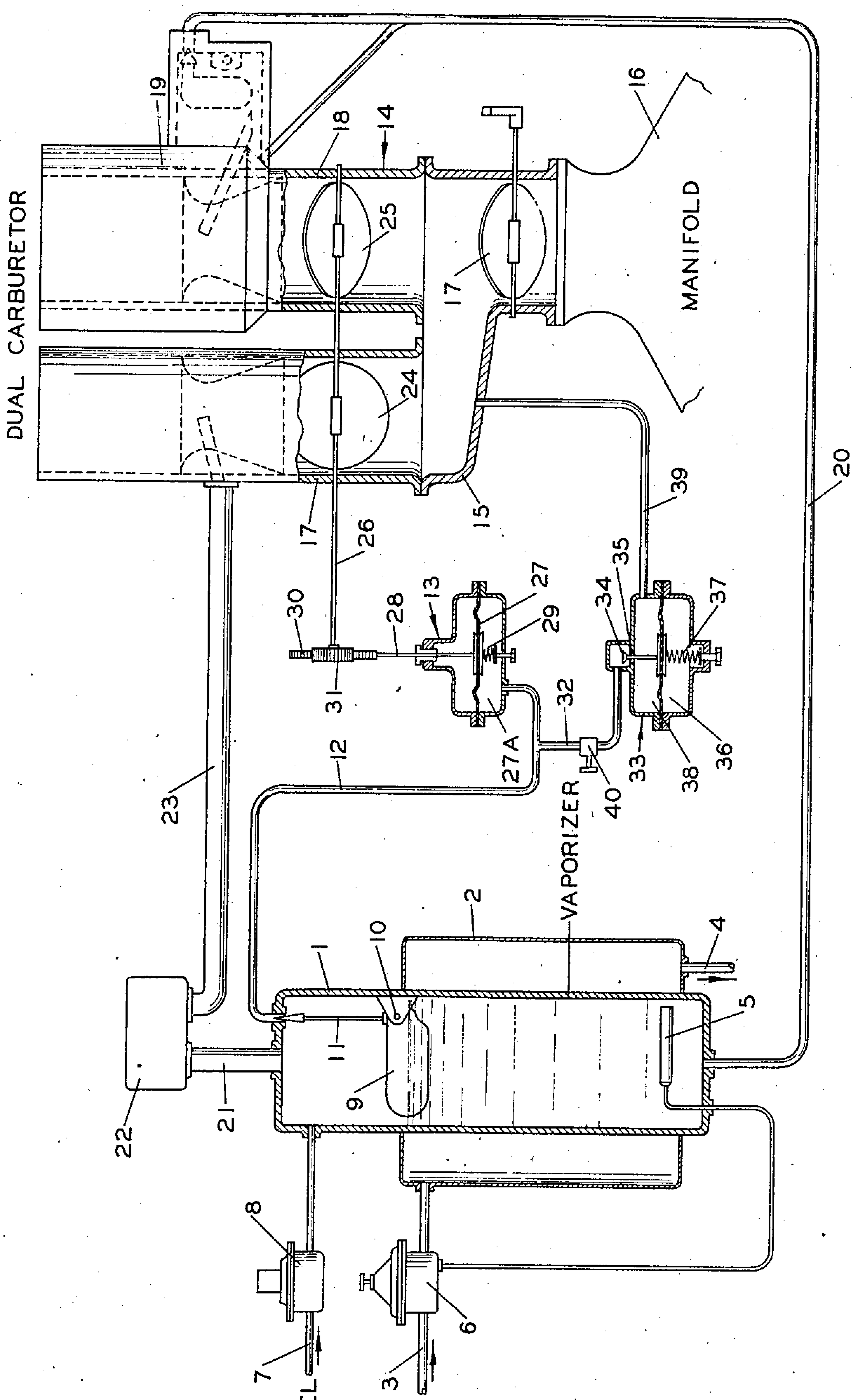
March 7, 1944. R. W. THOMAS 2,343,488

CARBURETOR FOR HIGHER THAN NORMAL VAPOR PRESSURE FUELS

Filed Nov. 15, 1941



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Patented Mar. 7, 1944

2,343,488

UNITED STATES PATENT OFFICE

2,343,488

CARBURETOR FOR HIGHER THAN NORMAL VAPOR PRESSURE FUELS

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Application November 15, 1941, Serial No. 419,354

