Sept. 26, 1961 E. A. JOHNSON 3,001,773

FUEL SYSTEM

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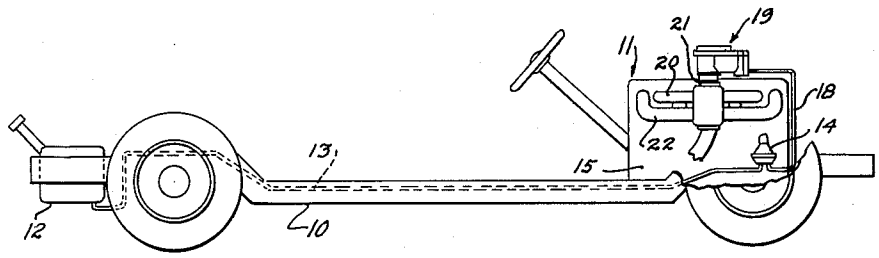


FIG. 1.

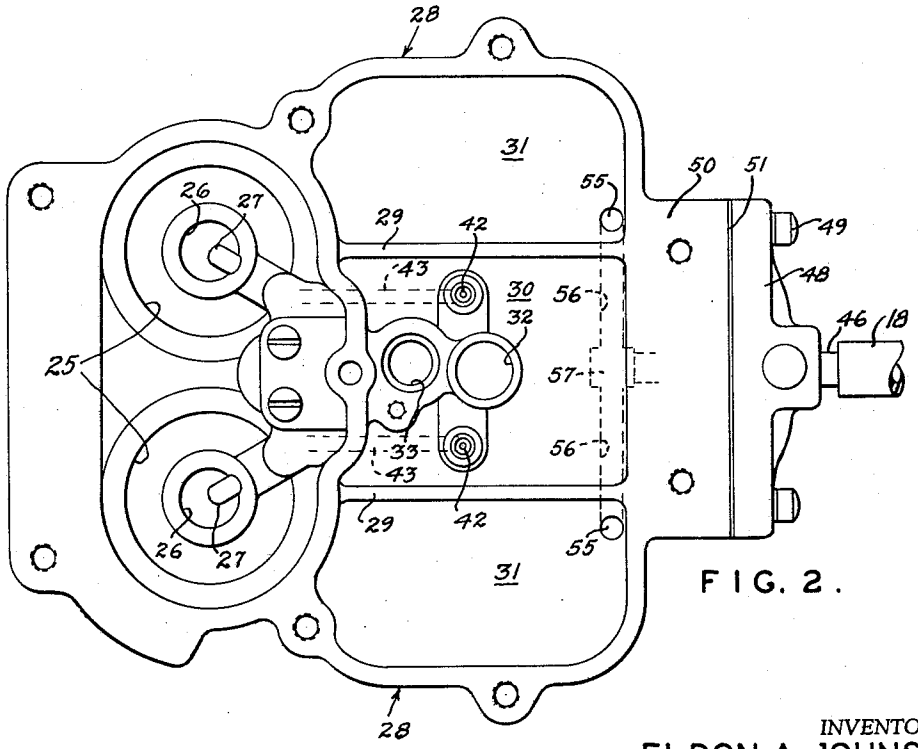


FIG. 2.

INVENTOR.
ELDON A. JOHNSON
BY
Laurence M. Goodridge
ATTORNEY

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FUEL SYSTEM

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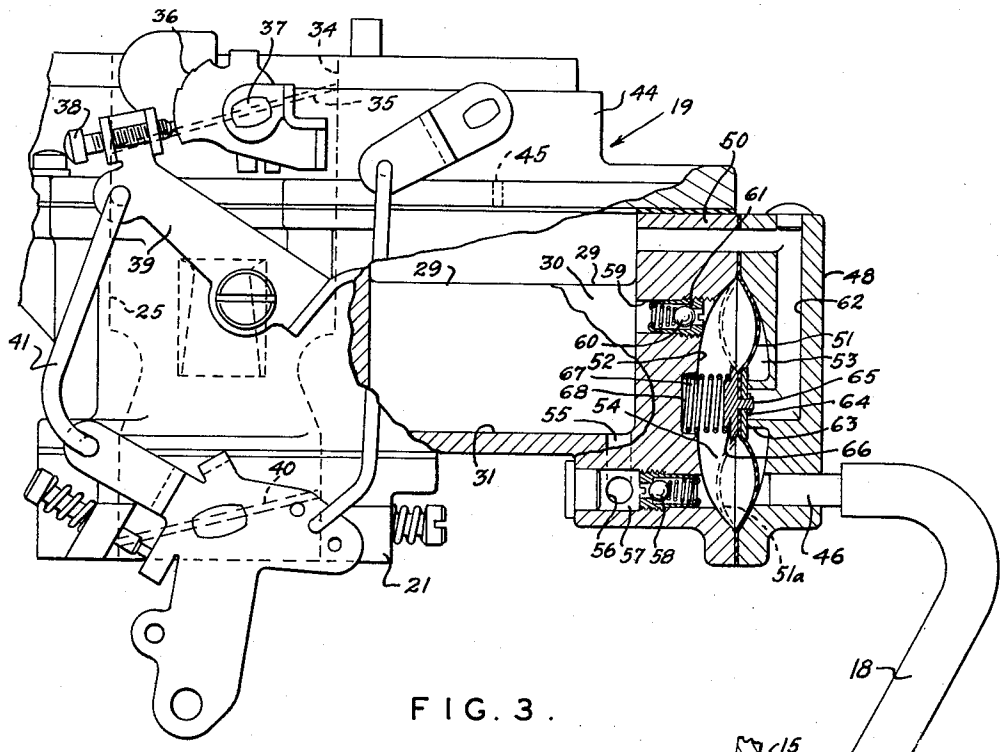
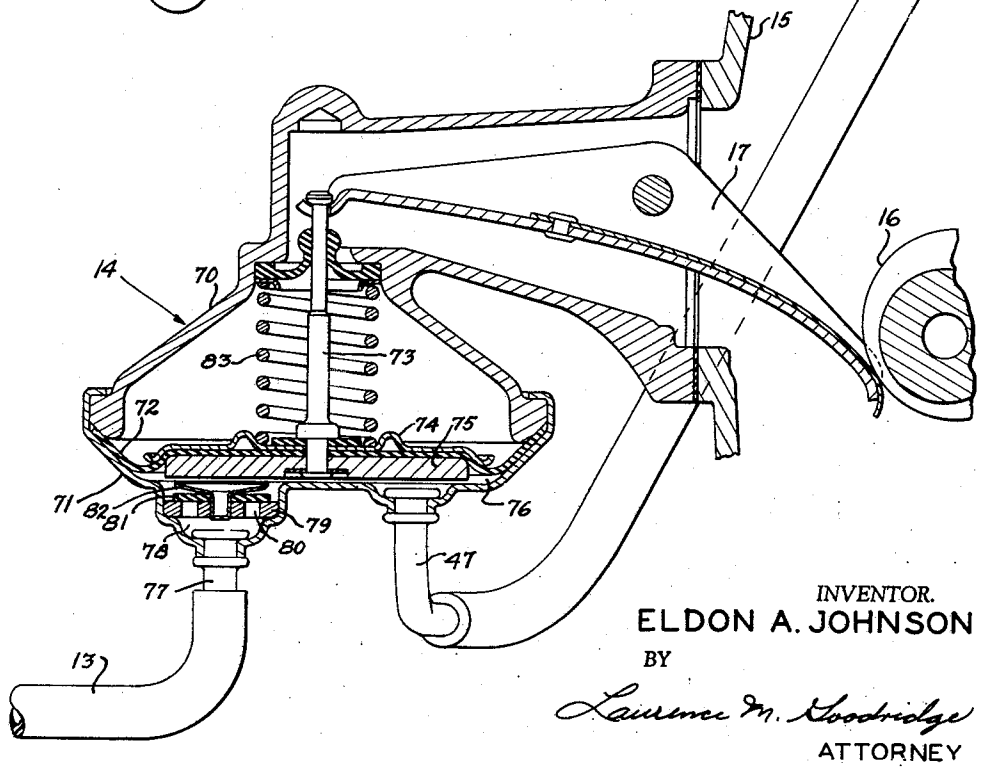


FIG. 3.



