly imposed conditions and a new equilibrium results.

The butterfly valves 46 and 47 on the common shaft 44 are termed the proportioning valves, and their relative position on the shaft is an important factor in determining the ratio of vapor to liquid carburetted. These valves are preferably attached to the said shaft at an angle of 60° to 80° from one another although, if desired, they may be 90° apart and still properly function for the purpose of this invention. This positioning of these valves with respect to one another permits the general equilibrium, abovementioned, to function for smoothness and constancy of operation. With the valves positioned 60° to 80° apart, this rapid change in fuel, that is, liquid to gas, or gas to liquid, is greatly dampened, resulting in carburation of gas and liquid at the same time, but not at the same rate. In this case, if the gas side valve were fully open, the liquid side valve would be from 10 to 30° open, while if the liquid side valve were fully open, the gas side valve would be open from the same 10 to 30°.

The ultimate air-fuel mixture flow and manual motor operation is controlled by the manual control butterfly valve 43.

During periods of acceleration when the manually controlled throttle is opened, either residual liquid fuel or the separated gas will be carbureted depending upon the relative position of diaphragm 26 and the relative position of the butterfly valves 46 and 47. In starting the motor either liquid or gaseous fuel will be used in a manner similar to that during periods of acceleration.

When the motor is turned off the suction created in venturis 36 and 37 ceases to exit and gasoline no longer flows through jet 38 nor gas through jet 41. If float 31 is permitting liquid to enter float chamber 30, the level soon rises sufficiently to prevent further flow. In addition, gas feed chamber 19 soon acquires the pressure of the atmosphere, and tension spring 20 then closes the gas metering valve 16. Under these conditions neither liquid nor gaseous fuel finds entrance into the Venturi portions of the carburetor.

The thermo-regulator 10 and control valve 13 which control the flow of warm water from the engine's cooling system are set to maintain the temperature of the liquid fuel in the vaporizing chamber such that the proper amount of high vapor pressure hydrocarbons will be vaporized therefrom. Such an amount of said high vapor pressure hydrocarbons should be removed from the liquid so that there will not be a tendency of the residual liquid to form vapor in tubes and chambers in which there should only be a liquid fuel, or in other words, the vapor pressure of the liquid fuel should be so reduced that there will be no tendency to form vapor lock. While the temperature of the liquid fuel in this vaporizing chamber may be varied within not too wide limits, some variation is permissible. I have found that under normal operating conditions a vaporizing chamber temperature approximately 120° F. gives excellent operation when using a natural gasoline of 26 to 40 pounds Reid vapor pressure. When using fuel of higher vapor pressure the vaporizing chamber temperature may be lower than 120° F. and for lower vapor pressures the temperature may be some higher and it may also be varied for different seasons of the year.

For idling of the motor, there may be sufficient leakage of air through the several butterfly valves to draw sufficient fuel, or definite provision may be made. In this latter case, tube **50** connects the carbureting portion of the carburetor at a point on the downstream side of the manually controlled throttle valve **43** to the float chamber **30** as shown for liquid fuel idling or the top of the vaporizing chamber for gaseous fuel idling. In either case valve **51** in the tube **50** controls the flow of liquid fuel or of gaseous fuel for idling.

The gas metering valve **16** is so constructed that there will be essentially no gas leakage therethrough when the valve is in a seated or closed position. To assist in preventing gas leakage, the valve may be faced with such hydrocarbon insoluble material as synthetic rubber, fiber or other swell-proof material. This valve facing is identified by numeral **48** on the drawing.

While one embodiment of my dual carburetor has been described in detail, it is obvious to those skilled in the art that many changes and alterations of the component parts may be made and yet remain within the intended scope of my invention.

What I claim is:

1. A fuel proportioning arrangement in an external combustion engine carburetion system adapted for handling fuels possessing a superatmospheric vapor pressure, comprising means separating said fuel into liquid and gaseous fuels, an intake tube for the liquid fuel and an intake tube for the gaseous fuel, each of said tubes including a venturi and a fuel nozzle, a passage for liquid fuel leading from the separating means connected with one nozzle and a passage for gaseous fuel leading from the separating means connected with the other nozzle, so that liquid and gaseous fuel flow is induced in accordance with air flow through said venturis, a valve in each of the intake tubes to control the air flow and thereby the fuel flow thereto, said valves being so connected that when one valve is moved toward closed position, the other valve is moved toward open position to vary the relative proportion of liquid and gaseous fuel induced in the branches by air flow through the venturis and means operably connected with valves and responsive to pressure variation of the gaseous fuel in the separating means, said means being adapted to move said valves in response to an increase of pressure to increase the flow of gaseous fuel and decrease the flow of liquid fuel through said intake tubes.

2. A fuel proportioning arrangement in an external combustion engine carburetion system adapted for handling fuels possesing a superatmospheric vapor pressure, comprising means separating said fuel into liquid and gaseous fuels, means controlling the admission of superatmospheric vapor pressure fuel to the separating means when the quantity of liquid fuel therein is reduced below a predetermined minimum, an intake tube for the liquid fuel and an intake tube for the gaseous fuel, each of said tubes including a venturi and a fuel nozzle, a passage for liquid fuel leading from the separating means connected with one nozzle and a passage for gaseous fuel leading from the separating means connected with the other nozzle, so that liquid and gaseous fuel flow is induced in accordance with air flow through said venturis, a valve in each of the intake tubes to control the air flow and thereby the fuel flow thereto, said valves being so connected that when one valve is moved toward closed position, the other valve is moved toward open position to vary the relative proportion of liquid and gaseous fuel induced in the branches by air flow through the venturis and means operably connected with valves and responsive to pressure variation of the gaseous fuel in the separating means, said means being adapted to move said valves in response to an increase of pressure to increase the flow of gaseous fuel and decrease the flow of liquid fuel through said intake tubes.

3. A fuel proportioning arrangement in an internal combustion engine carburetion system adapted for handling fuels possessing a superatmospheric vapor pressure comprising a vaporization chamber for separating said fuel into liquid and gaseous fuels, an impervious relatively movable member in the bottom of said chamber, a source of fuel supply for said chamber, a shut-off valve controlling the flow of fuel from said fuel supply to the chamber, said valve being connected with said member and relatively movable therewith, spring means tending to open said shut-off valve, an intake tube for the liquid fuel and an intake tube for the gaseous fuel, each of said tubes including a Venturi tube and a fuel nozzle, a passage for liquid fuel leading from the vaporization chamber connected with one nozzle and a passage for gaseous fuel leading from the vaporization chamber connected with the other nozzle, so that liquid and gaseous fuel flow is induced in accordance with air flow through said venturis, a valve in each of the intake tubes to control the air flow and thereby the fuel flow thereto, said valves being so connected that when one valve is moved toward closed position the other valve is moved toward open position to vary the relative proportions of liquid and gaseous fuel induced in the branches by air flow through the venturis and means operably connected with said valves and responsive to pressure variation of the gaseous fuel in the vaporization chamber, said means being adapted to move said valves in response to an increase of pressure to increase the flow of gaseous fuel and decrease the flow of liquid fuel through said intake tubes.

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