

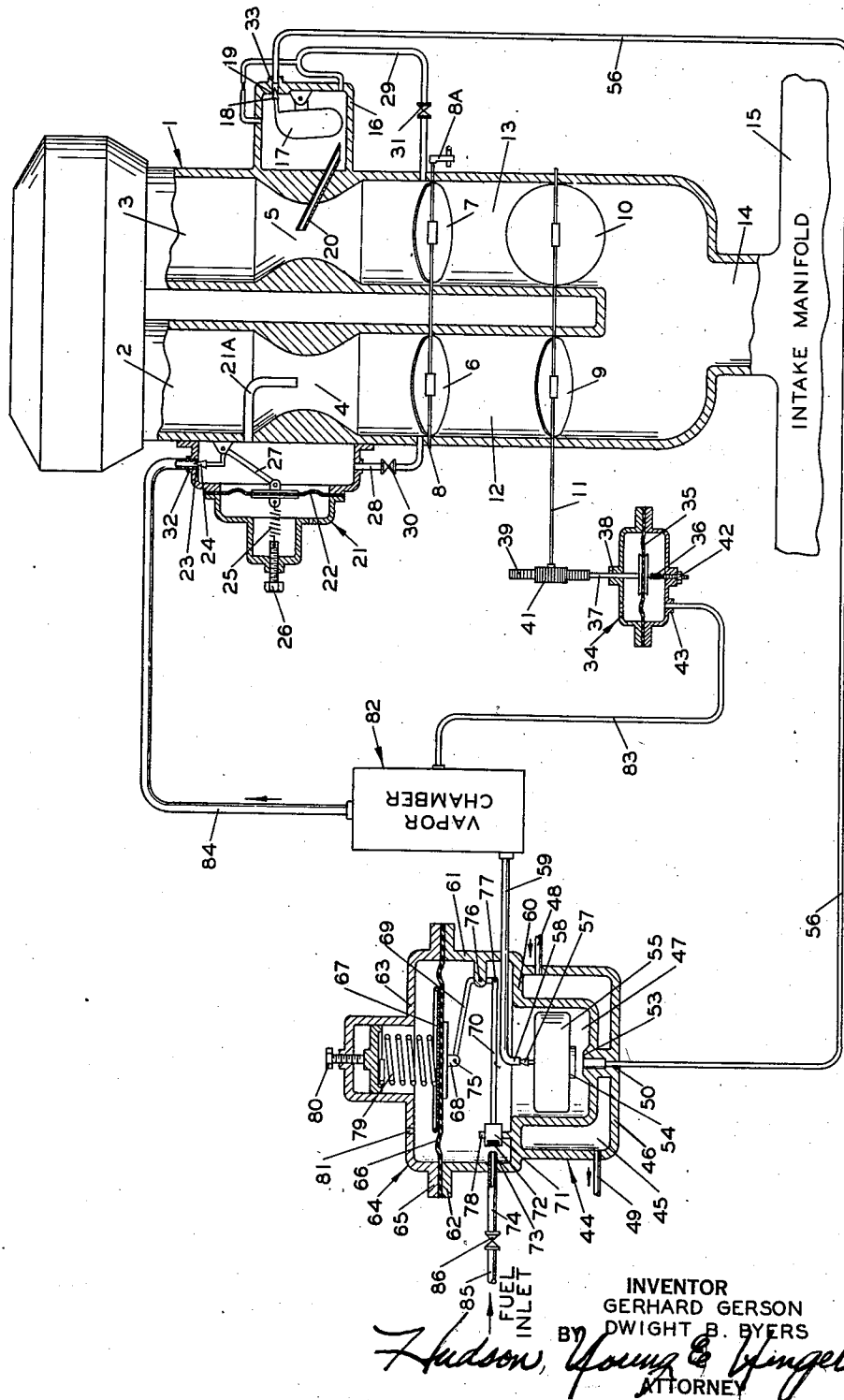
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G. GERSON ET AL

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FUEL PROPORTIONING DEVICE FOR INTERNAL COMBUSTION ENGINES

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FUEL PROPORTIONING DEVICE FOR
INTERNAL COMBUSTION ENGINES

Gerhard Gerson, Bartlesville, Okla., and Dwight
B. Byers, Sylvan Lake Village, Mich., assignors
to Phillips Petroleum Company, a corporation
of Delaware

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This invention relates to charge forming devices which contemplate the use of hydrocarbon fuels of wide boiling range in an internal combustion engine.