INVENTOR.
ELDON A. JOHNSON
BY
Laurence M. Goodridge
ATTORNEY

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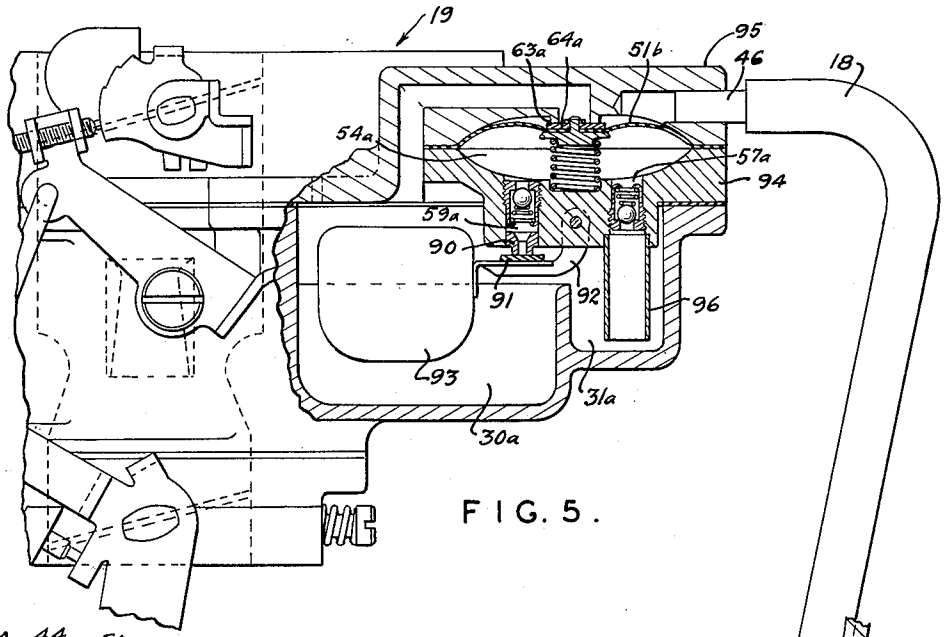


FIG. 5.

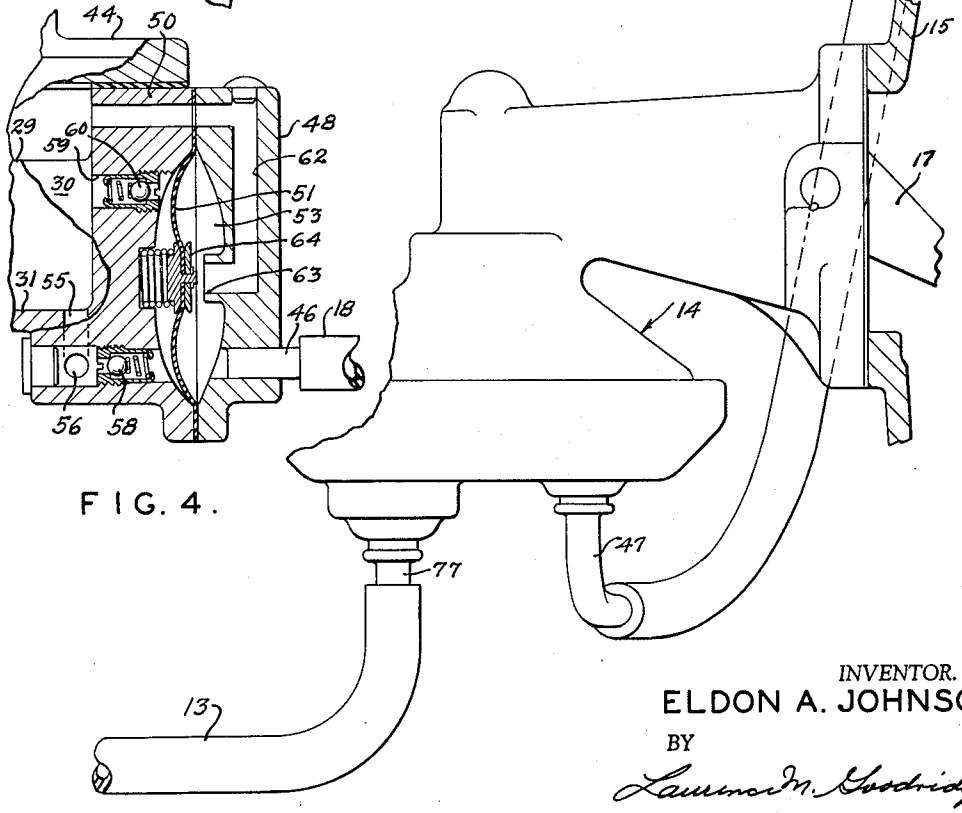


FIG. 4.

INVENTOR.
ELDON A. JOHNSON
BY
Laurence M. Goodridge
ATTORNEY

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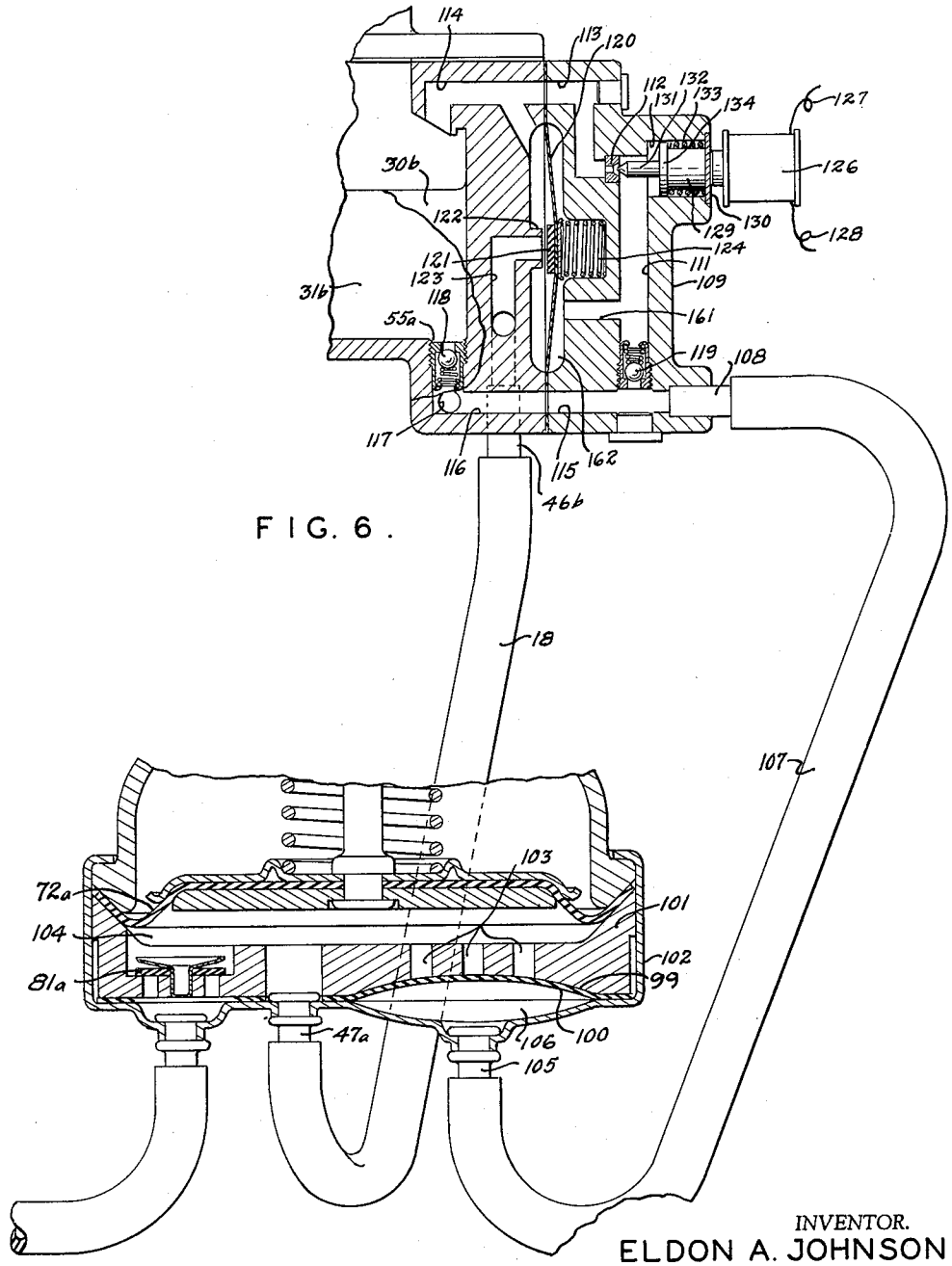


