

May 27, 1952

E. H. SHAFF

2,598,450

CARBURETOR

Filed June 9, 1938

3 Sheets-Sheet 1

FIG. 1

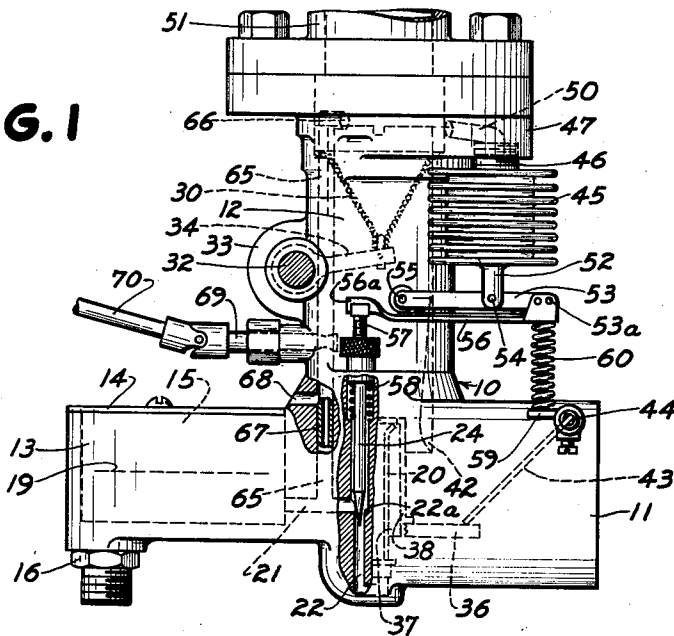


FIG. 2

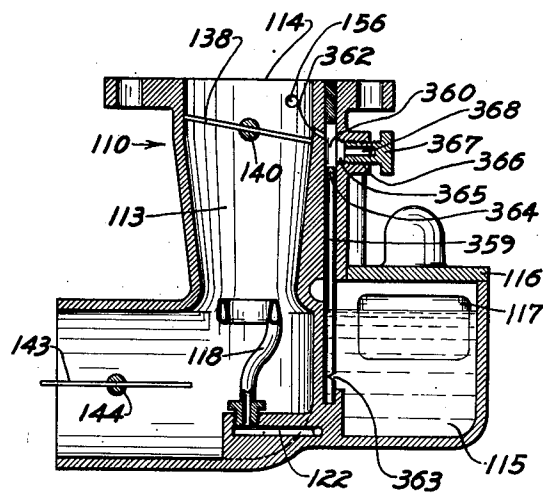
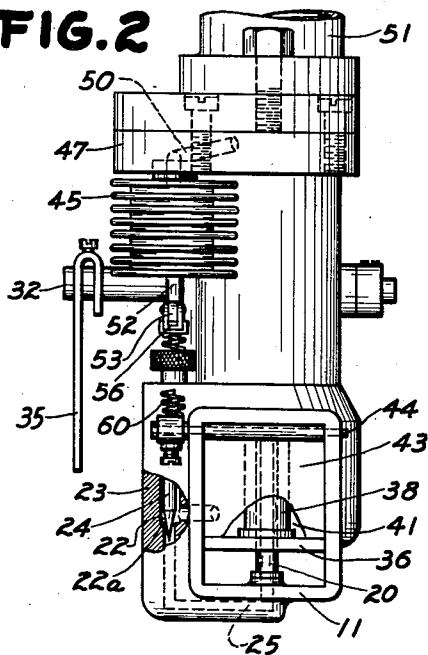


FIG. 6

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FIG. 5

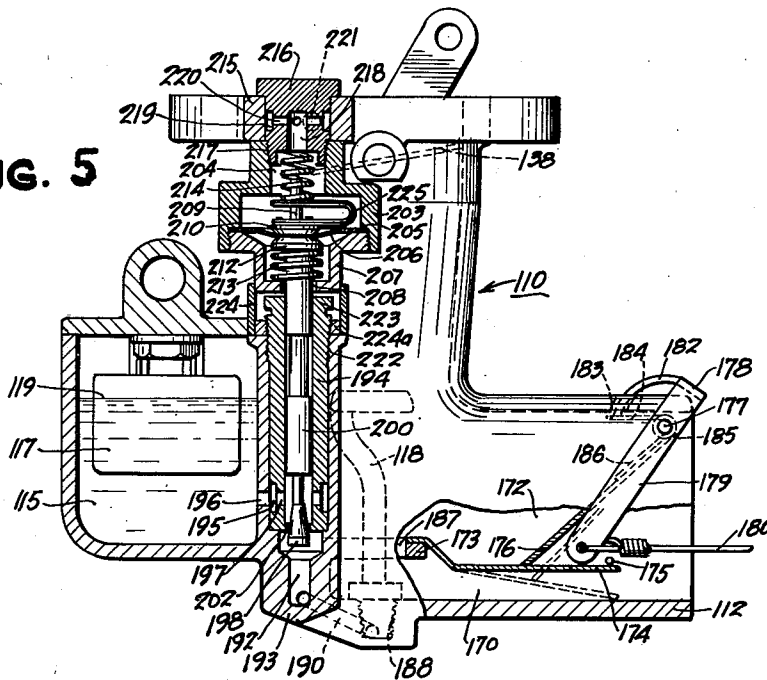
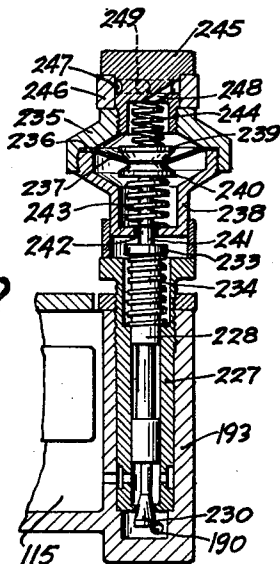


FIG. 7



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2,598,450

CARBURETOR

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Application June 9, 1938, Serial No. 212,738

17 Claims. (Cl. 123—119)

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This invention relates generally to carburetors and more particularly to carburetors adapted for use with internal combustion engines such as are used in automobiles. The present application discloses certain subject-matter common to my applications Serial No. 435,394, filed March 13, 1930, issued December 26, 1944, as Patent Number 2,365,910, and Serial No. 750,758, filed October 31, 1934, issued April 25, 1939 as Patent Number 2,156,128.