The desirability of utilizing hydrocarbon fuels of low boiling range (high vapor pressure) has long been recognized. The higher vapor pressure hydrocarbons have good anti-knock properties, and their highly volatile nature is conducive both to easy starting in cold weather and to complete and intimate admixture with air to provide a powerful combustion charge in the engine manifold under all conditions of operation.

Due to the lack of suitable equipment to carburet a fuel containing both heavy and light ends, the marketing of a usable motor fuel has been resolved into two general lines of operation. The first, and by far the most common mode of utilization, has been to remove the more volatile components from so-called natural gasoline (Reid vapor pressure 26-40 pounds per square inch), leaving a product in the range of 9-12 pounds per square inch Reid vapor pressure to be marketed as a motor fuel. In removing these light ends, prevention of vapor lock and evaporation loss is accomplished. At the same time, however, the anti-knock value of the fuel is so lowered that it is necessary to add some non-volatile anti-knock agent, such as tetraethyl lead, in order to provide a suitable fuel for high compression engines. The resultant product, commonly known as gasoline motor fuel, is utilized in liquid form in the conventional liquid carburetors currently used.

The second form of marketing and utilization of volatile motor fuels consists of further refining of the light ends referred to above to obtain propane, butane, and mixtures thereof. These products have been widely marketed as domestic and industrial heating fuels, and more recently have been marketed to some extent as motor fuels. As motor fuels, these products are carbureted from the vapor phase entirely, and are very high in anti-knock quality. However, they are relatively hard to store and transport, requiring high pressure storage tanks and heavy piping. They are also bulky as compared with regular gasoline motor fuels, since their heat or energy content per unit of volume is considerably lower than is the case with gasoline.

It is obvious then, that much economy would be realized if the need for separating the heavy ends from the light, and marketing the several products separately, could be eliminated. Such an objective could be reached by employing carburetors such as the one forming the subject of the present invention.

A principal object of our invention, then, is to provide carbureting means which will handle a

fuel whose constituents may vary widely in the matter of volatility.

A further object is to provide a means whereby both the normally liquid and the normally gaseous constituents of such aforementioned hydrocarbon fuel may be carbureted simultaneously and with equal facility.

It is further an object of this invention to proportion the consumption of the various components in the same ratio in which they separate from the higher than normal vapor pressure fuel, thus preventing the accumulation of either a liquid or a gaseous residue which is unusable.

A still further object is to provide means which will promote complete separation of the light from the heavy ends in the fuel before entering the carburetor proper, so that there will be no tendency for further separation in the liquid component. By this means vapor lock in the liquid side of the dual carburetor is prevented.

Another object is the provision of a proportioning means for the liquid and gaseous phases which is responsive to pressure of the gaseous phase flowing to the gas carburetor from the vaporizer throttled in accordance with the change in rate of utilization of the respective phases. A further aim of the invention is to accomplish these results during the maintenance of a substantially constant pressure in the vaporizer.

Other advantages and objects will be apparent to those skilled in the art from a study of the following disclosure.

In the drawing, numeral 1 refers generally to a dual carburetor, one side of which is adapted to accommodate liquid fuel, the other side being adapted to gaseous fuel. The gaseous and liquid sides are furnished respectively with air inlets 2 and 3, venturis 4 and 5, and main throttle butterfly valves 6 and 7, the latter two members being mounted on a common shaft 8. Fuel proportioning butterflies 9 and 10 are mounted on a common shaft 11 and are mounted substantially at right angles with respect to each other, so that 9, for example, will be closed as 10 is open. The two mixing chambers 12 and 13 join in a common riser 14, which is in communication with the engine manifold 15. A bell crank 8A is provided for simultaneous operation of the throttles 6 and 7 in a conventional manner.

