Dec. 25, 1945. G. GERSON 2,391,410

CHARGE FORMING DEVICE

Filed July 14, 1941 5 Sheets-Sheet 1

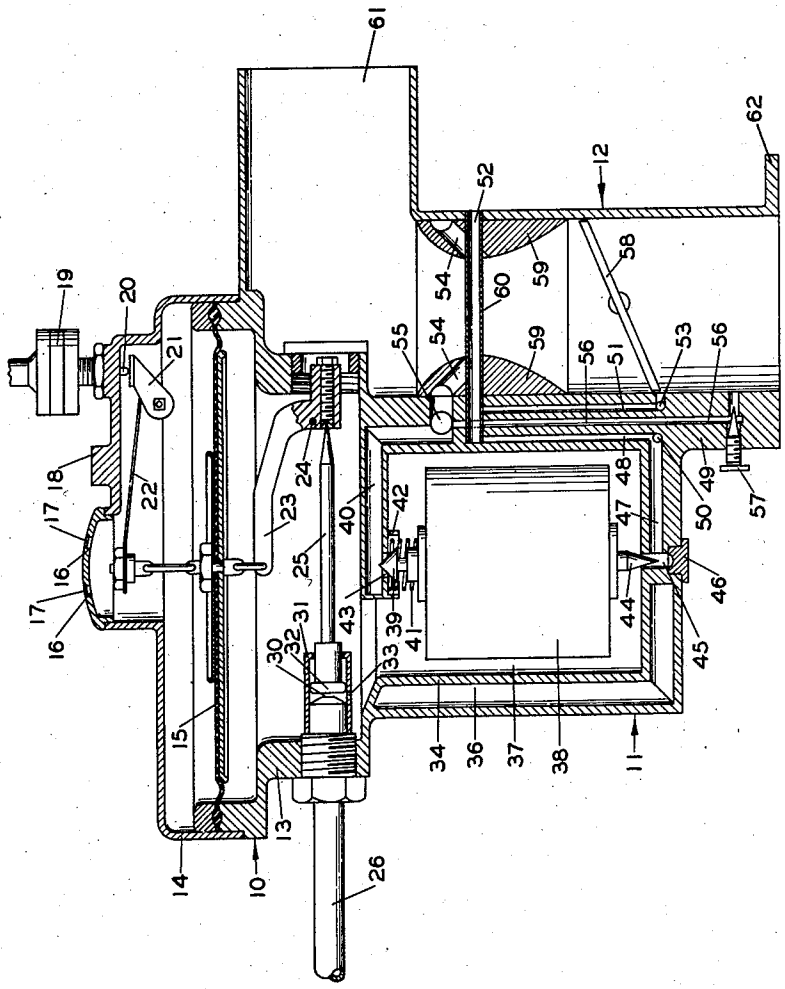


FIG. 1

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CHARGE FORMING DEVICE

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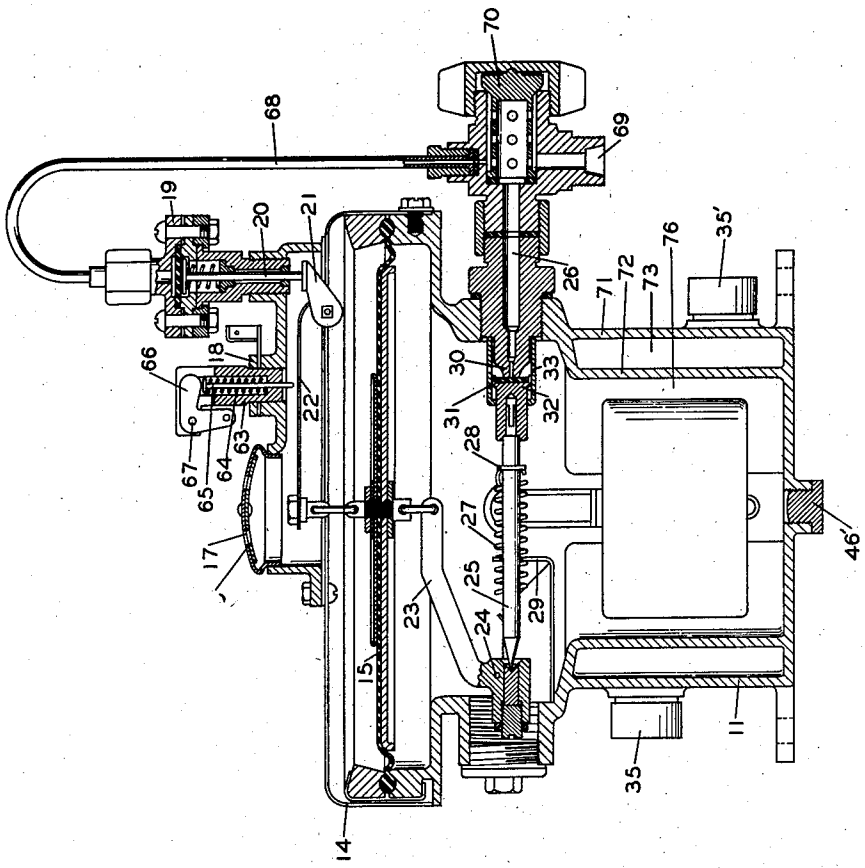