4 Claims. (Cl. 261—16)

The present invention relates to a carburetion system particularly adapted and arranged for the handling of higher than normal vapor pressure fuels. The device is so constructed as to be adaptable to hydrocarbon fuels having a variety of characteristics over a wide boiling range.

The characteristic properties of certain high vapor pressure hydrocarbons render them extremely valuable for use as a fuel in internal combustion engines. The high octane number of the more volatile components present, for example, in certain types of natural gasoline hydrocarbons, is particularly desirable for use in modern gasoline engines having high compression ratios adapted to increase enormously the horse-power and speed for given piston displacement. Likewise, the high volatility even under the most extreme conditions of cold weather facilitates complete dispersion in the air stream and instantaneous combustion not obtainable for instance with ordinary gasoline. The peculiar characteristics of these fuels and variations in vapor pressure and other properties due to weather conditions have presented a most difficult engineering problem. Up to the present time no system has been developed entirely suitable for handling these fuels in a satisfactory and efficient manner.

Extensive research has resulted from the recognition of the valuable properties possessed by these fuels and many attempts have been made to develop a system of carburetion which would be economical and suitable under the variety of operating and climatical conditions to which they may be subjected. One proposal divided the higher than normal vapor pressure fuel into liquid and gaseous phases and separately carbureted each phase. The arrangement provided a separating or vaporizing chamber with a dashboard liquid level indicator and a manual control for proportioning the relative carburetion of each phase in order to feed the respective phases to the engine in the same ratio in which they existed in the original fuel. A further arrangement was proposed for the automatic regulation of liquid versus gaseous phase feed to the engine in the ratio in which the respective phases existed in the higher than normal vapor pressure fuel. This device employs a vaporizing chamber provided with a float equipped with valves for regulating the relative flow of liquid and gaseous phases to the carburetor. The latter system also includes a special compensating device for maintaining a fairly constant outlet pressure to the vaporization chamber through a reducing valve irrespective of tank pressure change. The difficulty with the foregoing arrangement resided in the fact that the valves must be very accurately machined to regulate the flow of liquid to the liquid carburetor and throttle the gas flow. Likewise, reduction of the fuel to atmospheric pressure in the vaporization chamber necessitated the use of a fuel pump on the liquid side. I have found that a substantially more satisfactory arrangement results if the proportioning takes place in the fuel-air inlet to the engine by means which are automatically responsive to a change between the rate of consumption and the rate of separation of the respective phases. My arrangement likewise maintains a constant pressure at the point of separation and carburets the relative liquid and gaseous feed in the ratio in which they separate from the higher than normal vapor pressure fuel more efficiently, I believe, than accomplished in prior devices.

A primary object of the invention is to provide a suitable arrangement and efficient mode of carbureting higher than normal vapor pressure fuel. Another object of this invention is to obtain automatic feed regulation of liquid and gaseous phases separated from a higher than normal vapor pressure fuel. A further object of the invention is the provision of an arrangement whereby carburetion of the respective phases takes place in substantially the same ratio as the liquid vapor ratio after separation under the temperature and pressure existing in the vaporizer. Another object of the invention is the removal of sufficient gaseous phase or light ends of the hydrocarbon fuel and maintenance of the separated liquid phase under a sufficient constant pressure to avoid the occurrence of vapor lock. A further and most important object of this invention is the achievement of a carbureting arrangement for higher than normal vapor pressure fuels which provides a pressure responsive device proportioning the relative liquid and gaseous phase feed to the engine and means establishing a variable pressure thereon in accordance with the volume change of an accumulated portion of the separated liquid phase.