The liquid fuel side of the dual carburetor has a float chamber 16, fitted with a conventional float 17 and a needle valve 18 cooperating with a seat 19. On the downstream side of the needle, the liquid fuel nozzle 20 communicates with the Venturi section of the liquid carburetor. The equivalent of this arrangement is also provided for the vapor side of the dual carburetor in which the zero governor 21 serves the same purpose as does the float control on the liquid side. The zero governor is provided with a flexible dia-

phragm 22, a valve seat 23 and a valve member 24 cooperating therewith. The diaphragm is adjustably loaded by a tension spring 25 and a screw 26. The motion of the diaphragm is responsively communicated to the valve by a connecting member 27. A gaseous fuel nozzle 21A communicates between the venturi 4 and the space under diaphragm 22.

Both sides of the dual carburetor are equipped with idle fuel lines, 28 and 29, and with needle valves 30 and 31 in the respective lines for adjusting the fuel flow therethrough. Likewise, each side is fitted with a fuel inlet connection 32 and 33, respectively. The line 29 is further provided with a connection 29A connecting with the vapor space in the float chamber and having a restricted portion. Leakage is thus prevented through line 29 when the motor is stopped.

Numeral 34 indicates generally a butterfly governor which controls the proportional relationship between the liquid and vapor flow through the respective sides of the dual carburetor. This control is obtained by the action of the governor 34 upon the proportioning butterflies 9 and 10. In the governor, a diaphragm 35 is resiliently loaded by a tension spring 36. A member 37 is attached to the diaphragm and extends through a guide 38 to the outside of the governor body. Member 37 has formed upon it a rack 39 which engages a pinion 41 on the end of shaft 11. In this manner, motion of the diaphragm 35 is translated into angular motion of the proportioning butterflies attached to shaft 11. The spring 36 is adjustable by means of the screw 42, and a pressure connection leading to the governor interior is provided at 43.

The numeral 44 indicates generally a combination regulator and vaporizer with liquid level control. The lower portion of this combined device comprises the vaporizer in which 45 is a space for circulation of a heating medium, enclosed by the outer shell 46 and an inner compartment 47, the latter of which contains the fuel to be vaporized. An inlet and an outlet for the heating medium are provided respectively at 48 and 49, the contemplated medium being heated water from the engine cooling system, not shown. An outlet for liquid fuel is provided at 50. On the upper end of the fuel outlet connection 50 is formed a valve nozzle 53, which may cooperate with the valve disc 54 to effect closure of the liquid fuel outlet when the level of liquid in the vaporizer is not high enough to support the float 55. The valve 54 serves to prevent vapor lock in the liquid line when the vaporizer is dry and liquid fuel is introduced to the chamber. The line 56 connects the vaporizer outlet 50 to the float chamber 16 of the liquid fuel side of the dual carburetor.

On the upper surface of float 55 is provided a tapered valve member 57 which cooperates with seat 58 in the vapor outlet tube 59 to vary or throttle the flow of gaseous fuel component therethrough. The upper edges of the inner and outer chambers 47 and 46, respectively, are joined by an annular surface 60, completing closure of the water circulation space 45. On a suitably enlarged extension 61 of the outer wall 46 of the vaporizer unit is formed a flange 62, to which is bolted or otherwise attached a bonnet 63, thus forming the regulator portion of the combined regulator-vaporizer unit. The regulator portion is generally indicated by the numeral 64. The bonnet is provided with a corresponding flange 65, the two flanges being at-

tached to each other by bolts or other suitable means. Secured between the flanges is a flexible diaphragm 66. A suitable diaphragm backup plate 67 is fitted with attachment 68 for the valve actuating lever 69. A valve thrust rod 70 carries a valve member 71 containing a resilient seat 72, and cooperating with the nozzle 73 formed on the end of the fuel inlet tube 74. Pivots in the valve linkage are provided at 75, 76 and 77. The valve member 71 is maintained in alignment with the nozzle 73 by means of the guide web member 78, the valve member being slidable therein. The upper side of diaphragm plate 67 is adjustably loaded by compression spring 79 and adjusting screw 80. The bonnet 63 is vented to the atmosphere by port 81.

A vapor velocity reducing chamber, generally indicated by numeral 82 is placed in the outlet line 59 which leads from the vaporizer 44 to the zero governor 21. This chamber is simply a shell structure and may be of any desired shape, such as a cylinder or a rectangular box, for example. Its function is simply to provide a means for reducing the velocity of the vapor stream at the point where the pressure line 83 is connected for actuation of the butterfly governor 34. Line 84 is in effect a continuation of the line 59, and completes the connection between the vaporizer 30 and the zero governor.