FIG. 2

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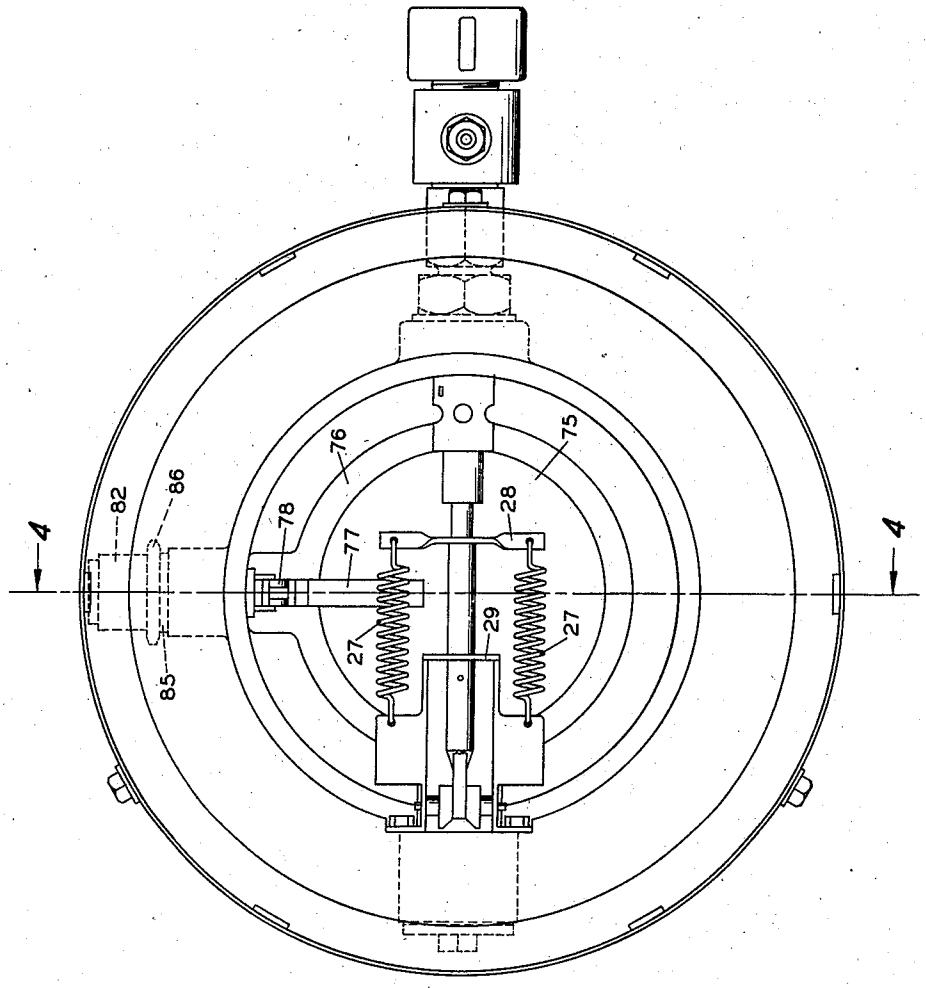