FIG. 6.

INVENTOR.
ELDON A. JOHNSON
BY
Laurence M. Goodridge
ATTORNEY

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FUEL SYSTEM

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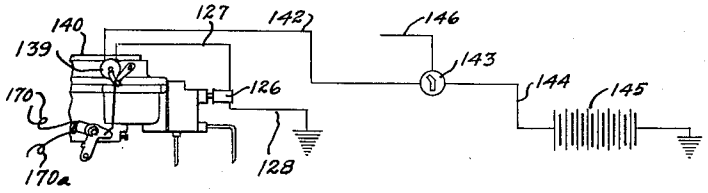


FIG. 7.

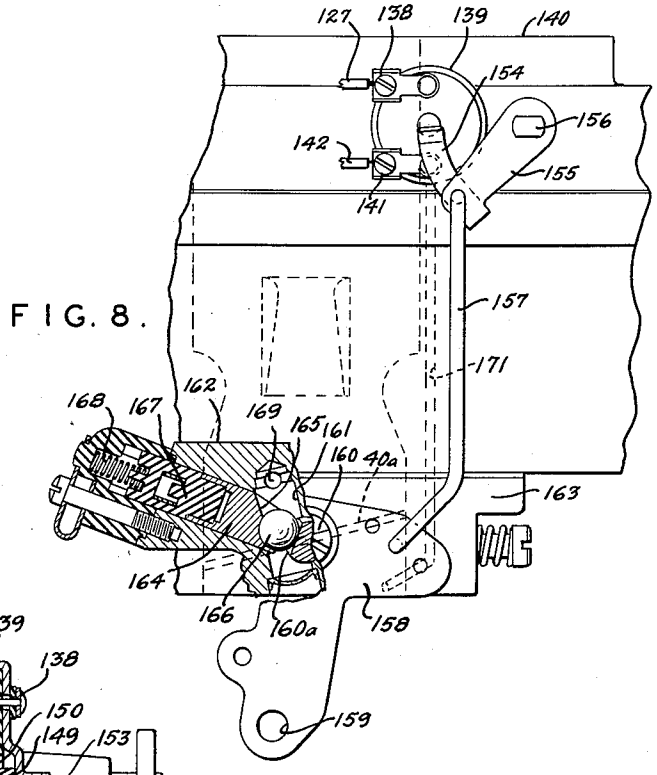


FIG. 8.

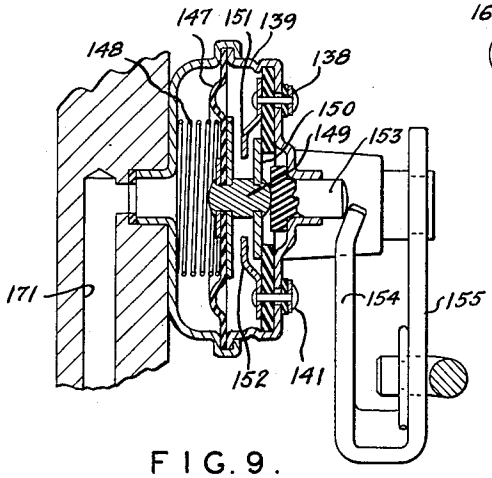


FIG. 9.

INVENTOR.
ELDON A. JOHNSON
BY
Laurence M. Goodridge
ATTORNEY

United States Patent Office 3,001,773 Patented Sept. 26, 1961

3,001,773

FUEL SYSTEM

Eldon A. Johnson, Sunset Hills, Mo., assignor to ACF Industries, Incorporated, New York, N.Y., a corporation of New Jersey

Filed Oct. 2, 1958, Ser. No. 764,978
15 Claims. (Cl. 261—36)

This invention relates to fuel supply systems for internal combustion engines and consists particularly in novel means for improving and simplifying the carburetor and relieving the carburetor of the possibility of malfunctioning due to abnormal or subnormal level in the constant level chamber.

There are fuel supply systems for internal combustion engines utilizing carburetors with constant level chambers of the overflow type and fuel pumps incorporating scavenger devices for evacuating the overflow chambers. Thus, under all normal operating conditions, including engine idling and low speed operation, a constant supply of liquid fuel is circulated from the pump through the carburetor bowl, thence back to the scavenger pump. In such systems, the scavenger pump is operated by a liquid link from the main pump and during periods of low fuel consumption, means operate such that the main pump diaphragm stroke is only sufficient to deliver fuel in quantities slightly in excess of that being consumed by the engine and to cause recirculation through the scavenger pump. In those devices, means referred to apply back pressure upon the main fuel pump in accordance with the delivery pressure of the scavenger pump so as to limit the main pump delivery in accordance with fuel demands of the engine. As long as liquid fuel is being circulated from the spill or overflow chamber through the scavenger pump, the delivery from the main pump will be restricted. However, when vapor or gaseous material is being drawn through the scavenger pump, the restriction in the main pump fuel delivery line is reduced so that the pumping action of the main pump will be proportionately increased to satisfy the deficiency in liquid fuel which resulted in the drawing of vapors into the scavenger pump. However, it has been found in some cases due to the mounting of the scavenger pump in connection with the fuel pump at some distance below the carburetor, so much time is required for draining the spill chamber and the lines to the scavenger pump inlet check valve that the level in the constant level chamber is excessively lowered with resultant leaning of the fuel mixture supplied to the engine. This results, in turn, in improper functioning of the engine until the main fuel pumping action is increased to make up the deficiency, as above described.

Accordingly, it is the main object of the present invention to rearrange the scavenger pump in relation to the carburetor spill chamber so that the main pump control function of the scavenger pump will be rendered substantially more sensitive.

Another object is to mount the scavenger pump directly upon the carburetor and in immediate proximity to the spill chamber.

Another object is to utilize the valving element whereby the scavenger pump controls or meters the main pump discharge, as the main pump discharge check valve, thereby eliminating one valve from the assembly and correspondingly simplifying and reducing the cost thereof.

Another object is to combine the scavenger pump with the main pump discharge valving parts which respond to scavenger pressure conditions.