The fuel supply line 85 leads from a source of high pressure fuel, not shown, and contains a shut-off valve 86. This valve serves as a safeguard against loss of fuel at unusually high temperatures by excessive vaporization in the vaporization chamber when the engine is stopped, which may exceed the shut-off pressure of float 17. The valve 86 may be of a manual or automatic type, in the latter case being operated by manifold suction, engine oil pressure, an electromagnet or any other suitable means which would maintain the valve open while running the engine, and closed while not running.

The merits and advantages of our fuel system and dual carburetor will be obvious from the following description of its operation.

Fuel in liquid form is delivered from the source, not shown, to the pressure regulator by means of the supply line 85. The fuel may be motivated by the effect of its own vapor pressure in the supply tank, or by a liquid pump. Valve 86 is opened manually or otherwise at the time the operator wishes to begin operation of the engine.

The pressure of the fuel is reduced to a nominal figure, preferably about $1\frac{1}{2}$ pounds per square inch, by the pressure regulator 64. Upon admission of the liquid fuel, the more volatile components may begin to vaporize because of the pressure reduction experienced in passing through the regulator valve, even though the vaporizer is yet cold. The heavier portions will remain in liquid form, however, and when sufficient liquid to buoy the float 55 has been admitted, the valve 54 will be thus opened and liquid fuel will proceed through line 56 to the liquid side of the dual carburetor. The float chamber 16 will subsequently fill to a level determined by the float control composed of members 17, 18 and 19.

Meanwhile, such vapor as may be present in the cold vaporizer will have filled the vapor feed line 59, the chamber 82, the pressure lines 83 and 84, and likewise, the space under the diaphragm of the butterfly governor 34. The diaphragm 35 will be displaced by pressure to a

position determined by the balancing force of the tension spring 36, and thus the butterflies 9 and 10 will assume some definite angular position. If the pressure of the vapor is high, the butterfly 9 will be substantially open and 10 substantially closed; if low, the converse relationship will be established.

Upon cranking of the engine, a suction is established in the manifold. This suction will be imposed on the liquid fuel jet 20 and the vapor fuel jet 21A, and will be imposed on the respective jets in proportion to the relative degree of opening of their respective proportioning butterflies 9 and 10. The subatmospheric pressure in the vapor side of the carburetor will cause opening of the zero regulator valve which is adjusted to open slightly below atmospheric pressure, thus admitting gaseous fuel to the carburetor. Liquid fuel will meanwhile be also introduced from the float chamber.

In this manner a charge of fuel is introduced to the vapor or liquid side of the carburetor, or to both sides simultaneously. When dispersed in the air streams in the venturi, a combustible mixture for starting the engine is furnished. Manipulations of the main throttles 6 and 7 will govern the engine speed in the usual manner, since these throttles coact to control the total flow through the respective sides of the carburetor.

With the engine running, flow of fuel is induced through the fuel regulator and vaporizer. Since the temperature of the engine cooling water is at first low, little heat will be supplied to the vaporizer. Vaporization will, therefore, be relatively slow, and the liquid level in the vaporizer will build up. As the float 55 rises, the needle 57 moves closer to the seat 58, throttling the pressure to line 59 and hence the pressure to the butterfly governor 34. As a result, the vapor butterfly 9 is urged toward the closed position, and liquid butterfly 10 is opened further. Thus the respective sides of the dual carburetor are made to utilize the vapor and liquid phases of the fuel in proportion to the quantities of each phase formed in the vaporizer.

As the engine and its cooling liquid are warmed, the vaporizer is influenced accordingly, and progressively greater proportions of the fuel admitted thereto are converted to vapor phase, with a corresponding decrease of the quantity of liquid phase. The vaporizer float will, therefore, be lowered, further opening the vapor outlet (needle 57 recess from seat 58) and causing adjustment of the proportioning butterflies in response to the increased pressure imposed on the butterfly governor.