In the operation of internal combustion engines, the fuel requirements vary with the heat and speed of the engine and with the load applied thereto, and the general object of the present invention is to provide a carburetor embodying new, improved and automatically operable means whereby such varying fuel requirements may be met with greater precision than has heretofore been possible.

Another object is to provide a carburetor having valve means for controlling the fuel mixture governed through automatic means sensitive to both the suction of the engine and the movement of the air through the carburetor and embodying a thermostatic device arranged to modify the action of the automatic control means according to the temperature of the carburetor.

Another object is to provide an improved fuel regulating device of a unitary character directly operated by suction of the moving engine and adapted to furnish a rich or lean mixture automatically as required.

Other objects and advantages will become apparent from the following description taken in connection with the accompanying drawings, in which:

Figure 1 is a side elevational view of the carburetor, certain of the fuel passages being shown in section;

Figure 2 is an end elevational view taken from the right in Figure 1, with parts broken away to show the interior construction;

Figure 3 is a vertical elevation, partially in section, of a carburetor embodying another form of the invention;

Figure 4 is a sectional view taken on the line 4—4 of Figure 3;

Figure 5 is a side elevation, partially in section, of a carburetor embodying another form of the invention;

Figure 6 is a transverse sectional elevation through the carburetor showing a modified idle arrangement; and

Figure 7 is a fragmentary sectional elevation of a modified form of fuel regulating means.

While I have shown in the accompanying drawings and will herein describe in detail the preferred embodiment of the invention together with several alternative embodiments thereof, it is to be understood that this disclosure is given for the purpose of illustrating the invention and is not intended as a limitation of the invention to the constructions disclosed. In the appended claims, I aim to cover all modifications and alternative constructions falling within the scope of the invention.

In the embodiments illustrated in Figures 1 and 2, the invention is illustrated as embodied in a carburetor having a hollow body 10 providing an L-shaped passage made up of a horizontal air-intake portion 11 communicating with a vertical mixing and outlet portion 12. On the side opposite from the intake portion 11, the body 10 has an upwardly opening cup-like reservoir 13, closed by a removable plate 14 and providing a float chamber 15 for containing a supply of liquid fuel. A nipple 16, screwed into the bottom of the reservoir 13, forms a fuel inlet which may be connected to the supply tank (not shown). Float controlled valve means of known construction (not shown) serves to maintain the fuel at a constant level indicated by the dotted line 19 in Figure 1.

Within the L-shaped passage of the carburetor a fuel discharge member 20 is mounted which receives liquid fuel from the float chamber 15 through a passage composed of a horizontal bore 21 extending angularly through the body 10 from the chamber 15 to a vertical bore 22 extending downwardly through a vertical rib 23 on the intake portion 11. The upper end of the bore 22 opens at one side of the vertical outlet portion 12 of the body 10 and a vertically movable needle valve 24 is mounted in the bore 22 for operation from the outside of the body toward and from a seat 22^a in the bore 22 below the end of the horizontal fuel passage 21. In the bottom of the intake portion 11, a transverse bore 25 Figure 2 is provided, connected at its opposite ends to the vertical bore 22 and the fuel discharge member 20. The fuel discharge member 20, preferably of tubular form, is screwed into the bottom of the portion 11 and extends upwardly beyond the fuel level 19.

To control the amount of suction applied to the discharge member 20 and the amount of air drawn past the member, a valve 30 is mounted in the discharge portion 12 of the body 10, above the member 20 and in its preferred embodiment the valve is in the form of a contractile coiled spring (Fig-

ure 1) of conical form, having its closed smaller end extending downwardly into the carburetor. For the purpose of opening the valve the spring is adapted to be extended by means of a transverse rock shaft 32 mounted in a projecting boss 33, and a lever 34 fixed on the shaft 32 and pivotally secured at its end to the pointed end of the valve 30. An operating lever 35 (Figure 2) is fixed on the shaft 32 outside of the body 10.

When the valve 30 is opened air is drawn into the carburetor through the intake portion 11 and preferably the intake is formed so that at least a part of this air will be drawn past the end of the fuel discharge member 20 at a comparatively high velocity so as to draw liquid fuel therefrom and vaporize this fuel. To this end a horizontal division wall 36 is provided in the intake portion 11, spaced upwardly from the bottom thereof and having an opening 37 therein through which the fuel discharge member 20 projects. A vaporizing sleeve 38 screw threaded into the opening 37 in the wall 36, extends upwardly about the member 20 in spaced relation thereto, the sleeve terminating a short distance above the top of the member 20 and being flanged inwardly adjacent the upper end thereof so as to increase the speed of the air moving therethrough.

The primary mixture of fuel and air thus formed may be mixed with a secondary supply of air so as to form a properly proportioned fuel mixture, and such secondary air may be drawn into the carburetor through a passage 41 formed between the division wall 36 and the top of the intake portion 11. Such secondary air passes upwardly about the sleeve 38, and in order to insure proper mixing of the secondary air and the primary fuel mixture, a Venturi sleeve 42 is fixed in the mixing portion of the body 10 so as to project downwardly about the sleeve 38 in concentric spaced relation thereto.

As hereinbefore mentioned, the liquid fuel supply to the fuel discharge member 20 may be varied by the vertically movable needle valve 24, while the secondary air supply may be varied by means such as a flap type valve 43 mounted for pivotal movement in the passage 41 upon a horizontal rock shaft 44. To permit such movement of the valve 43, the intake passage 11 is preferably made of rectangular cross section as shown in Figure 2.