Another object is to provide means for cutting off the fuel supply line between the main fuel pump and the carburetor, when the engine stops, so as to positively prevent forcing of fuel into the carburetor from the pump at such

time, as in case of high pressure in the pump and fuel line due to heat conditions.

Still another object is to provide a fuel supply system incorporating a carburetor fuel bowl of the overflow type and main and scavenger fuel pumps, together with a cut-off valve for the scavenger outlet controlled by a float in the spill or overflow chamber of the carburetor which senses stoppage of the powering means of the engine, that is, the drawing of fuel through the carburetor into the engine, to cut off delivery from the scavenger pump, thereby increasing the scavenger pump pressure and cutting off the main pump fuel discharge line to the carburetor.

Still another object is to provide a cutoff valve for the main pump discharge line which valve will be opened responsive to the action of a control device, such as a manifold suction responsive element, indicating that the powering means of the engine is in operation, and also responsive to energization of the engine's self starter circuit.

These objects and other more detailed objects hereafter appearing are attained in the present invention in which, in each form, at least the intake check valve for the scavenger pump is located in immediate proximity to the spill or overflow chamber in the carburetor. In certain of the forms herein disclosed, the entire scavenger pump unit, including its inlet and outlet check valves, is mounted directly on the carburetor fuel bowl. In another form, the scavenger outlet duct leading to the constant level chamber may be cut off by a valve actuated by a float in the spill chamber so that when the fuel level in the spill chamber rises to the stabilized point indicating stoppage of the engine, both the scavenger and main pump discharge lines will be cut off. In still another form, a solenoid-operated cutoff valve controls the main fuel pump supply line to the carburetor and is itself controlled by devices responding to energization of the ignition and starter circuit and pressure conditions in the intake manifold.

In the accompanying drawings,

FIG. 1 is a schematic side view of an automotive chassis and engine illustrating the components of my novel fuel supply system.

FIG. 2 is a top view of the carburetor of FIGS. 1 and 3 with the bowl cover removed.

FIG. 3 is a somewhat schematic side view, partly in section, of the fuel pump and carburetor assembly.

FIG. 4 is a sectional detail of the carburetor in FIG. 3 in a different position.

FIG. 5 is a view similar to FIG. 3 and showing carburetor modifications.

FIG. 6 is another view similar to FIGS. 3 and 5 and showing further modifications in the carburetor and fuel pump construction.

FIG. 7 is a wiring diagram applicable to the form in FIG. 6.

FIG. 8 is a detail of the carburetor in FIGS 6 and 7, portions being sectioned for clearer illustration.

FIG. 9 is a detail vertical transverse section taken on line 9—9 of FIG. 8.

In FIG. 1, there is illustrated a chassis **10** having any suitable internal combustion engine **11** mounted on the forward portion thereof and a fuel supply tank **12** mounted at the rear. The tank is connected by delivery tube **13** to a mechanical fuel pump **14** mounted at the side of crankcase **15** of the engine and operated by a cam **16** on the engine camshaft through a pivoted lever **17** (FIG. 3). The pump is connected by supply tubing **18** to the carburetor **19** mounted on manifold **20** by means of bolting flange **21** in the customary manner. An engine exhaust manifold is shown at **22**.

The carburetor (FIGS 2 and 3) has a pair of down-

draft mixture conduits 25, each including an inner venturi tube 26 into which discharges a main supply nozzle 27. At the side of the carburetor is a fuel supply bowl, generally indicated at 28, having parallel partitions or weirs 29, forming a central, constant level chamber or bowl 30 and side spill or overflow chambers 31. Within chamber 30, is a cylinder 32 for mounting an accelerating pump and a second cylinder 33 for receiving a suction step-up device, as shown for instance, in the Patent 2,635,625 to Moseley et al. Pivotally mounted in the merged upper part 34 of the mixture conduit structure is a butterfly choke valve 35 for which suitable control mechanism (not shown) is provided. A fast idle cam 36 is carried at the end of choke shaft 37 for cooperation with an abutment screw 38 on pivoted lever 39 connected to the throttle valve 40 by a link 41.

At the bottom of the constant level bowl 30 are a pair of metering orifice elements 42 connected to the main nozzles by cross passages 43. The orifice elements may be controlled by suitably-operated metering rods or valves, as shown in the above-mentioned patent to Moseley et al. Bowl cover 44, formed integral with air inlet 34, is provided with a suitable vent opening 45, which may be connected to a balance tube opening into the air inlet, or to the atmosphere outside the air inlet, as desired. Fuel inlet fitting 46 is mounted in the side wall of the bowl structure and is connected by means of tube 18 to main discharge fitting 47 of fuel pump 14. Bowl fitting 46 opens through a cap 48 secured by bolts 49 to scavenger pump body 50 which is formed as an integral enlargement on the bowl end wall. The diaphragm 51 clamped between cap 48 and body 50, divides cavity 52 between the cap and body into a pulsing chamber 53 and a pumping chamber 54. Ports 55 in the bottoms of spill chambers 31 connect with pump chamber 54 by means of a cross passage 56 and an inlet duct 57 receiving inlet check valve 58. An outlet duct 59 leads from pump chamber 54 into constant level bowl 30 and accommodates a discharge check valve 60. Valve seat 61 forms a calibrated restriction in the scavenger pump outlet passage, to be referred to hereafter.

Main fuel inlet fitting 46 communicates with pulsing chamber 53 and thence, through a passage 62, with constant level bowl 30. Passage 62 terminates within pulsing chamber 53 in a nipple 63 forming a valve seat. Cooperating with this seat is a disc valve element 64 centrally secured to diaphragm 51 by means of the upset head 65 of rivet projecting from a washer 66. A coiled spring 67 compressed between washer 66 and recess 68 in cavity 52 normally urges valve 64 toward seat 63 for closing main pump delivery passage 18, 46, 53, 63 and 62.

Fuel pump 14 consists of body members 70 and 71 clamping therebetween a main pumping diaphragm 72. An actuating stem 73 is centrally secured to diaphragm 72 by means of clamping washers 74 and 75, the outer peripheries of which are shaped to constantly maintain the intermediate free flexing portion of diaphragm 72 in a fold or bight directed into main pumping chamber 76. Fuel delivery tube 13 leading from tank 12 connects with main pump inlet fitting 77 which opens into pumping chamber 76 through inlet passage 78 formed in a depression in casing 71. A spider 79 in this depression has an annular series of inlet ports 80 controlled by a flexible disc inlet check valve 81 held in position by a mushroom valve retainer 82. The under wall of the valve retainer is conical as shown to permit upward flexing of the outward portion of valve disc 81. No outlet check valve is provided in the main pump, valve 64 in the scavenger device serving as an outlet check, as will be described hereafter. Diaphragm 72 is constantly urged downwardly, in the pumping direction, by a coiled compression spring 83.

During normal operation of the engine, cam 16 rotates to cause rocking of lever 17 and intermittent lifting of stem 73 and main pumping diaphragm 72 for drawing

fuel into pumping chamber 76. The intervening discharge strokes of the pump are produced by spring 83 so that, theoretically, the discharge pressure of the pump is limited by the characteristics of spring 83.

During each upward, charging stroke of main pumping diaphragm 72, the pressure in pulsing chamber 53 is reduced and scavenger diaphragm 51 is moved to the right as seen in FIG. 3, so as to draw fluid from spill chambers 31 into scavenger pumping chamber 54. It will be seen that scavenger diaphragm has considerable slack so as to form a relatively large loop or bight 51*a* in the free flexing portion thereof. Furthermore, chambers 53 and 54 are shaped to permit substantially greater flexing of diaphragm bight portions 51*a* than is necessary for seating valve 64 during the charging stroke of diaphragm 51. Consequently, early in this charging stroke, disc valve 64 seats upon nipple 63, thus sealing discharge tube 18 and, thereby, functioning as a main pump discharge check valve. As stated, diaphragm bight or loop 51*a* can continue its pumping movement so as to draw a substantial quantity of fluid into scavenger pumping chamber 54.