Once the vaporizer temperature reaches a running equilibrium, the butterflies which proportion the liquid and vapor phases will assume a definite position for a given condition of load, speed and fuel composition. Any change in these conditions will be reflected in the proportioning device, which will adjust itself to compensate for the particular condition imposed. In all cases, the proportioning will be governed by the respective amounts of liquid and vapor existing in the vaporizer. When the liquid phase prevails, the valve 57 will be entirely closed, there will be no pressure in the butterfly governor, and the vapor butterfly 9 will be entirely closed while the liquid butterfly 10 is full open. In the case where vapor is predominant, the float 55 will be lowered sufficiently to obtain maximum opening of valve 57, and the pressure in the butterfly governor will

be high. The vapor butterfly 9 will, therefore, be fully open and butterfly 10 completely closed. It is noted that the proportioning valves tend to cause consumption of the liquid and gaseous phases in their approximate ratio of separation.

The complete closing of the liquid valve 54 in the bottom of the vaporizer will seldom occur during normal running of the engine. This valve is not for the purpose of proportioning, but is provided in order to prevent complete emptying of the liquid from the vaporizer and insures a reserve of liquid fuel which will always be available for starting. Full opening of valve 57 will be obtained before closure of valve 54, and thus the full range of adjustment of the proportioning butterflies is controlled by the vapor valve 57 and its influence upon pressure in the butterfly governor.

While other devices proposed for dual carburetion of liquid and vapor phases of a fuel may at first appear to be similar to our present disclosure, there are a number of differences of great importance which we wish to point out.

The first is that the particular arrangement of the butterfly governor with respect to the rest of the elements is distinctly advantageous. It is obvious from the drawing and the description of operation that, while the float in the vaporizer controls indirectly the proportioning, with the aid of the butterfly governor, it does so without varying the pressure on the liquid fuel entering the carburetor. The regulator 64 maintains a constant pressure on the liquid and vapor in the vaporizer while these components are being withdrawn. Other dual feed devices with which the inventors are familiar use the vaporizer float or equivalent to shut off or throttle the fuel inlet when the liquid level is high, and necessarily this arrangement produces a variation in pressure in the vaporizer, which complicates metering of the liquid portion of the fuel because of the wide range of variable pressures imposed.

By maintaining a constant pressure in the vaporizer, using the float to control the gaseous discharge therefrom to the gas carburetor and thus effecting proportioning with the aid of a servo mechanism, this disadvantage is eliminated in the present invention. A further advantage resides in arranging the servo mechanism so as to be directly responsive to gaseous phase flowing to the carburetor, which avoids the necessity of a separate line and bleed-off and allows more accurate proportioning of the separate phases.

Another point of advantage we wish to demonstrate lies in the particular location and arrangement of the proportioning butterflies, the main throttles and the idling fuel jets with respect to each other.

It is known that the idling fuel jets are best located at or outside of the level of the main throttles, so that excessive suction will not be imposed upon the jet when the throttles are practically closed for idling of the engine. What is not common knowledge and we claim as new, is the fact that it makes a material difference whether the auxiliary or proportioning butterflies are located nearer or farther from the engine with relation to the main throttles and idling jets.

In the arrangement shown in the accompanying drawing, the best idling condition is obtained. In the event either proportioning butterfly closes fully, air flow will be precluded on that side of the carburetor. The same would hold true if the main throttles were placed below in-

stead of above the proportioning butterflies. However, in that case the suction on both idling fuel jets would continue because of the main throttles being slightly open, and fuel would flow from both jets even though the air inlet were blocked on one side by the proportioning butterflies. Thus an extremely rich mixture would be produced and idling of the engine seriously affected.

In the arrangement we illustrate, suction as well as air flow, are precluded simultaneously when either proportioning butterfly closes, and thus fuel is admitted from one side only, in proper admixture with air admitted through the same side of the carburetor.

Many deviations in the detail of our carburetor and fuel conditioning system are possible without departing from the teachings of our disclosure. A system of cranks and levers could be substituted for the rack and pinion arrangement shown on the butterfly shaft, for example. Likewise, the zero governor could be separate from the carburetor, the regulator 64 could be separated from the vaporizer, or the volume chamber 82 could be incorporated in the zero governor so long as all the fuel vapor were made to go through it. These deviations are within the scope of this disclosure and would not avoid the same.