FIG. 3

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CHARGE FORMING DEVICE

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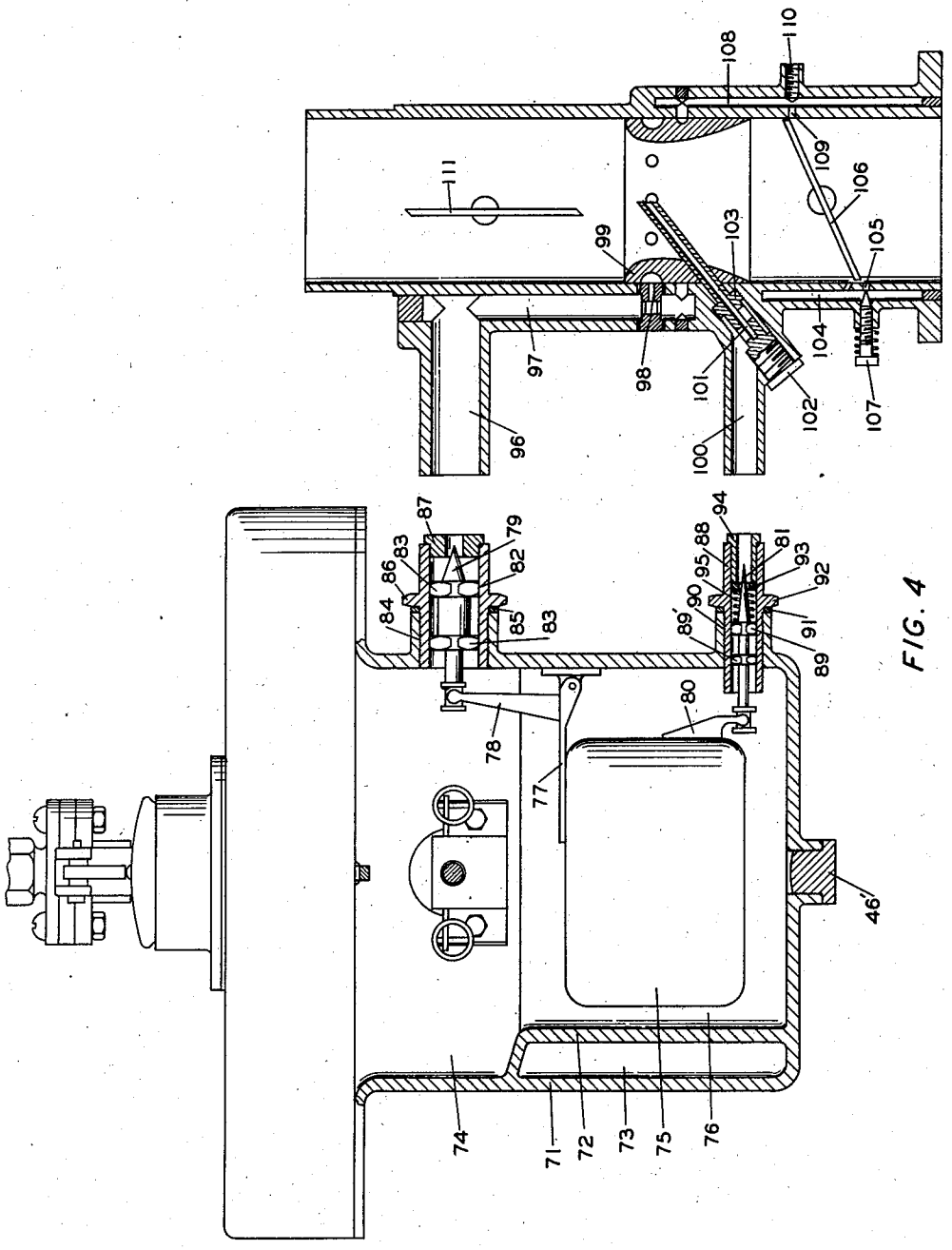


FIG. 4

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CHARGE FORMING DEVICE

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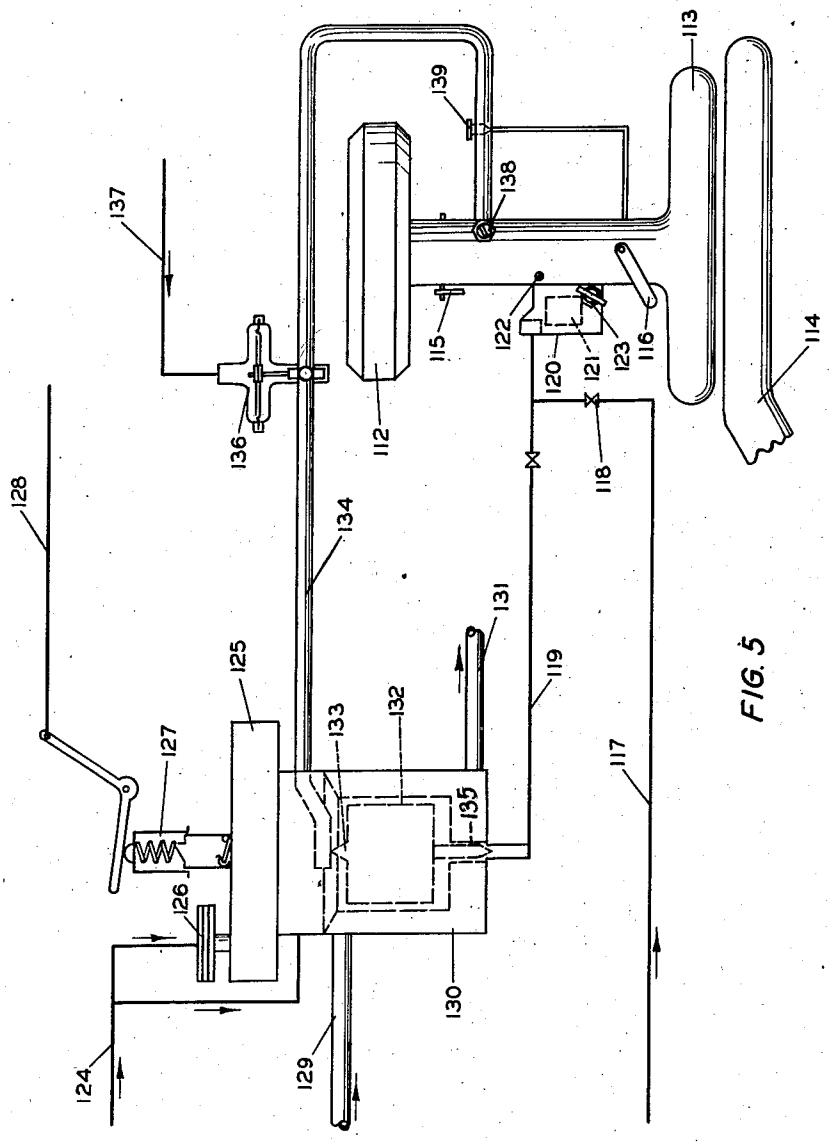