As the stroke of main pump diaphragm 72 reverses, inlet check 81, of course, closes and fluid in main pumping chamber 76 is forced outwardly through tubing 18 into pulsing chamber 53 where it is applied to scavenger pump diaphragm 51 so as to force the diaphragm to the left as viewed in FIG. 3, first flexing loop 51*a* in the opposite direction, then forcing disc valve 64 from its seat. The pumped fuel then passes through passage 62 into constant level bowl 30.

In time, after initial starting of the engine, liquid fuel will fill the constant level bowl and overflow into spill chambers 31. Thereafter, liquid fuel will be drawn into scavenger pumping chamber 54 upon each intake stroke and returned past outlet check 60 into the constant level bowl during each discharge stroke of the scavenger diaphragm. Due to restriction 61 in the scavenger pump outlet, there will be a resistance imposed on the discharge of fluid from the scavenger pump chamber 54, and this resistance is so calibrated as to limit the movement of diaphragm 51*a* to a flexing action of an amount such as indicated in the dotted line position in FIG. 3. The flexing action is in timed relation to the main pump, and the output pressure of both pumps is proportional. Ordinarily, this amount of movement of the diaphragm is all that is required to maintain a continuous circulation of fluid from the scavenger chamber 54 into the overflow chamber 30. The movement of the diaphragm 51*a* may be insufficient, however, to compress spring 67 and move valve 64 from its seat, so that, consequently, there is very little fuel delivered from the main pump 14 through the connection 18 to the passage 62 and fuel bowl 30.

This operation of the scavenger pump will continue so long as there is sufficient fuel being supplied to the outlet passages 55. However, when one or the other of these passages becomes uncovered, or for any other reason air or vapors are sucked into the pumping chamber 54, the flexing action of the scavenging pump diaphragm will increase as shown in FIG. 4. Air or vapors, as the case may be, have a much lower viscosity than fuel, and metering restriction 61 will become less of a resistance to the discharge; consequently, the degree of flexing of the diaphragm 51*a* under the effect of pump pressure will increase, increasing the stroke of the scavenger pump far enough to lift the valve 64 fully from its seat, as in FIG. 4, whereupon a full flow of fuel is delivered from the chamber 53 and passage 62 into the chamber 30 to supplement the decreased delivery into this same chamber by the scavenger pump, which now is discharging a smaller amount of liquid, in spite of its increase in stroke. This condition in which the scavenger pump stroke increases, lifting the valve 64, will continue until sufficient fuel has been delivered to again fill the passages 56, 57 and cover

the overflow outlets **55**, and fill chamber **54** with solid fuel.

It should be understood that, in the operation of the device, both the main pump **14** and the scavenger pump operated thereby may be delivering into the chamber **30** simultaneously, although the amount of delivery from the scavenger pump, under these circumstances, is below that required to meet engine demand.

Thus, during normal operation, the main pump **14** will continuously operate the scavenger pump, and the scavenger pump, in turn, will operate to circulate the fuel from the overflow chambers to the constant level chamber **30**. The stroke of the scavenger pump, however, will vary, depending upon the amount of solid fuel being circulated, thus lifting the valve **64** in varying degree and intermittently to supplement the amount of fuel delivered from the scavenger pump by fuel delivered directly from the main pump. At no time, however, will there be insufficient fuel delivered from the pumps to maintain the chamber **30** full of fuel, because lines **18**, chamber **53**, and passage **62** are always full of fuel. Preferably, the restriction **61** is calibrated to have a small flow capacity at scavenger pump pressure.

The relationship between the elements in this combination is not particularly critical, but it requires that the main pump **14** should have a capacity much greater than the scavenger pump. This is so because it is desirable, when the engine stops, to have the scavenger pump valve **64** seal the discharge from the main pump so that there will be no fuel delivery from the main pump directly into the overflow chamber **30**.

It will be realized that this will occur naturally when the engine is shut off with the combination of elements disclosed. When the engine ignition is cut off to stop the engine, the engine will rotate several times due to inertia of the parts, and the fuel drawn into the engine at that time will be little in comparison with the capacity for delivery of the main pump **14**. As a consequence, there will be enough fuel delivered either from the scavenger pump or from the main pump so as to cover outlets **55** and fill the pumping chamber **54** with solid fuel, and when the chamber **54** is full of solid fuel, the resistance of the diaphragm **51** to movement is increased due to the small size of restriction **61**, and this increase in resistance, plus the pressure of the spring **67**, is usually sufficient to prevent the valve **64** from lifting and allowing fuel to burp over into the fuel bowl of the carburetor from the main pump circuit when the engine stops and until pressure in the chamber **54** bleeds down. The valve **64** and diaphragm **51** are therefore temporarily maintained in the position shown in FIG. 3, rather than in the condition shown in FIG. 4, in which the discharge passage from the main pump is open.

It should be especially noted that inlet check valve **58** of the scavenger pump is mounted in immediate proximity to spill chambers **31**. Thus, a minimum of time will elapse between the ceasing of pumping of normal liquid fuel by the main pump, and the sensing of this fact by the scavenger pump so as to increase the main pump stroke. Accordingly, the spill chambers should be only large enough to maintain the scavenger inlet submerged under normal operating conditions while quickly exposing this inlet to gases when the liquid delivery of the main pump is deficient.

The operation of the modification in FIG. 5 is very similar to that above described with respect to FIGS. 3 and 4. In this modification, the discharge resistance imposed upon the scavenger pump is primarily determined by the float **93** and its valve **91**. The surface of the valve **91** is quite large, and the discharge metering orifice **90** provides a valve surface which extends over considerable area of the flat float valve **91**, so that during operation of the scavenger pump the discharge pressure thereof will tend to force the float off of its seat, and fuel will be supplied from the scavenger pump

into the fuel chamber **30***a* against the resistance imposed by the float valve **91** and the float **93**. The maximum resistance imposed by the float **93** and the valve **91** can be easily calibrated, since the maximum fuel level is known, and will never exceed the depth of the fuel chamber **30***a*. Thus, the amount of displacement and the maximum force imposed by the float **93** on the valve **91** can be easily calibrated. This closing force is so selected that sufficient restriction is provided to cause the scavenger pump diaphragm **51***b* to flex in the same manner as disclosed in FIG. 3, so the valve **64***a* will be maintained on the seat **63***a* as long as there is a substantial fuel supply within the scavenger bowl **31***a* and the pump chamber **54***a* is substantially full of fuel. However, when the pumping chamber **54***a* becomes low on fuel and float valve **91** opens, the flexing of the diaphraghm **51***b* increases, and the same operation occurs as illustrated in the modification shown in FIG. 4. Valve **64***a* is moved from its seat, and fuel is immediately available from the main pump **14***a* and delivered through the passage **62***a* into the float chamber **30***a*. Thus, fuel will be delivered from both the main pump **14***a* and the scavenger pump into the float chamber **30***a*, so that the level therein will always be maintained at maximum. When the ignition of the engine is turned off, the engine will rotate several cycles, and the fuel consumption at this time is very low as compared with the maximum delivery of the main pump **14***a*, which insures that the chamber **30***a* will be full of fuel so that the float **93** will be in the raised position, closing the valve **91**. The residual pressure in the chamber **54***a*, plus spring pressure, will then be sufficient to prevent intermittent surges or burping of fuel into the float bowl from the main pump through the circuit to the float chamber **30***a* after the engine stops and, unlike the first modification, this condition will continue until the engine is restarted.