Having disclosed fully the structure, operation and advantages of our invention, we claim:

1. A high pressure fuel charge forming device for internal combustion engines comprising means for separating said fuel into liquid and gaseous phases, means for proportioning flow of the respective phases to the engine, a valve for varying the pressure of the gaseous phase flowing to the proportioning means in accordance with a change in the quantity of liquid phase accumulated in the separating means and means responsive to said pressure variation on the downstream side of said valve operatively connected with the proportioning means tending to cause consumption of said phases in their approximate ratio of separation.
2. A high pressure fuel charge forming device for internal combustion engines comprising means for separating said fuel into liquid and gaseous phases, valve means in the fuel-air inlet to the engine for proportioning the relative flow of the respective phases, a variable opening valve for throttling the flow of gaseous phase from the separating means to the valve proportioning means in accordance with a change in the quantity of liquid phase accumulated in the separating means and a pressure responsive device exposed to the pressure of the gaseous phase on the downstream side of the valve operatively connected with said proportioning means tending to cause consumption of said phases in their approximate ratio of separation.
3. A high pressure fuel charge forming device for internal combustion engines comprising means for separating said fuel into liquid and gaseous phases, valve means in the fuel-air inlet to the engine for proportioning the relative flow of the respective phases, conduits for the respective phases leading from the separating means to the proportioning means, a throttling device in the gaseous phase conduit controlling the pressure of gaseous phase in accordance with a change in the quantity of liquid phase accumulated in the separating means and a pressure responsive device communicating with the gaseous conduit between the throttling device and the valve means and operatively connected with the

valve means tending to cause consumption of said phases in their approximate ratio of separation.

4. A fuel proportioning arrangement in an internal combustion engine carburetion system comprising a combination liquid and gaseous phase carburetor, means for separating the fuel into liquid and gaseous phases, variable means for reducing the pressure of gaseous phase flowing from the separating means to the carburetor and pressure responsive means disposed between the variable means and the carburetor for regulating the relative flow of liquid and gaseous phase fuel to the engine.

5. A fuel proportioning arrangement in an internal combustion engine carburetion system comprising means for separating said fuel into liquid and gaseous phases, means for proportioning flow of the respective phases to the engine, a variable opening valve controlled by the accumulation of liquid phase in the separating means for changing the pressure of gaseous phase flowing to the proportioning means and a pressure responsive device exposed to the pressure of the gaseous phase on the downstream side of the valve and operatively connected with the proportioning means tending to cause consumption of said phases in their approximate ratio of separation.

6. A fuel proportioning arrangement in an internal combustion engine carburetion system comprising a combination liquid and gaseous phase carburetor, means for separating said fuel into liquid and gaseous phases, means for proportioning flow of the respective phases to the engine, a valve for varying the pressure of gaseous phase flowing from the separating means to the carburetor, and pressure responsive means exposed to the pressure of the gaseous phase on the downstream side of the valve and operatively connected with the proportioning means for causing consumption of said phases in their approximate ratio of separation.

7. A high pressure fuel charge forming device for internal combustion engines comprising means for separating the fuel into liquid and gaseous phases, a fuel-air inlet to the engine for each phase, coacting valves adapted to inversely proportion the flow of fuel through the respective inlets to cause consumption of said phases in their approximate ratio of separation, connected throttle valves adapted to control the overall flow of fuel to the engine through said inlets and a fuel idling line for each phase connected with the inlets adjacent said throttle valves.

8. A high pressure fuel charge forming device for internal combustion engines comprising means for separating the fuel into liquid and gaseous phases, a fuel-air inlet to the engine for each phase, coacting valves adapted to inversely proportion the flow of fuel through the respective inlets, connected throttle valves adapted to control the overall flow of fuel to the engine through said inlets, a fuel idling line for each phase connected with the respective inlets adjacent said throttle valves, a valve for controlling the pressure of the gaseous phase flowing from the separating means to the carburetor, and pressure responsive means exposed to the pressure of the gaseous phase on the downstream side of the valve and operatively connected with the proportioning means tending to cause consumption of said phases in their approximate ratio of separation.

GERHARD GERSON.
DWIGHT B. BYERS.