FIG. 5

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UNITED STATES PATENT OFFICE

2,391,410

CHARGE FORMING DEVICE

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Application July 14, 1941, Serial No. 402,417

7 Claims. (Cl. 261—16)

This invention relates to a motor fuel system for wide boiling range condensates. More particularly it relates to a fuel induction method and apparatus for utilizing high or low vapor pressure hydrocarbon compounds or any mixture thereof as direct motor fuels.

An object of the present invention is to provide a method and apparatus for effectively utilizing such compounds as motor fuel for internal combustion engines.

An object is also to provide a fuel system designed to operate not only with butane and fuels of higher vapor pressure, but also operate with fuels of intermediate and low vapor-pressures, such as natural and regular gasolines. These latter will not vaporize completely with the heat ordinarily available and may thus remain in both liquid and vapor form. Therefore the present apparatus is designed to operate with either a liquid fuel, or a gaseous fuel, or any mixture thereof.

An object is to provide a fuel system and apparatus designed to operate efficiently on natural gasolines, for example, 26 pound and 40 pound Reid vapor pressure natural gasolines and the like, in which the fuel consumption is comparable to that obtained in the present standard type of engine operating on regular gasoline.

Another object of this invention is to provide a system in which there is a separation of the fuel into liquid and vapor phases, both being effectively used in the carburetor or gas-air mixer, whereby the vapor may be utilized as an anti-knock compound.

Another object is to provide fuel induction apparatus which will operate with fuels of varying vapor pressures without requiring a manual change of adjustments.

Another object of this invention is to provide a dual feed fuel system for an internal combustion engine consisting of a combined single stage pressure regulator and heated vaporizer and a carburetor adapted to handle liquid and vapor simultaneously where the fuel ranges from propane to heavy motor fuels.

Another object is to provide a relatively simple, compact, and inexpensive system which will be rugged and operate satisfactorily under the usual traffic and weather conditions encountered in driving trucks, buses, or passenger automobiles.

Still other objects and advantages of this invention will be apparent from the following detailed description taken in conjunction with the accompanying drawings, forming a part of this specification, and in which:

Figure 1 is a vertical section, through the pressure regulator, vaporizer, and carburetor of a preferred embodiment of this invention;

Figure 2 is a vertical section, partly in elevation, through the pressure regulator and vaporizer of another embodiment of this invention;

Figure 3 is a plan view of the embodiment shown in Figure 2;

Figure 4 is a side elevation, partly in section, through the embodiment shown in Figure 2 and at right angles to that of Figure 2. This figure also shows a vertical section through another embodiment of the carburetor, aligned opposite the liquid and vapor outlets of the regulator and vaporizer but not directly connected thereto; and

Figure 5 is a diagrammatic section showing a fuel system, incorporating the applicant's invention, adapted to operate with a standard carburetor and using both regular gasoline and natural gasoline for fuel. An accelerating pump, economizer, and air strainer as commonly employed in automotive fuel systems are also shown.

Referring now more particularly to the drawings, in Figure 1 are shown the pressure regulator, vaporizer and carburetor combined as an integral unit. It is to be understood, however, that if preferred, these units may be individual and not integral. The numeral 10 indicates generally the regulator while 11 indicates the vaporizer or vaporizing chamber and 12 the carburetor. Applicant in this embodiment prefers to use a single stage pressure regulator of the type illustrated in his U. S. Patent No. 2,201,894, issued May 21, 1940. It will be seen by reference to this patent and the drawings presented here that the regulator 10 consists of a body casting 13, preferably of aluminum or other similar material. A cover 14 of pressed steel is fitted over the top of the body and encloses the main diaphragm 15 and the interior of the vaporizer. Breathing holes 16 having a screen at 17 are provided in the cover. A connection for an accelerating pump device, if desired, may be machined in the boss 18, provided for that purpose. An auxiliary regulating device or compensator 19 is attached having a pin 20 adapted to be displaced downward and co-act with the lever arm 21 connected with the flat spring 22 which in turn varies the resistance of the main diaphragm 15. This diaphragm is stretched across the top of the regulator and held in place in the usual manner. Linked to the diaphragm on its under side is a lever arm 23 pivotally mounted at 24 and having its lower end so constructed that movement of the arm in a vertical plane causes the valve mechanism 25 to

move horizontally to open or close the fuel inlet 26. The operation of the regulator and valve assembly is fully described in my U. S. Patent No. 2,201,894, issued May 21, 1940.