In the form of FIG. 6, scavenger diaphragm **100** is clamped to main pump body **101** by means of lower casing or cap structure **102**. A plurality of ample ports **103** are formed in body **101** immediately above diaphragm **100** to hydraulically connect main pumping chamber **104** with pulsing chamber **99** between diaphragm **100** and casing **101**. The remaining portions of the main fuel pump are generally similar to corresponding parts in FIGS. 3 and 5, including inlet check **81***a*, main pumping diaphragm **72***a*, and inlet and outlet fittings **77***a* annd **47***a*.

A single fitting **105** formed in the bottom wall of scavenger pumping chamber **106** is connected by a tube **107** and a fitting **108** to cap **109**, which is secured to a thickened body part **110**, formed on the side of fuel bowl structure **28***a*. Fting **108** communicates through a passage **111** in cap **109**, restricted orifice **112**, and passages **113** and **114**, respectively, in the cap and thickened bowl wall portion, with central constant level chamber **30***b*, corresponding with chamber **30** in FIG. 3. Fitting **108** also communicates by means of passages **115** in the cap and **116** and **117** in the bowl structure with ports **55***a* at the bottoms of spill chambers **31***b*. An inlet check valve **118** is received in each port **55***a* and an outlet check valve **119** is provided in passage **111**. Passage **111** is connected by a short duct **161** to pressure chamber **162** at the right side of diaphragm **120**, to be described.

Secured between cap **109** and thickened bowl wall portion **110** is the diaphragm **120** carrying a central disc valve **121** for seating on the nipple **122** formed at the end of a passage **123** with which main fuel inlet fitting **46***b* communicates. Diaphragm **120** and valve **121** are normally urged leftwardly, toward a restricting position with respect to seating **122**, by a coiled spring **124**.

A solenoid **126**, having control wiring **127** and **128**, is mounted on cap **109** and has an armature **129** on opposite sides of brass cover plate **130** on cavity **131**

formed in cap 109. At the inner end of the armature is a pointed pin 132 forming a valve for cooperating with previously-mentioned orifice restriction 112. A coiled spring 133 compressed between cover 130 and a collar 134 on the armature constantly urges valve 132 leftwardly, or towards its seating position.

As shown in FIG. 7, solenoid control wire 128 is grounded. Control wire 127 extends to a teminal 138 on a housing 139 secured to carburetor air inlet horn 140. The other terminal 141 of this casing is connected by a wire 142 to ignition switch 143, thence by wire 144 to battery 145. A wire 146 leads to the usual ignition circuit (not shown). As will be well understood, the ignition-battery circuit will include the usual generator which, however, is not here represented.

Casing 139, as shown in detail in FIG. 9, encloses a flexible diaphragm 147 constantly urged rightwardly by a coiled spring 148. Centrally secured to the diaphragm in a pin 149 which carries a switch blade 150 for bridging contacts 151 and 152 in electrical connection with terminals 138 and 141 previously mentioned. A push pin 153 is slidably received in the cover portion of casing 139 and is normally urged outwardly by spring 148 acting through pin 149. A camming arm 154, formed on a lever 155 pivoted at 156 to the bowl cover, is connected by a link 157 to throttle-operating arm 158. The arm is provided with a perforation 159 for connection by suitable linkage (not shown) to the accelerator pedal in the driver's compartment. Throttle 40*a* is mounted on a shaft 160 which is journalled in the side walls of the carburetor. One end of shaft 160 extends into a chamber 161 formed in a boss 162 on throttle body 163. Slidable in a side wall of boss 162 is a plunger 164 having a dished lower extremity 165 which cooperates with a ball 166 received in chamber 161. The end of the throttle shaft is segmented as at 160*a* for actuating ball 166 under certain conditions. Projecting from plunger 164 is a switch blade carrying member 167 of insulating material which is constantly urged downwardly by a coil spring 168. Intake manifold suction, posterior to throttle 40*a* is transmitted to chamber 161 through a port 169. This type of throttle-operated starter switch structure is more fully described in Coffee Patent No. Re. 22,030.

Briefly, when there is no suction in the intake manifold, as when the engine powering means is not in operation, ball 166 will be dropped between segmented face 160*a* on the end of throttle shaft 160 and dished end 165 on plunger 164. When the throttle valve is opened to its proper starting position, switch carrier 167 will be elevated sufficiently to close the switch contacts (not shown) and energize the automatic starter circuit wires 170 and 170*a*. When the engine starts to run under its own power, the suction in the intake manifold will increase sharply so that, when the throttle is returned to its idling position, as will normally occur, ball 166 is released and drawn upwardly to render throttle shaft 160 inoperative thereafter to re-close the starter switch as long as the engine is running.

Casing 139, previously mentioned, is connected by a passage 171 to the engine intake manifold so that manifold suction conditions are applied to the left-hand side of diaphragm 147. The right-hand side of the diaphragm will be exposed to atmospheric conditions through a suitable vent in the cap portion of casing 139.

The structure of FIGS. 6–9 operates as follows: When ignition switch 143 is closed and the throttle valve is opened for starting the engine, switch blade 150 will be closed, through link 157, lever elements 155 and 154, and push pin 153, to energize solenoid 126. This causes withdrawal of valve 132 from its seat element 112 to permit a supply of fuel to flow to the carburetor and engine for starting. After the engine starts to run under its own power, the intake manifold suction will build up sufficiently to hold diaphragm 147 in its leftward position maintaining switch 150 closed. The switch cannot thereafter open, as long as the engine is running, even under the most adverse engine suction conditions which would be accompanied by substantial opening of the throttle. This, in turn, acts through lever elements 154 and 155 to mechanically hold switch 150 closed and solenoid 126 is energized to hold open the valve 132.

During pumping action of main pump diaphragm 72*a* scavenger pump diaphragm 100 is caused to reciprocate, alternately drawing fluid past inlet check valves 118 and forcing this fluid through outlet check valve 119 and orifice restriction 112 and passages 113 and 114 into constant level bowl 30*b*. When substantial quantities of vapor or gaseous matter are being drawn past inlet checks 118 and forced past check 119 and through passage 161 into pressure chamber 162, there is insufficient back pressure against diaphragm 120 to hold valve 121 in a restricting position against the main pump discharge pressure so that valve 121 opens and the main pump diaphragm is permitted increased pumping action. However, when liquid is being pumped through passages 116, 111, and 161, the resultant back pressure on diaphragm 120 will cause restriction of the main pump discharge passaging 46*b*, 123, and 162. As previously explained in connection with FIGS. 3 and 5, during normal operation, valve 121 will act as a metering valve to adjust the pumping action of the main pump in proportion to the requirements of the engine. Also, as previously explained, disc valve 121 will be drawn against seating 122 during each intake stroke of the main pumping diaphragm so that this valve functions in lieu of the usual discharge check valve heretofore mounted in the pump body.

It should be understood that in this modification, the scavenger pump and the diaphragm operated valve are two distinct elements, rather than combined, as heretofore in the previous modifications, and that the valve 121 is normally held closed due to the fact that, although the pressure in lines 18 and 107 is substantially the same, the area upon which this pressure acts on the diaphragm 120 and the valve 121 is so out of proportion that the valve 121 will slightly open only intermittently on each pump stroke so long as there is a solid column of fuel held under pressure in the chamber 162 by the small restriction 112. This, in turn, depends upon whether or not there is sufficient fuel in the overflow chamber 31*b* to feed the scavenger pump 106, which draws the fuel in through the intake valve 118 and exhausts the fuel through the outlet 119, filling the chamber 162 and producing a head of fuel pressure against the diaphragm 20 proportional to the resistance of the metering restriction 112. This metering restriction is so selected as to have a capacity which is preferably smaller than the maximum rate of fuel consumption by the engine.