The present invention solves the inherent difficulties encountered in the carburetion of higher than normal vapor pressure fuels by providing a positive and direct means for proportioning the feed of the respective liquid and gaseous phases to the engine in response to a change between the rate of separation and the rate of consumption of the respective phases. The arrangement I have developed includes a dual carburetor connected with the intake manifold of an internal combustion engine and having a double butterfly valve control, the valves being mounted at an angle to each other on a common shaft and inversely proportioning the liquid to gaseous fuel feed ratio admitted to the intake manifold. The relative valve position is controlled by a butterfly governor which is responsive to pressure variable in accordance with the volume change of an accumulated volume of separated liquid phase to rotate the butterfly valve shaft and thereby proportion fuel feed. The temperature of the vaporizer is accurately controlled by a thermostatic valve, preferably adjustable, regulating the admission of heat, for example, through a heating jacket connected with the engine circulatory system, and a float connected with a variable opening control valve meters the effective flow of gas or other fluid from a suitable source of constant pressure to the diaphragm governor, thereby impressing a pressure thereon in accordance with the relative accumulation of the separated liquid phase as determined by the float. The gaseous pressure in the vaporizer is maintained slightly superatmospheric and preferably about 3 to 3½ pounds per square inch by a primary pressure regulator reducing the pressure of the higher than normal vapor pressure fuel. A zero governor is located in the vapor feed line to the vapor side of the dual carburetor. As a source of regulative pressure for the butterfly governor, I preferably utilize the separated gaseous phase in the vaporizer. The vapor line or other source of fluid pressure to the butterfly governor is provided with a bleed-off communicating with the manifold intake tube mixing chamber or directly with the manifold through a special vacuum opened device or check valve. An orifice or other means is provided between the vapor line and the check valve, which orifice is preferably adjustable to within limits to meter the flow into the manifold, thereby varying the pressure conditions on the butterfly governor. The check valve is closed at standstill but is opened wide under the suction in the manifold or intake tube when the engine is started. A small continuous flow of fluid is normally allowed by the variable pressure producing device or control valve through the control line, orifice and bleed-off line to the manifold which may impress a slight positive or negative pressure on the butterfly governor, causing the valves to assume an intermediate position for the particular fuel and carbureting the respective phases in the ratio of their separation. The extreme positions of the butterfly governor and hence extreme valve positions depend on the degree of pressure impressed by the variable pressure producing device which in turn is regulated by volume change of the separated liquid phase in the vaporizer. Due to the orifice in the bleed-off line, when the liquid level is low and the control valve wide open, the result will be a maximum positive pressure on the butterfly governor resulting in maximum gaseous and minimum liquid phase feed to the manifold. The other extreme condition will occur when the pressure control valve completely shuts off flow of control fluid and a negative pressure is impressed on the butterfly governor by the suction effect communicated through the orifice and control line to the governor from the intake tube or manifold, thereby adjusting the butterfly valves for maximum liquid and minimum gaseous phase feed to the manifold. As stated, however, normally and under relatively constant conditions the valves will assume an intermediate position while the control valve throttles the flow of fluid through the control system and orifice to the manifold. While such a condition prevails a slight suction or negative pressure will ordinarily act on the butterfly governor which diaphragm loading is then balanced by a small compression spring below the diaphragm. It is thus apparent that by these means I provide an efficient and positive means controlling the liquid to vapor phase feed ratio to the engine directly responsive to a change between the rate of separation and the rate of consumption of the respective phases.

The accompanying drawing illustrates diagrammatically one form of apparatus which may be utilized in the practice of this invention.