The construction and operation of this valve mechanism will be more readily understood by reference to Figures 2 and 3 where greater detail is shown. Coiled springs 27 attached to the yoke 28 and the stem guide 29 bolted to the regulator body serve to assure the proper functioning of this valve. Fuel is admitted to the regulator through the inlet 26 and the restricted orifice 30. Flow of the fuel is controlled through the tubular member 31 in which the orifice 30 is placed and in which is slidably mounted head 32 of valve 25. Movement of this valve either closes the orifice by seating head 32 or retracts the head allowing the fuel to flow through the ports 33 into the vaporizing chamber.

Integral with the regulator body 13 is the vaporizer comprising an outer body member indicated generally by the numeral 11 and an inner body member 34. These members are separated and form a heating chamber there between. Connections similar to 35—35', Figure 2, leading from the hot water jacket or exhaust gas manifold of the engine provides for the circulation of the hot water or gas as a heating medium in the annular space 36 between members 11 and 34. A thermostatically governed heat control, not shown, is provided where water from the engine is used to heat the vaporizer to insure raising the water to the proper temperature. It will thus be seen that liquid fuel will flow from inlet 26 and collect in chamber 37 formed on the interior of member 34. Heat transmitted from chamber 36, through member 34, tends to vaporize the liquid. Thus a liquid and a vapor phase of fuel are provided for and may exist within the regulator and vaporizer bodies.

In the embodiment of this invention shown in Figure 1, a float 38 is positioned within chamber 37. On the upper end of the float a needle valve 39 is mounted to control the flow of vapor out of the vapor outlet 40. This needle valve may be of a standard type and has a coiled spring 41 retained by the collar 42 to insure an efficient functioning in opening or closing passage 43 in outlet 40.

On the bottom of float 38 is a needle valve 44 adapted to open or close a liquid outlet passage 45 which is centrally bored through the bottom of the vaporizer chamber. This passage is closed at its lower end by a removable drain plug 46. Horizontally bored through the bottom member is a passage 47 communicating with passage 45 and with a second vertical passage 48 bored in the side wall 49 between the vaporizer and the carburetor. A liquid main adjustment screw 50 is positioned within this wall and adapted to accurately control the flow of liquid through passage 47. This screw projects so that it may be manually adjusted from the exterior of the assembly similar in manner to the way a standard carburetor is adjusted.

A second vertical passage 51 in wall 49 provides for the flow of liquid to the motor for idling. It will be seen from Figure 1 that this passage communicates at its lower end with the interior of the carburetor, just below the throttle valve, and at its upper end, through passage 52, with passage 48. A liquid idling adjustment screw 53 is provided and projects from wall 49 so that it may be manually adjusted from the exterior of the assembly.

As before mentioned needle valve 39 controls the flow of vapor through the main vapor discharge passage 40. This passage at its lower end communicates with the interior of the carburetor through the vapor discharge openings 54. A main vapor adjustment screw 55 is also provided and projects from wall 49 so that a manual adjustment may be made. Where it is found desirable to include an economizer as part of the auxiliary equipment, see Figure 5, one of the connections to the economizer may be made at this point also.

Communicating with the lower end of passage 40, around passage 52, is a smaller vertical passage 56 extending through wall 49 and into the interior of the carburetor below the throttle valve. This passage provides for vapor induction to the carburetor when the engine is operating under idling conditions. A vapor idling adjustment screw 57 is provided and may be manually adjusted to secure the proper flow.

Carburetor 12, as shown in Figure 1, is integral with the vaporizer and regulator. A throttle valve 58 and venturi 59 are provided and are similar to those customarily used in standard gasoline carburetors. Since their operation and construction are well known in the art, it is not further described here. Liquid discharge jet 60 provides a fuel outlet from passage 52 into the interior of the carburetor. Passage 52 as above described provides a common passage communicating with the liquid passages 48 and 51 in wall 49. It should be noted that vapor idling passage 56 does not communicate with passage 52. Air inlet 61 may be connected to an air strainer as shown in the embodiment of Figure 5. The lower end 62 is connected to the engine intake manifold in the usual manner.

Figure 2 of the drawings shows another embodiment of this invention. A device to make starting of the engine easier is shown attached to the regulator at 18. It comprises a tubular plug 63 externally threaded and screwed into the top of the regulator. This plug is centrally bored throughout and adapted to receive a coil spring 64 and a push pin 65 slidably mounted therein. A head on this push pin retains the spring in place and contacts the upper end of lever arm 66. This arm is pivotally mounted at 67 and connected at its lower end in any suitable way to a control wire or rod, and thus may be operated from a distant point such as the cab of a truck. The lower end of push pin 65 extends down to a point above spring 22 and may be depressed sufficiently by lever arm 66 to engage the spring and vary the resistance of the main diaphragm 15. It will thus be seen that this starting device can be used for manually enriching the fuel mixture when starting the engine.