The present invention provides for automatically controlling these two valves 24 and 43 by inter-related means whereby to vary the fuel mixture in accordance with the varying requirements of the engine. To this end suction responsive means in the form of a longitudinally collapsible diaphragm or bellows 45 is mounted externally of the carburetor body 10 for connection with the valves 24 and 43, and is arranged to be contracted by the suction of the engine. The bellows 45 is of the Sylphon type and tends to expand longitudinally. The lower end of the bellows 45 is closed while at its upper end it carries a threaded nipple 46 screwed into an arm 47 projecting horizontally from the top of the portion 12 of the body 10. Thus, the bellows 45 is supported at the side of and parallel to the portion 12. Within the arm 47 a bore 50 is formed extending from the nipple 46 to the inside of the portion 12 above the valve 30 so that the interior of the bellows 45 will be subjected to the suction of the engine when the carburetor is connected to an engine manifold 51.

At its closed lower end the bellows 45 carries a lug 52 to which a lever member 53 is pivoted at 54 intermediate its ends, one of the ends of the lever 53 being pivoted at 55 upon the side of the

body 10. Through the medium of the lever 53 the expansive and contractive movement of the bellows 45 is communicated to the two valves 24 and 43, and this is preferably accomplished by means including a temperature responsive element arranged to modify the effect of the bellows upon one of the valves so as to provide a leaner fuel mixture as the temperature of the engine increases. In the form shown a bimetallic thermostatic element 56 has one end fixed upon the outer end 53^a of the lever 53, while the body of the element extends along the lever and beyond the fixed pivot point 55 thereof. At its movable projecting end 56^a the element 56 overlies an adjustable screw 57 (Figure 1) mounted in the top of the valve 24. The valve 24 is pressed upwardly toward an open position and against the overlying end of element 56 by means of a spring 58 surrounding the valve in a counterbored portion of the bore 22.

It will be seen that the thermostatic element 56 and the lever member 53 function together as a single lever, and that by arranging the element so that the inner end 56^a bends downwardly when heated, the opening of the valve 24 by the lever will be modified and the amount of fuel flowing past the valve will be varied in an inverse relation to the temperature of the engine.

As hereinbefore mentioned, the lever 53 also has an operative connection with the air valve 43. For this purpose a lever 59 (Figure 1) is secured on the end of the rock shaft 44 so as to project substantially horizontally therefrom, beneath the movable outer end 53^a of the lever 53. The lever 59 is arranged so that when the outer end thereof is moved upwardly the valve 43 is opened, and a resilient connection between the outer end 53^a of the lever 53 and the lever 59 is provided by an expansive spring 60 suitably secured to the two levers.

Thus when the bellows 45 is expanded due to a low degree of suction in the manifold, the outer end 53^a of the lever 53 will be in its lowest position so as to compress the spring 60. During idling or periods of slow engine operation, such compression of the spring 60 will hold the air valve 43 closed so that sufficient air will pass through the sleeve 38 to insure proper operation of the carburetor. However, when the engine is being operated at high speed, with the valve 30 open, the spring 60 will be compressed due to the low degree of suction in the manifold, but the yielding connection provided by the spring 60 will permit the air impinging against the valve 43 as it moves toward the bottom of the sleeve 38 to open the valve 43.

By reason of the compression of the spring 60 by the opening of the air valve 43, during such periods of high speed engine operation under a normal load, the outer end 53^a of the lever 53 is forced upwardly against the normal expansive tendency of the bellows 45 so that the inner end 56^a of the element 56 is lowered and the fuel valve 24 closed slightly so as to provide a comparatively lean fuel mixture for such high speed engine operation.

While the above described controlling means automatically provides a fuel mixture of sufficient richness to start an engine under most conditions, an auxiliary, manually controllable fuel supply is preferably provided for use in extremely cold weather. In the form shown a vertical bore 65 is formed in the body 10, extending upwardly from the horizontal bore 21 of the fuel passage through the wall of the body portion 12,

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the bore 65 having a lateral extension 66 at its upper end (Figure 1) whereby it communicates with the manifold above the throttle valve 30. Within the bore 65 a short distance above the fuel level 19, a jet nozzle 67 is positioned and a horizontal bore 68 extending through the body 10 from the bore 65 to the exterior of the body permits air to be drawn into the vertical bore past the nozzle so as to draw fuel therefrom. The operation of the auxiliary fuel nozzle 67 is controlled by a rotatable horizontal valve member 69 positioned in the bore 65 above the air inlet 68 and operable by a rod 70 universally connected thereto. The provision of an auxiliary fuel discharge means, controllable independently of the automatic means is of great importance since it renders it unnecessary to disturb the fine adjustment of the automatic means.

When the engine is cold, the inner end 56^a of the thermostatic element 56 will be at its highest point and the fuel valve 24 will therefore be opened to its greatest extent. As the engine is cranked, very little suction is created in the manifold so that the bellows 45 will remain in its extended position and the fuel valve 24 will be open to its greatest extent. The air valve 43 will also be held in closed position by the action of the spring 60 which is then compressed by the expansion of the bellows 45. All of the air passing into the carburetor will therefore pass through the sleeve 38 and will be effective in drawing fuel from the discharge member 20.

As soon as the engine begins firing, it will turn over more rapidly, thereby increasing the degree of suction in the manifold and acting through the bellows 45 to move the fuel valve 24 to its idle position so as to reduce the amount of fuel available and thus provide for a fuel mixture suitable for idling. It will be understood that the throttle valve 30 will normally be maintained in a slightly opened position to permit the passage of a small amount of fuel for idling purposes. The adjusting screw 57 may be utilized for varying the idling mixture. Since the bellows 45 is contracted during idling of the engine, the spring 60 will be under less compression so that the air valve 43 may be slightly opened by the air passing toward the lower air passage in the intake portion 11. This permits more air to be drawn through the carburetor, but a less amount of air is drawn through the vaporizing sleeve 38 and as a result the fuel mixture will be rendered more lean.