Referring to the drawing, a vaporizer or separating means 1 is supplied with a jacket or other suitable heat exchange means 2 connected to the engine water jacket or a source of heat for the admission of a heating medium through conduit 3. A conduit 4 is provided for the discharge of the medium to the engine or to the source of heat. A temperature bulb 5 and thermostatic valve 6 accurately and adjustably regulate the temperature within the vaporization chamber, thereby determining the extent of gaseous phase separation. The vaporization temperature must be carefully controlled to prevent any possibility of vapor evolution occurring in the carburetor. The higher than normal vapor pressure fuel is fed to the system from a pressure storage tank, not shown, through the conduit 7 and first stage pressure regulator 8, which reduces the fuel pressure from that existing in the tank to slightly above atmospheric pressure. I prefer to maintain the vaporizer pressure at approximately 3 to 3½ pounds per square inch. The vaporizer is equipped with a float 9 which is fixed to a shaft 10 rotatably mounted on the inside of the vaporizer. A control valve 11 is so mounted with respect to the float as to accurately throttle the fluid flow through control conduit 12 in accordance with liquid level within the latitude of float movement. The stem of the valve may be pivoted a short distance from shaft 10 for the proper leverage, while the control valve per se projects into the end of the fluid control conduit 12 and regulates the pressure impressed on the butterfly governor 13. A dual carburetor, shown generally at 14, is provided with a liquid and gaseous phase mixing chamber 15 which communicates with the intake manifold 16 of the internal combustion engine. A conventional throttle valve 17 is disposed in the flow connection between the mixing chamber and the intake manifold. The dual carburetor is provided with gaseous and liquid phase carbureting intake tubes 17 and 18, respectively. Liquid is supplied to the liquid phase carbureting intake tube provided with the usual venturi from a conventional liquid float chamber shown generally at 19, which is fed liquid phase fuel from the vaporization chamber through a conduit 20. The upper part of the vaporization chamber communicates with the gaseous carbureting tube 17 through the conduit 21, zero pressure regulator 22 and conduit 23. The zero pressure regulator is adapted to reduce the pressure of the gaseous fuel from that existing in the vaporizing chamber to a suitable pressure and is adjusted to permit flow at slightly below atmospheric pressure in response to pressure reduction in the gaseous carbureting tube which is equipped with a conventional venturi, shown in dotted lines. The gaseous and liquid carbureting tubes are provided with butterfly valves 24 and 25, respectively, which are mounted on a common shaft 26 at an angle of approximately 90 degrees to each other. If desired, the butterfly valves may be at an angle somewhat less than 90 degrees, proportioning the flow ratio between intermediate limits. The butterfly governor is provided with a diaphragm 27 which is exposed to a positive or negative variable pressure communicated to the compartment 27A through the control conduit 12 and bleed-off line 32, respectively. The governor is provided with a stem 28 fixed at one end to the diaphragm and has an adjustable coil spring 29 which tends to maintain the diaphragm in its upper position opposing subatmospheric pressure from the control line. The stem 28 has a rack 30 secured to its opposite end which meshes with a pinion 31 attached to the extended end of butterfly valve shaft 26. It is obvious that a system of levers or other device may replace the rack and pinion arrangement. Likewise, a piston and cylinder may be employed in place of the diaphragm governor shown in the drawing without affecting the operation.

The conduit 12 leading to compartment 27A in the butterfly governor 13 is provided with a bleed-off line 32 which is connected to the mixing chamber through a shut-off 33. The shut-off is provided with a valve 34, the stem of which is loosely guided in a passage 35 to allow gaseous flow therethrough and connected with a diaphragm 36. The valve 34 is maintained in closed position at standstill by an adjustable tension spring 37 connected to the underside of the diaphragm. The passage 35 in the shut-off communicates with a compartment 38 which is in turn connected with the mixing chamber 15, as shown, or alternatively with the manifold 16 of the dual carburetor by a conduit 39. A needle valve or fixed orifice 40 is provided in the conduit 32 between the shut-off valve and the control line. The restriction provided by the needle valve 40 is so adjusted that sufficient pressure or vacuum may be communicated to the compartment 27A to properly position the butterfly valves for various positions of the control valve 11. In other words, the control valve must be able to impress a sufficient pressure on the butterfly governor diaphragm to move the gaseous and liquid phase valves to their extreme open positions, respectively. By suitable regulation of the pressure regulator 8 or other regulative means if an outside source of fluid pressure is employed, a sufficient fluid pressure may be available to obtain proper operation of the butterfly governor.