Compensator 19 is also shown in greater detail. Reference to applicant's above mentioned patent should be made for details of the functioning of this device. A connecting conduit 68 connects the compensator and the liquid fuel inlet from the supply tank. Liquid fuel enters at passage 69 and flows through a fuel filter 70 into passage 26 and then through orifice 30 as previously described. The connections and assembly of parts are not further described since they are shown in detail in Figure 2.

Construction and operation of the valve mechanism 25 is similar to that previously described.

In this embodiment, Figures 2, 3 and 4, the vaporizer 11 has an outer wall 71 surrounding an inner wall 72. Hot water from the engine or exhaust gases are circulated by means, not shown,

attached to the connections 35—35' through the annular space 73 between walls 71 and 72. In this way heat is supplied to vaporize the liquid which has collected within the lower part of expansion and vaporization chamber 74 after it flows from orifice 30. A float 75 in the float chamber 76 raises and lowers its position depending upon the liquid level maintained within the float chamber. This movement is transmitted through the pivoted arm 77, contacting the top of the float, and the connecting arm 78 to control the position of the vapor needle valve 79. An arm 80 projecting from the side of the float transmits the float movement to control the position of the liquid needle valve 81.

Vapor needle valve 79 is slidably mounted within an upper projecting tubular conduit or vapor line 82 and held in position by the annular shoulders 83. As shown this vapor line is externally threaded as at 84 to facilitate mountings within the outer wall 71. To prevent leakage a gasket 85 is inserted behind shoulder 86. An interchangeable vapor orifice plate 87 within line 82 cooperates with the needle valve to control the flow of vapor therethrough.

Liquid needle valve 81 is slidably mounted within the lower projecting tubular conduit or liquid line 88. It is held in position by the annular shoulders 89—89' on the needle stem. This liquid line is externally threaded as at 90 to facilitate mounting within wall 71. To prevent leakage a gasket 91 and a shoulder 92 are provided. Cooperating with the needle valve is an interchangeable liquid orifice plate 93 held in position within line 88 by the inserted sleeve member 94. A coiled spring 95 held between orifice plate 93 and shoulder 89 on the valve stem is provided to assure a proper functioning of the valve.

A drain plug 46' is also provided in this embodiment for chamber 76 as shown in Figures 2 and 4.

The carburetor shown in Figure 4 is designed to be connected by suitable conduits or piping to the vapor line 82 and the liquid line 88 of the combined regulator and vaporizer. Line 82 is connected to the vapor inlet passage 96 which communicates through vertical passage 97 with the main vapor jet 98 in the venturi 99. Liquid line 88 is connected to liquid inlet passage 100 which communicates through the liquid discharge jet 101 into the Venturi chamber. Flow through this jet is controlled by means of the adjustable head piece 102 co-acting with an inner sleeve 103. Liquid for idling purposes is provided through vertical passage 104 which has an outlet port 105 entering below the main throttle valve 106. Flow through this port may be controlled by means of the adjustable screw 107 having a needle point cooperating with the port. Vapor for idling purposes enters through passage 108 and port 109 being controlled by means of an adjustable screw 110 cooperating with the port. A choke butterfly 111 completes this carburetor assembly.

Figure 5 shows one embodiment of the invention arranged to operate with a standard combination carburetor designed for propane-butane and regular gasoline. This type of combination carburetor is manufactured by the Ensign Carburetor Company, State of California, and in ordinary use is intended for use with either a gaseous or liquid phase fuel. In accordance with my invention, however, both liquid and gaseous fuel may be, and ordinarily are simultaneously carbureted in the device. A carburetor of similar design is illustrated in Figure 4. The liquid side of the device shown in Figure 5, however, is provided with a float chamber of conventional design to alternately permit operation on regular gasoline. The carbureting means, as shown, is well known and in itself forms no part of my invention. The air strainer 112 for the air intake, the intake manifold 113, and the exhaust manifold 114 for the engine are the conventional equipment. A choke lever 115 and a main throttle lever 116 are also provided. Regular gasoline flows from a supply tank through inlet line 117, valve 118 into liquid line 119 and then into chamber 120. A float 121 in this chamber controls this flow in the usual manner. Liquid idling adjustment screw 122 and liquid main adjustment screw 123 are provided to obtain the proper flow. Natural gasoline, propane, butane, or the like flows from a supply tank through fuel inlet line 124 to the vaporizer and regulator unit 125 as described above in connection with Figures 1 and 2. A compensator 126 and accelerating pump device 127 connected by means of rod 128 to the accelerator lever are also shown connected to the regulator. The accelerating device 127, as shown in Figure 5, comprises an inverted spring pressed cup which is adapted to be depressed on actuation of the throttle and apply air pressure to the top of the regulator diaphragm 15 through a back pressure valve, not shown, to open valve 32 and form a rich mixture during acceleration. The operation of this device, however, is not material to my invention. Water or exhaust gases from the engine for heating the vaporization chamber in the regulator flow through pipe 129 into the outer chamber or jacket 130 and out through pipe 131. Float 132 having needle valve 133 to control the vapor passing through the vapor and suction line 134 and needle valve 135 to control the flow of liquid out through line 119 is mounted within the vaporization chamber of regulator 125. An economizer 136 having a conduit 137 connecting it to the intake manifold may be used in vapor line 134 to enrich the mixture under certain comparatively high pressure conditions in the intake manifold, for instance, when climbing a hill at low speed and fully opened throttle. The device includes a diaphragm which controls the movement of a valve in vapor line 134. The device acts as an economizer in restricting the vapor flow to form a normal or lean air-vapor mixture at certain low pressure conditions in the intake manifold. A main vapor adjustment screw 138 and a vapor idling adjustment screw 139 are also provided for the usual control purposes.