Any time that bubbles of air or vapors begin to accumulate within the chamber 162 or on the discharge side of the check 119, the force on the diaphragm 120 diminishes very rapidly, due to the fact that the pressure drops in the chamber 162. As the closing force on the diaphragm 120 diminishes, it will eventually become insufficient to hold the valve 121 closed against the full head of pump pressure from the main pump through the line 18, and fuel will then pass the valve 121 and flow through the passages 162 and 114 to the fuel bowl. A supplemental amount of fuel is simultaneously delivered through the passages 111 and 113 from scavenger pump action.

When the ignition is turned off, solenoid 126 is completely de-energized, and spring 133 closes metering restriction 112. The consumption of fuel of the engine will be low, and it will rotate several times due to the inertia of the parts. Since the fuel consumption is low and the pump capacity is relatively large, there will be sufficient fuel delivered to fill overflow chamber 31*b* so that the booster pump will be producing a full head of

fuel to close the valve 121. If now heat produces an excessively high pressure in any one of the lines 107 or 118, the valve 121 will remain closed, preventing fuel burping through the line 18 and into the fuel bowl.

Accordingly, means have been provided for accomplishing all of the objects set forth heretofore. Of course, the various carburetor and engine control features may be modified in various respects as will occur to those skilled in the art and exclusive use of all modifications as come within the scope of the appended claims is contemplated.

I claim:

1. A fuel supply system for an internal combustion engine comprising a carburetor having bowl structure forming a constant level chamber of the overflow type and a spill chamber for receiving overflow therefrom, a cavity in a wall of said bowl structure, a flexible diaphragm traversing said cavity and forming, respectively, a pulsing chamber and a scavenger pumping chamber on opposite sides thereof, inlet and outlet ducts with check valves leading from said pumping chamber to said spill and constant level chambers, respectively, a main fuel pump having a discharge passage leading to said pulsing chamber and thence to said constant level chamber, there being a valve seat on a portion of said discharge passage opening into said pulsing chamber and a valve element carried by said diaphragm for cooperating with said seat to variably restrict said discharge passage responsive to varying pressure differential in said pulsing and pumping chambers.

2. A fuel supply system as described in claim 1 in which said diaphragm has sufficient slack to flex in rhythm with the pumping action of said main pump for causing pumping through said ducts even when said valve element is in a restricting position with respect to said seat.

3. A fuel supply system as described in claim 2 in which said valve element is designed to seat during each intake stroke of said main pump so as to function as an outlet check valve therefor.

4. A fuel supply system for an internal combustion engine, said system comprising a carburetor having a constant level fuel bowl of the overflow type and a spill bowl for receiving overflow fuel from said fuel bowl, means forming a cavity within said carburetor and an inlet passage to said cavity, a flexible diaphragm sealed across said cavity and forming two chambers, a check valve element carried by said diaphragm, an outlet passage from one of said cavity chambers to said fuel bowl, said outlet passage having a valve seat surface within said one cavity chamber, a spring biasing said check valve element against said valve seat surface to close said outlet passage, an inlet duct connecting said spill bowl with the other one of said two chambers, an inlet valve structure within said inlet duct, an outlet duct means connecting said other chamber with said fuel bowl, an outlet valve structure within said outlet duct, a main fuel pump having an outlet therefrom, conduit means connecting said pump outlet with one end of said carburetor inlet passage, the other end of said carburetor inlet passage opening into said one cavity chamber whereby pulsations of fuel pumped through said conduit means will exert pressure pulses on said diaphragm.

5. A fuel supply system for an internal combustion engine, said system comprising a carburetor having a constant level fuel bowl of the overflow type and a spill bowl for receiving overflow fuel from said fuel bowl, means forming a cavity within said carburetor and an inlet passage to said cavity, a flexible diaphragm sealed across said cavity and forming a pulsating chamber and a scavenging chamber, a check valve element carried by said diaphragm, an outlet passage from said pulsating chamber to said fuel bowl, said outlet passage having a valve seat surface within said pulsating chamber, a spring biasing said check valve element in opposition to fuel pressure in said pulsating chamber and against said valve seat surface to close said outlet passage, an inlet duct connecting said spill bowl with said scavenging chamber, an inlet valve structure within said inlet duct, an outlet duct means connecting said scavenging chamber with said fuel bowl, an outlet valve structure within said outlet duct, a main fuel pump having an outlet therefrom, conduit means connecting said pump outlet with one end of said carburetor inlet passage, the other end of said carburetor inlet passage opening into said pulsating chamber whereby pulsations of fuel pumped through said conduit means will exert pressure pulses on said diaphragm.

6. A fuel supply system for an internal combustion engine, said system comprising a carburetor having a constant level fuel bowl of the overflow type and a spill bowl for receiving overflow fuel from said fuel bowl, a main fuel pump having a pumping chamber and an outlet therefrom, said carburetor including a pair of chambers, fuel passage means connecting one of said chambers to said main fuel pump outlet and said fuel bowl, said fuel passage means including a valve seat surface and a check valve element within said one chamber, means biasing said check valve element against said valve seat surface to close said fuel passage, a scavenging pump including fuel duct structure connecting said spill bowl and said fuel bowl with the other one of said chambers, an inlet valve within said duct structure between said spill bowl and said other chamber, means forming a restricted orifice within said duct structure between said other chamber and said fuel bowl, a diaphragm exposed to fuel in said pumping chamber and to fuel in said duct structure for exerting pumping pressures to the fuel in said duct structure.

7. A fuel supply system for an internal combustion engine, said system comprising a carburetor having a constant level fuel bowl of the overflow type and a spill bowl for receiving overflow fuel from said fuel bowl, a main fuel pump having a pumping chamber and an outlet therefrom, said carburetor including a pair of chambers, fuel passage means connecting one of said chambers to said main fuel pump outlet and said fuel bowl, said fuel passage means including a valve seat surface and a check valve element within said one chamber, means biasing said check valve element against said valve seat surface to close said fuel passsage, a scavenging pump means including fuel duct structure connecting said spill bowl and said fuel bowl with the other one of said chambers, an inlet valve within said duct structure between said spill bowl and said other chamber, means forming a restricted orifice within said duct structure between said other chamber and said fuel bowl, a diaphragm exposed to fuel in said pumping chamber and to fuel in said duct structure for exerting pumping pressures to the fuel in said duct structure, closure means for said restricted orifice including a valve and a valve seat, and structure for biasing said valve against said valve seat.

8. A fuel supply system for an internal combustion engine, said system comprising a carburetor having a constant level fuel bowl of the overflow type and a spill bowl for receiving overflow fuel from said fuel bowl, a main fuel pump having a pumping chamber and an outlet therefrom, said carburetor including a pair of chambers, fuel passage means connecting one of said chambers to said main fuel pump outlet and said fuel bowl, said fuel passage means including a valve seat surface and a check valve element within said one chamber, means biasing said check valve element against said valve seat surface to close said fuel passage, a scavenging pump means including fuel duct structure connecting said spill bowl and said fuel bowl with the other one of said chambers, an inlet valve within said duct structure between said spill bowl and said other chamber, means forming a restricted orifice within said duct structure between said other chamber and said fuel bowl, a

diaphragm exposed to fuel in said pumping chamber and to fuel in said duct structure for exerting pumping pressures to the fuel in said duct structure, and closure means for said restricted orifice including a valve, a valve seat and structure for biasing said valve against said valve seat, said biasing structure comprising a float device within said fuel bowl.