In operation when the engine is started, higher than normal vapor pressure fuel is led from a storage tank, not shown, through conduit 7, first stage regulator 8, and into vaporizing chamber 1. Thermostatic valve 6 is adjusted to the proper vaporization temperature under normal running conditions in order to insure sufficient vaporization of "light ends" from the fuel to avoid the occurrence of vapor lock in the liquid carburetor. Separation of the higher than normal vapor pressure fuel into liquid and gaseous phases takes place in the vaporizing chamber, the liquid phase flowing to the liquid carburetor through the line 20 and the gaseous phase to the gaseous carburetor tube through conduit 21, zero regulator 22, and conduit 23 in accordance with the setting of the butterfly valves. Shut-off 33 is opened by suction from the manifold. A very small portion of the gaseous phase separated in the vaporizing chamber passes through the conduit 12 to the butterfly governor 13 and through the bleed-off 32, shut-off 33 and conduit 39 to the carburetor, the amount depending on the position of the control valve 11 as determined by the relative rate of liquid versus gaseous phase consumption as previously described. The relative flow of liquid to gaseous phase fuel to the engine intake manifold is controlled by the relative position of the butterfly valves 24 and 25 which is altered in accordance with conditions prevailing in the vaporizing chamber. That is, the valve controlling the flow of liquid fuel will be opened when a surplus of liquid phase accumulates in the vaporizing chamber and when the liquid level is low, indicating an increase in the relative rate of liquid phase consumption, needle valve 11 allows increased flow of control fluid to the butterfly governor 13, valve position then being altered to increase the flow of gaseous phase to the intake manifold and decrease the flow of liquid phase. It is found, however, that under normal operating conditions a balanced relationship will exist between the flow of liquid and gaseous phase fuel to the engine, the butterfly valves then assuming an intermediate position while the control valve 11 is partially open to exert a nominal pressure on the butterfly governor diaphragm. A continuous but small flow of fluid then takes place through the bleed-off 32, needle valve 40, compartment 38, valve 34, and conduit 39 to the carburetor. A sufficient differential under these conditions exists across the needle valve 40 to enable sufficient pressure to be built up in the butterfly regulator to cause the butterfly valves to assume an intermediate position. It is obvious that the adjustment of the needle valve 40 will depend on fluid pressure in the vaporizing chamber or other supply source as well as the pressure requirements for proper movement of the butterfly valves.

As previously stated, the conduit 39 may be connected into the mixing chamber 15 above the throttle valve. By connecting into the mixing chamber or the manifold a sub-atmospheric pressure is provided to dispose of the control fluid from the control system.

Obviously, the arrangement herein shown and described constitutes but a single embodiment and various changes in design and structure of the apparatus may be made without departing from the spirit of the invention. For example, other proportioning means may be employed in place of the biased valves shown.

Having thus described my invention, I claim:

1. An internal combustion engine charge-forming device for utilizing hydrocarbon fuels at least certain components of which possess super-atmospheric vapor pressure comprising a vaporization chamber having a float wherein, on pressure reduction, vaporization of the high pressure components of said fuel takes place to form a liquid fuel and a gaseous fuel, carbureting means for the liquid fuel and carbureting means for the gaseous fuel, a fuel-air intake tube connecting the gaseous carbureting means with the engine and a fuel-air intake tube connecting the liquid fuel carbureting means with the engine, passages for each of said fuels connecting the vaporization chamber with each carbureting means whereby liquid and gaseous fuel flow from the vaporization chamber is induced in accordance with air flow through said carbureting means, a valve in each

of the intake tubes between the carbureting means and the engine to control the air flow and thereby the fuel flow through the respective intake tubes, 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 flow induced by air flow through the carbureting means and said valves connected through operating means which operating means is actuated by vapor pressure from the vaporization chamber, the float in the vaporization chamber rising upon an increase in the liquid level in the vaporization chamber to dampen the flow of vapor to the operating means which in turn actuates the operating means to open the valve in the liquid carburetor further and at the same time close the vapor carburetor valve an equal amount.