It is to be understood in connection with the Figure 5 embodiment that inlet line 117 is not essential, but preferred only, and that regular gasoline can be fed through inlet line 124 if desired. In doing so, regular gasoline would flow through the regulator-vaporizer unit to the carburetor in the same way the natural gasoline does. It will also be obvious to those skilled in the art that the fuel tanks and unit 125 must either be placed sufficiently high, in relation to the carburetor, to insure gravity flow of fluid thereto or an ordinary fuel pump must be used in connection with line 119 to secure the proper flow of fuel into the carburetor.

The operation of my invention will now be described in connection with the assembled system shown in Figure 5. Natural gasoline or mixtures of gasoline and liquefied gases coming from the supply tank directly or through a fuel pump enter

the single stage regulator 125 when the diaphragm governed regulator valve 32, as shown in Figure 1, opens by the suction of the engine, this valve automatically shutting off the fuel flow when the engine is not operating. The fuel wholly or partly vaporizes in the expansion and vaporization chamber of the regulator. From there the vaporized fractions flow through the upper vapor outlet line 134 to the openings in the venturi and from there with the air stream into the intake manifold of the engine. The liquid fractions collect in the lower part of the float chamber 132 which forms a part of the expansion and vaporization chamber, and are heated by circulating water or exhaust gases from the engine passing through the outer chamber or jacket 130 surrounding the float chamber. Liquid not vaporized remains in the float chamber and raises the float thereby opening the lower liquid outlet passage and closing the upper vapor outlet. Liquid in the float chamber may then flow through the open passage 119 to the discharge jet in the venturi and from there into the air stream into the engine.

Since the variable orifice 43 as shown in Figure 1 in the vapor line is chosen large enough to charge the cylinders with the right gas-air mixture when only vapor is available, a needle valve 133 is provided which limits the gas quantity according to the float position. A needle valve 135 in the liquid similarly limits the liquid flow, thus the proportion of vapor and liquid feeding the engine depends first on the position of the float, which governs the two needle valves according to the quantity of non-vaporized liquid fuel in the float chamber, and second upon the fact that the liquid jet in the venturi discharges the less fuel the lower the liquid level is in this jet. When the float chamber is filled with liquid to such an extent that the needle valve 133 in the vapor line is shut off, the needle valve 135 in the liquid line 119 opens the full orifice. This results in shutting off the regulator valve, since the vapor outlet is closed the suction from the carburetor cannot act on the main diaphragm 15 to admit more fuel through valve 32 until the pressure in the vaporization chamber again drops below the regulator outlet setting. A slight pressure may be built up due to a temperature rise in the regulator vaporization chamber since vaporization of the incoming liquid fuel does not take place anymore, which will in addition to the force exerted by the flat spring 22 push diaphragm 15 upward thereby causing head 32 of valve 25 to close orifice 30. No liquid from the fuel supply tank can then enter the regulator until sufficient liquid from the float chamber has been used by the engine to lower the float, opening the needle valve in the vapor and suction line. Simultaneously, the pressure, if any, in the regulator will be released and the suction will reopen the regulator inlet valve 32.

Tension of the flat spring 22 in the regulator is adjusted when the engine is not running so as to just shut off the regulator inlet valve 32 against the inlet fuel pressure, since the suction acting on the diaphragm with starting and idling speed as well as with wide open throttle and low speed is extremely small. If this tension is greater than necessary to overcome the inlet pressure the valve will not be opened with low suction. It is thus apparent that the regulator functions to maintain a substantially constant pressure in the vaporizer, irrespective of the degree of suction communicated thereto from the carburetor induced by air-flow to the engine. As previously stated, vapor control valve 133 is shut off as the liquid valve 135 opens the full orifice to line 119. It is obvious, therefore, from the foregoing description that, for intermediate positions of valves 133 and 135, the total fuel flow induced into the carburetor by air-flow will be composed of various intermediate proportions of liquid and gaseous fuel. Since the pressure in the vaporizer is substantially constant, the total fuel flow will always be a function of the air flow due to the degree of suction in the carburetor.