When the car is placed in gear and the clutch engaged so as to put the engine under load, the engine speed of course, is reduced with a corresponding reduction in the engine suction. This permits the bellows to expand, causing the fuel valve 24 to be moved toward its open position and the air valve 43 to be closed. Thus a rich fuel mixture is provided as above described with reference to the engine starting operation.

As more speed is desired, the accelerator is advanced so as to open the throttle valve 30, whereby additional air is permitted to enter the manifold, causing the suction therein to be further reduced so that the bellows 45 may expand and open the fuel valve.

As the car gets underway, the rich fuel mixture becomes unnecessary. Accordingly as the speed of the engine increases, an increased amount of air is drawn into the carburetor. This additional air impinges against the air valve 43 and tends to open it against the compression of the spring 60, and acting through the lever 53

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tends to close the fuel valve slightly. Such an action is, of course, desirable since the increased velocity of the air passing the fuel discharge member tends to draw an undue amount of liquid fuel therefrom. As the temperature of the engine increases, the action of the thermostatic element 56 modifies the effect of the bellows 45 so that the fuel mixture is rendered more lean. When the desired speed determined by the setting of the throttle valve 30 has been attained the amount of air which may be drawn through the valve will have reached the maximum and the engine suction will increase so as to contract the bellows 45. Thus the fuel valve 24 will be moved slightly toward closed position so that a relatively lean fuel mixture will be supplied for maintaining the speed attained.

In Figures 3 to 7, the invention is illustrated as embodied in a carburetor having a hollow body 110 providing an L-shaped passage constituting a horizontal air inlet 112 communicating with a vertical mixing chamber 113 having a discharge outlet 114. Opposite the inlet 112, the body 110 has an upwardly opening fuel reservoir 115 closed in any suitable manner as by a plate 116 and adapted to contain a supply of liquid fuel. Fuel is delivered to the reservoir 115 in any well known manner from a fuel tank (not shown), and the usual float 117 serves to maintain the fuel at a constant level relative to the top of a fuel discharge member 118, as indicated at 119 in Figures 3, 5 and 6. This carburetor is of the type wherein engine suction is utilized in controlling the flow of fuel to the discharge member, for securing at all stages of operation the fuel-air proportion best calculated for efficient, smooth running of the engine; and novel suction responsive means, presently to be described, furnishes the necessary fuel control.

Within the inlet 112, a horizontally extending projection 120 provides a base for a fuel discharge member or nozzle 118, of any suitable type, fuel being supplied thereto from the float chamber 115 through a horizontal passage 122 communicating with the chamber through a port 123 and a vertical bore 124 formed in a vertically extending member 125 providing a chambered container for the suction responsive fuel control means disposed exteriorly of the body 110 adjacent the reservoir 115. While the member 125 may be formed as a separate unit secured in any desirable manner to the body 110, as a matter of practical expediency it is preferably formed as an integral part thereof as is also the reservoir 115. As shown, the member 125 may be formed conveniently at one side of the juncture of the reservoir 115 with the body 110 (Figure 4).

Within the bore 124 there may be fitted a bushing 126 which is adapted to slidably receive a valve stem 127 having at its lower end a reduced portion 128 carrying a valve 129. This valve may be of frusto-conical shape and is adapted to engage with a valve seat 130 at the lower end of the bushing 126. In the outer wall of the bushing 126 is an annular channel 132, and ports 133 communicate with the interior of the bushing adjacent the reduced portion 128 of the valve stem to permit the passage of fuel from the float chamber 115 past the valve 129 when the latter is open. Where the member 125 is formed of a material that may be bored to form a smooth, true bearing surface, the bushing 126 may, of course, be dispensed with.

In its lower part the mixing chamber 113 is formed as a Venturi tube 137 and the fuel nozzle

118 discharges at the throat of this tube. The amount of air drawn into the mixing chamber 113 and thereby the amount of suction applied to the fuel nozzle 118 is governed by a throttle valve 138 mounted in the upper part of the mixing chamber 113, a rock shaft 140 being journaled at opposite ends in the wall of the body 110 and having at one end an arm 142 adapted to be connected with the usual control means manipulative by the operator. A conventional choke valve 143 fixed on a rock shaft 144 and operable by a lever 145 connected to manipulative means (not shown) is positioned in the air inlet 112 and may be closed to shut off the inflow of air when an exceptionally rich fuel mixture is desired as when starting the cold engine.

As the engine speed increases there will be a corresponding increase in suction tending to increase the velocity of air issuing into the mixing chamber 113 past the fuel discharge head. This tends to increase the amount of fuel discharged by the nozzle 118 to a degree in excess of engine requirement for economical operation, unless means are provided for controlling the flow of fuel to the nozzle. In the present instance, this control is automatically exercised by the valve 129 which is adapted to restrict the flow of fuel from the reservoir 115 to the discharge member proportionately to the increase in engine suction.

To actuate the valve 129, therefore, I provide means sensitive to the engine suction and connected to the valve stem 127. Thus, a piston 146 is fixed at the upper end of the stem 127 and is reciprocable within a cylinder 147, herein shown as an enlargement of the upper end of the bore 124. Springs 148 and 150 are adapted to exert pressure against the upper and lower faces, respectively, of the piston 146 to maintain the same in a normally neutral position within the cylinder 147, the spring 150 being preferably slightly stronger than the spring 148. In this normal position of the piston the valve 129 will be kept open to permit a relatively free flow of liquid fuel to the passage 122. An adjustable screw plug 152 closes the top of the cylinder and forms a seat for the spring 148, the plug being adjustable to adjust the tension of the spring against the piston to regulate the normal opening of the valve 129 as desired, a lock nut 153 securing the plug in any adjusted position.

Engine suction is adapted to form a vacuum on one side of the piston 146, herein shown as the upper side, whereby the piston will be drawn upwardly in the cylinder 147 and thereby draw the valve 129 toward the seat 130 to control the flow of liquid fuel past the valve. Communication between the body 110 and the cylinder 147 in order to secure the effect of the engine suction is provided herein by a passage 154 in the wall of the body 110 opening into the cylinder through a port 155 and to the interior of the body 110 through a port 156 between the throttle valve 138 and the discharge opening 114.