2. An internal combustion engine charge-forming device for utilizing hydrocarbon fuels at least certain components of which possess superatmospheric vapor pressure comprising a vaporization chamber having a float wherein, on pressure reduction, vaporization of the high pressure components of said fuel takes place to form a liquid fuel and a gaseous fuel, carbureting means for the liquid fuel and carbureting means for the gaseous fuel, a fuel-air intake tube connecting the gaseous carbureting means with the engine and a fuel-air intake tube connecting the liquid fuel carbureting means with the engine, passages for each of said fuels connecting the vaporization chamber with each carbureting means whereby liquid and gaseous fuel flow from the vaporization chamber is induced in accordance with air flow through said carbureting means, a valve in each of the intake tubes between the carbureting means and the engine to control the air flow and thereby the fuel flow through the respective intake tubes, 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 flow induced by air flow through the carbureting means, means maintaining a substantially constant pressure in the vaporization chamber, and said valves connected through operating means which operating means is actuated by vapor pressure from the vaporization chamber, the float in the vaporization chamber rising upon an increase in the liquid level in the vaporization chamber to dampen the flow of vapor to the operating means which in turn actuates the operating means to open the valve in the liquid carburetor further and at the same time close the vapor carburetor valve an equal amount.

3. An internal combustion engine charge-forming device for utilizing hydrocarbon fuels at least certain components of which possess a superatmospheric vapor pressure comprising means having a float for separating said fuel into liquid and gaseous fuels, carbureting means for the liquid fuel and carbureting means for the gaseous fuel, a fuel-air intake tube connecting the liquid carbureting means with the engine and a fuel-air intake tube connecting the gaseous fuel carbureting means with the engine, a valve in each of the intake tubes between the carbureting means and the engine to control the air flow and thereby the fuel flow induced by the respective carbureting means, said valves being so connected that when one valve is moved toward closed position, the other valve is moved toward open position to thus vary the relative proportions of liquid and gaseous fuel flow induced by air flow through the respective carbureting means, and said valves connected through operating means which operating means is actuated by vapor pressure from the vaporizing means, the float in the vaporizing means rising upon an increase in the liquid level in the vaporizing means to dampen the flow of vapor to the operating means which in turn actuates the operating means to open the valve in the liquid carburetor further and at the same time close the vapor carburetor valve an equal amount.

4. An internal combustion engine charge-forming device for utilizing hydrocarbon fuels at least certain components of which possess a superatmospheric vapor pressure comprising means having a float for separating said fuel into liquid and gaseous fuels, carbureting means for the liquid fuel and carbureting means for the gaseous fuel, a fuel-air intake tube connecting the liquid carbureting means with the engine and a fuel-air intake tube connecting the gaseous fuel carbureting means with the engine, a valve in each of the intake tubes between the carbureting means and the engine to control the air flow and thereby the fuel flow induced by the respective carbureting means, said valves being so connected that when one valve is moved toward closed position, the other valve is moved toward open position to thus vary the relative proportion of liquid and gaseous fuel flow induced by air flow through the respective carbureting means, means and said valves connected through operating means which operating means is actuated by vapor pressure from the vaporizing means, the float in the vaporizing means rising upon an increase in the liquid level in the vaporizing means to dampen the flow of vapor to the operating means which in turn actuates the operating means to open the valve in the liquid carburetor further and at the same time close the vapor carburetor valve an equal amount.

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