The auxiliary regulating device or compensator 126 prevents starting and idling difficulties or having the fuel mixture too lean under full load low speed conditions, where the tension of the spring 22, Figure 2, has been adjusted for a high vapor pressure fuel, and another fuel of low vapor pressure is used. A conduit 68 from the fuel inlet line 124 of the regulator transmits the inlet pressure to the auxiliary diaphragm. The pin 20 connected to this diaphragm acts on the regulator spring and decreases its tension when the inlet pressure is low and increases the tension when fuel of higher vapor pressure is used. This device not only prevents irregularities under starting or idling conditions but makes possible the use of most of the gaseous remainder in the supply tank after the liquid is used regardless of the decreasing inlet pressure.

While applicant has described specific embodiments, it is to be understood that the form of this invention, herewith shown and described, is a preferred example of the same and that various modifications may be made therein without materially departing from the spirit of this invention as defined by the appended claims.

I claim:

1. A charge forming device for utilizing hydrocarbon fuel, at least certain components of which possess a superatmospheric vapor pressure, comprising a vaporization chamber wherein, on pressure reduction, vaporization of the high pressure components of said fuel to form a gaseous fuel portion and a liquid fuel portion takes place, means maintaining a substantially constant pressure in the vaporization chamber, carburetion means for said gaseous and liquid fuel portions, a passage for the gaseous fuel portion and a passage for the liquid fuel portion leading from the vaporization chamber to the carburetion means, whereby fuel flow is induced in accordance with air-flow through said carburetion means, a float for said vaporization chamber, a valve for each of said passages operably connected with said float for controlling the flow of liquid and gaseous fuel portions to said carburetion means in accordance with the liquid level in said vaporization chamber.

2. A charge forming device for utilizing hydrocarbon fuel, at least certain components of which possess a superatmospheric vapor pressure, comprising a vaporization chamber wherein, on pressure reduction, vaporization of the high pressure components of said fuel to form a gaseous fuel portion and a liquid fuel portion takes place, means maintaining a substantially constant pressure in the vaporization chamber, carburetion means for said gaseous and liquid fuel portions, a passage for the gaseous fuel portion and a passage for the liquid fuel portion leading from the vaporization chamber to the carburetion means, whereby fuel flow is induced in accordance with air-flow through said carburetion means, a float for said vaporization chamber, a valve for

each of said passages operably connected with said float one of said valves being opened as the other valve is closed.

3. A charge forming device for utilizing hydrocarbon fuel, at least certain components of which possess a superatmospheric vapor pressure, comprising a vaporization chamber wherein, on pressure reduction, vaporization of the high pressure components of said fuel to form a gaseous fuel portion and a liquid fuel portion takes place, means maintaining a substantially constant pressure in the vaporization chamber, carburetion means for said gaseous portion and said liquid portion, whereby fuel flow is induced in accordance with air-flow through said carburetion means, means for proportioning the relative flow of the gaseous portion and the liquid portion to the carburetion means, said means being controlled by the liquid level in the vaporization chamber.

4. A charge forming device for utilizing hydrocarbon fuel, at least certain components of which possess a superatmospheric vapor pressure, comprising a vaporization chamber wherein, on pressure reduction, vaporization of the high pressure components of said fuel to form a gaseous fuel portion and a liquid fuel portion takes place, means maintaining a substantially constant pressure in the vaporization chamber, carburetion means for said gaseous portion and said liquid portion, whereby fuel flow is induced in accordance with air-flow through said carburetion means, means for proportioning the relative flow of the gaseous portion and the liquid portion to the carburetion means, said means being controlled by the liquid level in the vaporization chamber and means for controlling the temperature of the vaporization chamber.

5. A charge forming device according to claim 3 wherein the means maintaining a substantially constant pressure in the vaporization chamber includes a fuel inlet and a regulating valve associated therewith said valve being responsive to changes in pressure within the vaporization chamber and controlling the passage of fuel thereinto.

6. A charge forming device according to claim 3 wherein the means maintaining a substantially constant pressure in the vaporization chamber includes, a spring controlled diaphragm means responsive to changes in pressure in said vaporization chamber, a fuel inlet to said vaporization chamber, valve means associated with said fuel inlet and controlled by said diaphragm regulating the admission of fuel into the vaporization chamber, and an auxiliary regulating device in direct communication with the fuel inlet and controlled by the pressure of the fuel therein automatically regulating the tension of the spring controlling the diaphragm according to variations of pressure of said fuel at the said inlet.

7. A charge forming device according to claim 3 wherein the means maintaining a substantially constant pressure in the vaporization chamber includes a diaphragm forming two compartments therein, spring means controlling the movement of said diaphragm and an auxiliary spring tension adjusting means in the first of said compartments, a fuel inlet means and a valve associated therewith in the second of said compartments, said valve being associated with said diaphragm and responsive to the movement thereof controlling the flow of fuel through said inlet, said vaporization chamber being in communication with said second compartment.

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