Temperature changes both of the atmosphere and of the engine affect the degree of vaporization of the fuel and thus affect the quantity of fuel necessary to create a given amount of engine power. The necessary adjustment of the fuel supply to compensate for these variations may be automatically effected by securing a thermostat 157 between the upper side of the piston 146 and the spring 148, the thermostat being of substantially U-shape and of a character to contract when heated to decrease the tension of the

spring 148. Equalizing expansion of the spring 150 will force the piston and thus the valve 129 upwardly to restrict the passage of fuel. Thus, the tension of the springs will be varied in response to temperature changes to secure the proper adjustment of the valve 129.

While the piston 146 is preferably closely fitted to the wall of the cylinder 147, the stem 127 may be relatively loosely fitted in the bushing 126 so as to minimize friction. However, there must be sufficient clearance about the piston to permit movement in the cylinder, in consequence of which a certain amount of air will escape to the part of the cylinder above the piston when the engine suction creates a vacuum. Moreover, upward movement of the piston increases the space therebelow which creates a suction which must be compensated for; or due to the loose fit of the stem 127 some liquid fuel will be drawn into the space below the piston which might, if not otherwise provided for, escape past the piston and be drawn into the carburetor in a relatively unatomized condition and disrupt the smooth, even running of the engine. Hence, a port 158 leading from the space in the cylinder below the piston opens to the upper part of the reservoir 115 to furnish an air relief port and to return any liquid that might escape past the stem 127. A small amount of liquid will, however, cling to the cylinder wall and provide some lubrication for the piston 146 to minimize friction.

At first, I found that the piston 146 would stick in the cylinder 147 due to the close fit necessary for proper operation, in spite of the lubrication provided by the liquid as described. However, I have discovered that by coating the periphery of the cylinder with a substance that will minimize friction this sticking is entirely prevented and a close fit giving improved results is possible. For example, I have found that chromium plating gives excellent results.

The carburetor may comprise an idling system such, for example, as that disclosed in my copending application Serial No. 750,758, filed October 31, 1934, and here shown in Figure 6.

The idling system comprises tube 359 extending upwardly within the reservoir 115 to an auxiliary mixing chamber 360 in the wall of the body 110 adjacent the valve 138. A port 362 forms a communication between the auxiliary chamber 360 and the interior of the body 110 above the valve 138 in its closed position. As high suction is created through the port 362 due to the closure of the mixing chamber 113, fuel will be drawn up through the tube 359 through port 363 and will discharge into the chamber 360 through a restricted nozzle 364. Air must be mixed with the fuel in order to form a combustible mixture and is introduced to the chamber 360 through a bore 365 formed in a boss 366 which is internally threaded to receive a regulating screw 367 having a central slot 368. By manipulating the screw 367 to increase or decrease the exposure of the outer end of the slot 368 accurate regulation of the amount of air for any given condition may be had. Suction through the port 362 simultaneously forcibly draws air through the passage 365 and fuel through the nozzle 364 which will mix thoroughly in the chamber 360 and then pass through the port to the engine through the discharge opening 114.

To summarize briefly, the operation of the carburetor shown in Figures 3 and 4 is as follows:

When the engine is in a quiescent state, the fuel valve 129 will be in its widest open position.

As the engine is cranked, very little suction is created so that the piston 146 will not be moved to any appreciable extent, the spring 148 serving to maintain it near its lowermost position, and the fuel valve will remain fully open. The throttle valve 138 and the choke valve 143 will be adjusted on the usual manner during starting and a rich supply of fuel will be drawn from the fuel nozzle 118 to start the engine.

As soon as the engine begins firing, it will turn over more rapidly, thereby increasing the degree of suction and acting to move the piston 146 and with it the valve 129, the latter being carried toward closed position so as to reduce the amount of fuel available and thus provide a somewhat lean fuel mixture. This result accrues due to the fact that while the amount of fuel passing to the discharge member is restricted, the quantity of air passing the nozzle 118 will remain constant except as controlled by the throttle or choke valves.

In idling the engine, the throttle valve 138 will be closed, resulting in a substantially complete closing of the mixing chamber 113. The full force of engine suction will then operate to close the valve 129 and to draw a supply of fuel sufficient for idling through the idling nozzle or port 362.

When the car is placed in gear and the clutch engaged so as to put the engine under load, the engine speed, of course, is reduced with a corresponding reduction in the engine suction. This, together with the simultaneous opening of the throttle valve, permits the piston to return to its normal position and the fuel valve 129 will be moved toward open position. Thus a rich fuel mixture is provided as above described with reference to the engine starting operation.

As the car gets under way and more speed is desired, the accelerator is advanced so as to further open the throttle valve 138, whereby additional air is drawn through the chamber 113, causing the suction between the throttle valve and the outlet 114 to be further reduced and insuring an unrestricted, rich fuel supply. After the car has reached the desired speed, as determined by the setting of the throttle valve, however, the rich fuel mixture becomes unnecessary. Accordingly, as the amount of air that may be drawn past the throttle valve reaches the maximum, the engine suction will increase and again move the piston 146. Thus the fuel valve 129 will be moved slightly toward closed position so that a relatively lean fuel mixture will be supplied for maintaining the speed attained.

Changes in atmospheric temperature or the engine temperature will also affect the valve 129 through the action of the thermostat 157 which operates to vary the tension of the spring and thereby the normal adjustment of the suction sensitive means, to provide a leaner or richer mixture as necessary.

While the invention has thus far been described in connection with what is known as a "plain tube" carburetor the same may be embodied with equal effectiveness in a carburetor of the "air valve" type as shown in Figure 5. In essential respects the latter form of carburetor is the same as the former except that the air inlet 112 is divided into a plurality of air passages, herein shown as a lower or primary air passage 170 and an upper or secondary air passage 172.