9. A fuel supply system for an internal combustion engine, said system comprising a carburetor having a constant level fuel bowl of the overflow type and a spill bowl for receiving overflow fuel from said fuel bowl, a main fuel pump having a pumping chamber and an outlet therefrom, said carburetor including a pair of chambers, fuel passage means connecting one of said chambers to said main fuel pump outlet and said fuel bowl, said fuel passage means including a valve seat surface and a check valve element within said one chamber, means biasing said check valve element against said valve seat surface to close said fuel passage, a scavenging pump means including fuel duct structure connecting said spill bowl and said fuel bowl with the other one of said chambers, an inlet valve within said duct structure between said spill bowl and said other chamber, means forming a restricted orifice within said duct structure between said other chamber and said fuel bowl, a diaphragm exposed to fuel in said pumping chamber and to fuel in said duct structure for exerting pumping pressures to the fuel in said duct structure, said orifice means including a valve seat, a valve, and structure to bias said valve against said valve seat, and means including a solenoid to open said valve against the action of said biasing structure.

10. A fuel supply system for an internal combustion engine, said system comprising a carburetor having a constant level fuel bowl of the overflow type and a spill bowl for receiving overflow fuel from said fuel bowl, means forming a mixture conduit extending through said carburetor, a throttle valve movably mounted within said mixture conduit, a main fuel pump having a pumping chamber and an outlet therefrom, said carburetor including a pair of chambers, fuel passage means connecting one of said chambers to said main fuel pump outlet and said fuel bowl, said fuel passage means including a valve seat surface and a check valve element within said one chamber, means biasing said check valve element against said valve seat surface to close said fuel passage, a scavenging pump means including fuel duct structure connecting said spill bowl and said fuel bowl with the other one of said chambers, an inlet valve within said duct structure between said spill bowl and said other chamber, means forming a restricted orifice within said duct structure between said other chamber and said fuel bowl, a diaphragm exposed to fuel in said pumping chamber and to fuel in said duct structure for exerting pumping pressures to the fuel in said duct structure, said orifice means including a valve seat, a valve, and structure to bias said valve against said valve seat, and means including a solenoid to open said valve against the action of said biasing structure, said last means comprising an electrical circuit including said solenoid and a switch operatively connected to said throttle.

11. A fuel supply system for an internal combustion engine, said system comprising a carburetor having a constant level fuel bowl of the overflow type and a spill bowl for receiving overflow fuel from said fuel bowl, means forming a mixture conduit extending through said carburetor, a throttle valve operatively mounted within said mixture conduit, a main fuel pump having a pumping chamber and an outlet therefrom, said carburetor including a pair of chambers, fuel passage means connecting one of said chambers to said main fuel pump outlet and said fuel bowl, said fuel passage means including a valve seat surface and a check valve element within said one chamber, means biasing said check valve element against said valve seat surface to close said fuel passage, a scavenging pump means including fuel duct structure connecting said spill bowl and said fuel bowl with the other one of said chambers, an inlet valve within said duct structure between said spill bowl and said other chamber, means forming a restricted orifice within said duct structure between said other chamber and said fuel bowl, a diaphragm exposed to fuel in said pumping chamber and to fuel in said duct structure for exerting pumping pressures to the fuel in said duct structure, a valve device in said duct structure for controlling fuel flow through said orifice, an electrical circuit including a solenoid and a switch for closing said circuit to open said valve device, air motor means operatively connected to said switch, and means forming a passage from said air motor to a point in said mixture conduit downstream of said throttle valve.

12. A carburetor comprising a constant level fuel bowl of the overflow type and a spill bowl for receiving overflow fuel from said fuel bowl, means forming a cavity within said carburetor and an inlet passage to said cavity, a flexible diaphragm sealed across said cavity and forming two chambers, a check valve element carried by said diaphragm, means forming a fuel passage in said carburetor extending into one of said cavity chambers and to said fuel bowl, said fuel passage having a valve seat surface within said one cavity chamber, a spring biasing said check valve element against said valve seat surface to block said fuel passage, fuel duct means connecting said spill bowl and said fuel bowl with the other one of said two chambers, an inlet valve structure in said fuel duct means between said spill bowl and said other chamber, means forming a restricted orifice within said fuel duct means between said other chamber and in said fuel bowl, and means to control the flow of fuel through said restricted orifice, said carburetor inlet passage extending from an inlet thereto to said one cavity chamber, whereby pulsations of fuel pumped into said inlet passage will exert pressure pulses on said diaphragm.

13. A carburetor comprising a constant level fuel bowl of the overflow type and a spill bowl for receiving overflow fuel from said fuel bowl, means forming a cavity within said carburetor and an inlet passage to said cavity, a flexible diaphragm sealed across said cavity and forming two chambers, a check valve element carried by said diaphragm, means forming a fuel passage in said carburetor extending into one of said cavity chambers and to said fuel bowl, said fuel passage having a valve seat surface within said one cavity chamber, a spring biasing said check valve element against said valve seat surface to block said fuel passage, fuel duct means connecting said spill bowl and said fuel bowl with the other one of said two chambers, an inlet valve structure within said fuel duct means between said spill bowl and said other chamber, means, forming a restricted orifice within said fuel duct means between said other chamber and said fuel bowl, and means to control the flow of fuel through said restricted orifice, the inlet end of said carburetor inlet passage being adapted to be connected to a fuel pump, the other end of said carburetor inlet passage opening into said one cavity chamber whereby pulsations of fuel pumped through said inlet passage will exert pressure pulses on said diaphragm, said orifice control means including a float in said fuel bowl to bias said orifice control means in an orifice closing direction.

14. A carburetor comprising a constant level fuel bowl of the overflow type and a spill bowl for receiving overflow fuel from said fuel bowl, means forming a cavity within said carburetor and an inlet passage to said cavity, a flexible diaphragm sealed across said cavity and forming two chambers, a check valve element carried by said diaphragm, means forming a fuel passage in said carburetor extending into one of said cavity chambers and to said fuel bowl, said fuel passage having a valve seat surface within said one cavity chamber, a spring biasing said check valve element against said valve seat surface to block said fuel passage, fuel duct means con-

necting said spill bowl and said fuel bowl with the other one of said two chambers, an inlet valve structure in said fuel duct means between said spill bowl and said other chamber, means forming a restricted orifice within said fuel duct means between said other chamber and said fuel bowl, and means to control the flow of fuel through said restricted orifice, the inlet end of said carburetor inlet passage being adapted to be connected to a fuel pump, the other end of said carburetor inlet passage opening into said one cavity chamber whereby pulsations of fuel pumped through said inlet passage will exert pressure pulses on said diaphragm, said orifice control means including a closure valve, a spring operatively connected to said closure valve to bias said closure valve into an orifice closing position and a solenoid means mounted on said carburetor to open said closure valve against the bias of said spring.

15. A carburetor comprising a constant level fuel bowl of the overflow type and a spill bowl for receiving overflow fuel from said fuel bowl, means forming a cavity within said carburetor and an inlet passage to said cavity, a flexible diaphragm sealed across said cavity and forming two chambers, a check valve element carried by said diaphragm, means forming a fuel passage in said carburetor extending into one of said cavity chambers and to said fuel bowl, said fuel passage having a valve seat surface within said one cavity chamber, a spring biasing said check valve element against said valve seat surface

to block said fuel passage, fuel duct means connecting said spill bowl and said fuel bowl with the other one of said two chambers, an inlet valve structure in said fuel duct means between said spill bowl and said other chamber, means forming a restricted orifice within said fuel duct means between said other chamber and in said fuel bowl, and means to control the flow of fuel through said restricted orifice, the inlet end of said carburetor inlet passage being adapted to be connected to a fuel pump, the other end of said carburetor inlet passage opening into said one cavity chamber whereby pulsations of fuel pumped through said inlet passage will exert pressure pulses on said diaphragm, said orifice control means including a ball valve in said duct structure and a spring biasing said ball valve into said orifice.

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