Division of the inlet 112 into the primary and secondary air passages is effected by means of a

relatively short division wall 173 integral with the rear wall of the body 110 and a flexible spring extension 174 secured in any suitable manner to the end of the wall 173 and extending between the side walls of the inlet 112 which may for the purpose be of rectangular shape. The uppermost position of the spring extension 174 is defined by stationary pins 175, and the flexibility of the extension permits its outer end to be bent downwardly toward the lower wall of the inlet when it is desired to close the primary air passage to any extent as in choking the engine to start the same when cold.

For moving the flexible division wall, I provide a flap valve 176 suspended from a shaft 177 extending across the top of the secondary air passage 172 and passing through the side walls thereof. Positioned over the top wall of the inlet chamber and supported at its ends by the outer ends of the shaft 177 is a yoke 178 having as an extension of one end an arm 179 connected as by a rod 180 to any suitable manual operating means. An arcuate downwardly extending finger 182 is carried by the yoke 178 and passes through an aperture 193 in the upper wall of the inlet chamber. The free end of the finger 182 bears against a horizontally extending loop 184 of a spring 185 which is coiled about the shaft 177 and has downwardly extending end 186 bearing against the valve 176. Normally the spring 185 maintains the valve 176 in light abutment against the resilient extension wall 174. However, when the arm 179 is actuated to move the yoke 178 counterclockwise as viewed in Figure 5, the finger 182 will depress the spring loop 184 and place the spring under sufficient tension to urge the valve 176 against the member 174 with force enough to cause the latter to assume the light dotted line position indicated in Figure 5, thereby closing the primary air passage to any desired extent.

Air drawn through the primary passage 170 is directed upwardly through an opening 187 in the division wall 173 past a fuel nozzle 118 of any suitable form, which extends through the opening 187 and is secured in the lower wall of the inlet over a well 188. Thus, the air stream issuing through the opening or port 187 will be effectively concentrated about the nozzle to draw vaporized fuel therefrom most efficiently.

Fuel is delivered to the well 188 through a passage 190 communicating with a vertical bore 192 in a rib portion 193 projecting from the body 110 adjacent the fuel reservoir 115. The upper part of the bore 192 is of enlarged diameter to receive a bushing 194 which has an annular channel 195 adjacent a port 196 in the wall of the reservoir 115. Fuel passing through the port 196 and into the channel 195 may enter the bushing through a plurality of ports 197. For controlling the passage of fluid from the bushing into the bore 192 a valve 198 is secured to a stem 200 slidably mounted within the bushing. Movement of the valve 198 toward or away from a valve seat 202 will thus control the flow of fuel to the fuel discharge member.

Suction responsive means of somewhat different construction than that shown in Figure 3 may be employed for controlling the valve 202. As herein shown, a hood member 203 having a bore 204 is disposed coaxially above the bore 192 and adapted to receive the upper end of the stem 200. Below the bore 204, the body of the hood opens into a space of substantial diameter, and an annular shoulder 205 is formed adjacent the lower edge, providing a seat for a relatively loose dia-

phragm 206 of suitable flexible material, such as a specially prepared air tight fabric, which is secured in place against the shoulder by means of a chambered nut 207. The hood and nut together, it will be observed, form a substantial chamber divided by the diaphragm 206.

The stem 200 passes through an aperture 208 in the nut 207 and has a reduced portion 209 at its upper end which passes axially through the diaphragm 206. A pair of convex disks 210 and 212 rigid with the stem and disposed above and below the diaphragm, respectively, provide an air tight connection between the valve stem and the diaphragm.

Resilient suspension of the valve stem 200 in a position to normally maintain the valve 202 open is effected by means of a spring 213 which forms a support between the disk 212 and the nut 207, and a spring 214 within the bore 204 which surrounds the upper end of the reduced portion 209 of the stem and exerts downward pressure upon the upper disk 210 to counterbalance the spring 213.

A rigid support for the hood 203 is provided by an apertured horizontal ear 215 integral with and extending laterally from the upper end of the body 110. Through this ear extends a bolt 216 which threadedly engages within the upper end of the bore 204 as at 217 and tightly secures the hood against the ear. The lower surface of the plug provides a seat for the spring 214, and within the bolt 216 is a vertical bore 218 which communicates with an annular channel 219 through a plurality of radial ports 220. Coincident with the channel 219 is a port 221 opening to the interior of the body 110 above the throttle valve 138. Engine suction will be effective through the passageway thus provided through the bolt 216 to create a vacuum condition in the space above the diaphragm and cause the latter to flex upwardly. Because of the rigid connection between the diaphragm and the valve stem 200 the latter will be caused to follow the movement of the diaphragm when the engine suction reaches an intensity which will overcome the force of the spring 214. The valve 202 will thus be carried toward its closed position in proportion to the intensity of the engine suction, and the flow of fuel to the discharge member 118 is thereby directly controlled.

Adjustment of the valve 202 to compensate for changes in operating conditions may be secured by rotating the bushing 194 which is preferably in screw threaded engagement, as at 222, with the upper end of the member 193. For convenience in adjusting the bushing an integral nut 223 is formed at its upper end which may be exposed for manipulation when desired by shifting a loose sleeve 224, the latter being provided to keep dust or dirt from the bushing. A lock nut 224^a locks the bushing in adjusted position.

As in the form of suction responsive means shown in Figure 3, a thermostatic element 225 may be interposed between the spring 214 and the upper disk 210 to vary the tension of the spring suspension as required by changes in atmospheric or engine temperatures, whereby a further accurate relative adjustment of the valve 202 is secured. The carburetor will thus be maintained at all times in a condition to secure the most efficient and economical operation of the engine.

The modified form of suction responsive means shown in Figure 7 differs from that previously described in comprising valve and suction responsive means formed as separate cooperative

units. Thus, in this instance, a manually adjustable bushing 227 slidably supports a valve stem 228 carrying a valve 230 at its lower end for controlling the flow of fuel. A head 233 on the upper end of the stem 228 forms an abutment for a spring 234 seated within an enlargement of the bore in the upper end of the bushing 227, the spring being designed normally to urge the stem and valve upwardly into valve closing position. Above the bushing, a centrally apertured hood member 235 has near its lower edge a shoulder 236 providing a seat for the edge of a loose air-tight diaphragm 237 which is secured in place by a chambered nut 238. Upper and lower disks 239 and 240 fast with the upper end of a short stem 241 serve to clamp the diaphragm 237 therebetween and render the stem 241 responsive to movement of the diaphragm. The lower end of the short stem extends through an aperture 242 in the nut 238 and rests upon the head 233. Springs 243 and 244 provide a sensitive resilient cushion for supporting the stem 241 and are arranged to force the same against the head 233 with sufficient pressure to normally keep the valve 230 open.

The central aperture of the hood is adapted to threadedly receive a bolt 245 for securing the hood rigidly against a supporting member 246, which may be similar to the ear 215. An annular channel 247 about the periphery of the bolt, and a duct 248 connecting the channel with the space above the diaphragm 237 provide communication with the interior of the carburetor body, a port 249 opening into said body near the channel 247 completing the passage through which the effect of the engine suction may become operative to move the diaphragm. Because of the sensitive construction of this form of the fuel control, an exceedingly critical adjustment is possible.

The operation of the carburetor shown in Figure 5 is in essential respects the same as described above in connection with Figures 3 and 4. Thus, when the engine is cold, the valve 198 will be fully open, and as the engine is cranked the comparatively light suction created will not sufficiently move the diaphragm 206 to effect the open position of the fuel valve. In this operation, the operator will actuate the arm 179 to cause the finger 182 to press against the arms 184 of the spring 185 and thus depress the flap valve 176 which will force the resilient division extension 174 toward the dotted line position shown in Figure 5 to restrict the amount of air passing the fuel discharge member to secure a rich fuel mixture.

After the engine begins firing, the valve 175 will be released and the resilient member 174 will return to its horizontal position, leaving the primary air passage 170 open so that a strong up draft of air will issue through the opening 187 past the fuel nozzle 118 and cause a leaner air-fuel supply to be delivered to the engine. It will be understood that the throttle valve 138 will normally be maintained in a slightly open position to permit the passage of a small amount of fuel-air mixture for idling purposes. When the throttle 138 is opened to race the engine or to gain speed, air will also be delivered through the secondary air passage 172 by the opening of the valve 176 due to the pressure of incoming air. Hence the supply of air to the mixing chamber will be increased and a leaner mixture results.

When the engine is placed under load the engine speed is reduced with a resultant decrease in suction and the unrestricted flow of fuel to

the discharge member provides a rich fuel mixture. Then, as the car gets under way and the engine speed determined by the setting of the throttle valve has been attained, the amount of air which may be drawn past the valve will reach the maximum and the engine suction will increase so as to move the diaphragm 206. Thus, the fuel valve 198 will be moved toward closed position and restrict the flow of fuel to the discharge member 118 so that a relatively lean fuel mixture will be supplied for maintaining the speed attained.

While several forms of suction and temperature responsive fuel valve control means have been shown, it should be understood that any form may be substituted for any other; and although certain particular forms have been shown in combination with the carburetor as a matter of expediency for purposes of illustration, this should not be construed as a limitation, as any form of the suction responsive means as temperature means may be used therewith.

From the foregoing it will be apparent that I have provided a carburetor having improved apparatus for automatically varying the richness of the fuel mixture responsive to the requirements of the engine. Moreover, the improved fuel discharge means insures more efficient vaporization of the fuel than in devices heretofore in use. Consequently, the present carburetor furnishes to the engine a supply of thoroughly mixed fuel and air which is at all times as lean as may be used and which will cause the engine to run evenly and smoothly.

I claim:

1. A carburetor having, in combination, a hollow body providing intake and discharge openings, a fuel discharge member in said body, a fuel supply connection for said member, a valve in said connection, a spring urging said valve toward its open position, an expansive bellows mounted on said body and adapted for connection with an engine manifold so as to be subject to the engine suction, and means connecting said bellows to said valve and acting against said spring to close said valve as the engine suction is increased, said means including a thermostatic element arranged as the engine temperature increases to reduce the valve opening for any given position of the bellows.

2. In a carburetor, having a hollow body with intake and discharge openings therein, a fuel discharge member in said body with a fuel supply passage leading thereto, a valve for controlling said passage, a throttle valve operable independently of said fuel control valve and mounted in said body between said fuel discharge member and said discharge opening, suction responsive means communicating with the interior of said body between said throttle valve and said discharge opening, and means connecting said suction responsive means to said fuel valve operable to move said valve toward closed position as the engine suction increases, said last mentioned connecting means including a thermoresponsive element arranged to modify the valve controlling action of said suction responsive means.

3. In a carburetor having a hollow body with intake and discharge openings therein, a fuel discharge member in said body with a fuel supply passage leading thereto, means providing a cylinder for slidably receiving a valve stem, a valve carried at one end of said valve stem for controlling the flow of fuel through said passage,

a chamber above the opposite end of said stem, an air tight suction responsive diaphragm dividing the chamber into two portions one of which is tightly sealed by said diaphragm, means rigidly connecting a part near the upper end of said valve stem to said diaphragm for movement therewith, springs on each side of said diaphragm in balance for normally maintaining said part in one position to keep said valve open, and an opening communicating with the sealed portion of said chamber and the interior of said body whereby said diaphragm is operable to move said valve toward closed position as the engine suction increases, said openings affording the only passage into said sealed portion so that the full effect of engine suction is operative only on the one side of said diaphragm.

4. In a carburetor, an induction passage, a fuel outlet therein, a throttle controlling said passage, a fuel reservoir, a fuel passage connecting the reservoir to the fuel outlet, and means for controlling the flow of fuel through said fuel passage including a movable valve member, a fixed valve member comprising a tube forming a guide for the movable valve member and provided with radial openings for the flow of fuel, a non-resilient diaphragm connected to said movable valve member, opposed coil springs urging the movable valve member in opposite directions, and a chamber closed by said diaphragm and connected to the induction passage posterior to the throttle.

5. In a carburetor, an induction passage, a fuel outlet therein, a throttle controlling said passage, a fuel reservoir, a fuel passage connecting the reservoir to the fuel outlet, and means for controlling the flow of fuel through said fuel passage including a movable valve member, a fixed valve member comprising a tube forming a guide for the movable valve member and provided with radial openings for the flow of fuel, a non-resilient diaphragm connected to said movable valve member, opposed coil springs urging the movable valve member in opposite directions, and a chamber closed by said diaphragm and connected to the induction passage posterior to the throttle, said valve members, yielding means, diaphragm, and chamber being constructed and arranged to be assembled and inserted in the carburetor as a unit.

6. In a carburetor for an internal combustion engine, a throttle, a fuel nozzle, a fuel passage supplying said nozzle, a valve controlling the rate of flow through said passage, and means for varying the position of said valve comprising a suction responsive member subjected to the varying suction posterior to the throttle and operatively connected to said valve, a pair of spring-like members respectively urging said valve toward open and closed position, and temperature responsive means operative to move the valve toward open position upon a decrease in temperature.

7. A carburetor for an internal combustion engine, a throttle, a fuel nozzle, a fuel passage supplying said nozzle, a valve controlling said passage, and means for controlling said valve comprising a member subjected to the varying suction posterior to the throttle and adapted to move the valve toward closed position upon an increase in suction, yielding means urging the valve toward open position in opposition to said suction, and temperature responsive means acting on said valve to move the valve in response to variations in temperature.

8. In a carburetor for an internal combustion engine, an induction passage, a throttle therein, a fuel nozzle discharging in said passage, a fuel duct supplying fuel to said nozzle, a fuel control valve for varying the rate of fuel flow through said duct, means subjected to variations in the pressure in said passage posterior to the throttle for controlling said valve and adapted to move the valve to decrease the fuel flow upon increase in suction, and means including an element responsive to variations in temperature for moving the valve toward open position upon a decrease in temperature.

9. In a carburetor for an internal combustion engine, an induction passage, a throttle controlling the passage, a fuel nozzle discharging in the passage, a fuel duct supplying fuel from a source to said nozzle, a valve controlling the effective area of the fuel duct, and means for controlling the position of said valve comprising a movable member subjected to variations in the pressure in the induction passage posterior to the throttle and adapted to move the valve in a direction to decrease the effective area of the fuel duct upon increase in suction, and temperature responsive means adapted to move the valve in a direction to decrease the effective area of the fuel duct as the temperature increases.

10. In a carburetor for an internal combustion engine including an induction passage, having a venturi and a throttle posterior thereto, a fuel supply chamber, a main fuel supply including a nozzle discharging substantially at the throat of said venturi, a fuel duct connecting the chamber and the nozzle for supplying fuel thereto, and means forming an idling fuel supply including an idle nozzle discharging posterior to the throttle; in combination therewith of a fuel control valve for variably controlling the main fuel supply and means for controlling the position of said valve comprising a movable member subjected to variations in the pressure in the induction passage posterior to the throttle and means for varying the position of said valve in response to variations in temperature.

11. In a charge forming device for an internal combustion engine, a fuel valve adapted to be variably adjusted to control the proportions of fuel and air in the mixture, the combination of means responsive to normal intake suction and operable upon any increase in suction to move said fuel valve toward closed position, and a thermostat operable in accordance with engine temperatures and interposed between said fuel valve and said suction responsive means, whereby the latter is operable upon the fuel valve through the medium of the thermostat.

12. In a charge forming device for an internal combustion engine, a fuel valve adapted to be variably adjusted to control the proportions of fuel and air in the mixture, a throttle for regulating the engine speed, means for operating said fuel valve comprising a thermostat responsive to engine temperature and a suction motor responsive to the suction of the intake passage anterior to said throttle, said thermostat and said suction motor being connected to said fuel valve in series.

13. In a charge forming device for an internal combustion engine, a fuel valve adapted to be variably adjusted to control the proportions of fuel and air in the mixture, the combination of means responsive to the temperature of the en-

gine for setting said fuel valve and means responsive to the suction of the engine and movable independently of the valve for varying the setting of said valve as determined by said temperature responsive means.

14. In a charge forming device for an internal combustion engine, a fuel valve adapted to be variably adjusted to control the proportions of fuel and air in the mixture, thermally responsive means operable in accordance with engine temperature for determining the position of the fuel valve, means responsive to an increase in engine suction for moving the said fuel valve toward closed position and independent means responsive to a decrease in engine suction for moving said fuel valve toward open position.

15. In a charge forming device for an internal combustion engine, a fuel valve adapted to be variably adjusted to control the proportions of fuel and air in the mixture, the combination of means operable upon an increase in the normal intake suction to urge the said fuel valve toward closed position, and independent means responsive to a decrease in the normal intake suction to move said fuel valve toward open position.

16. Means for controlling the fuel to air ratio of the fuel mixture supplied to an internal combustion engine during starting, warming up and normal operating conditions comprising a charge forming device having in combination, a fuel valve movable to different positions to vary the fuel mixture ratio, a throttle valve for controlling the quantity of mixture supplied to the engine, and means for changing the position of said fuel valve in accordance with changes in the temperature under which the engine operates, in accordance with changes in the intake suction of the engine brought about by changes in the engine speed and by changes in the position of the throttle valve.

17. In a charge forming device for an internal combustion engine, a fuel valve adapted to be variably adjusted to control the proportions of fuel and air in the mixture, thermostatic means normally holding the fuel valve open when the engine is cold and tending to move said fuel valve toward closed position as the engine temperature increases, and a suction operated member connected to the thermostat and operable to move said fuel valve toward closed position through the medium of the thermostat upon increase in engine suction.

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