June 19, 1962 E. A. JOHNSON 3,039,748

FUEL SUPPLY FOR INTERNAL COMBUSTION ENGINE

Filed Aug. 25, 1958 3 Sheets-Sheet 1

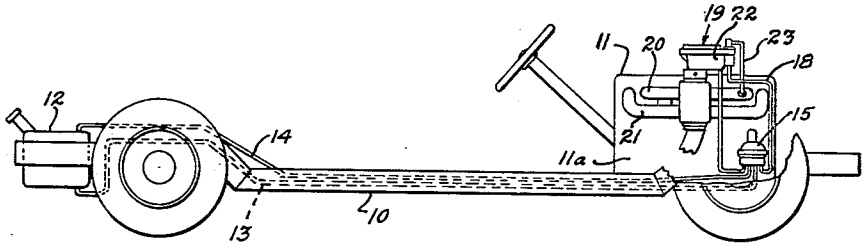


FIG. 1.

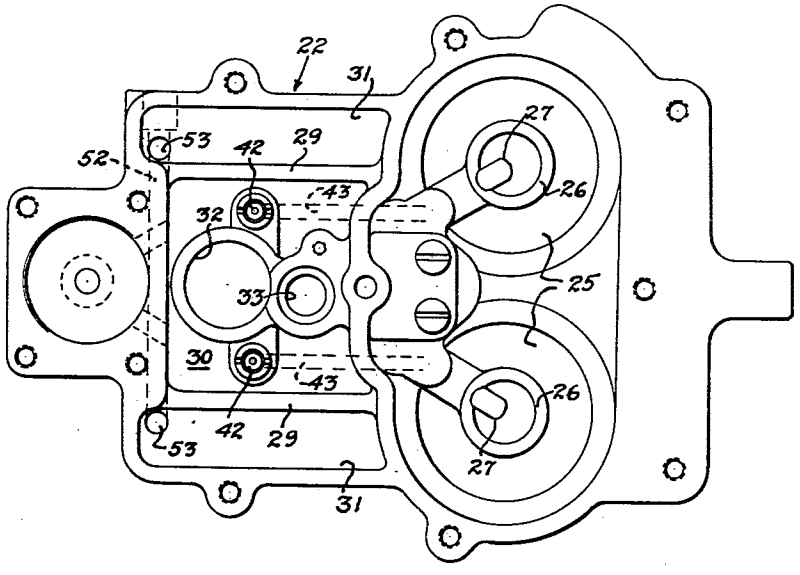


FIG. 2.

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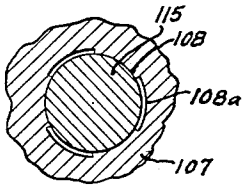


FIG. 4.

FIG. 3.

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FUEL SUPPLY FOR INTERNAL COMBUSTION ENGINE

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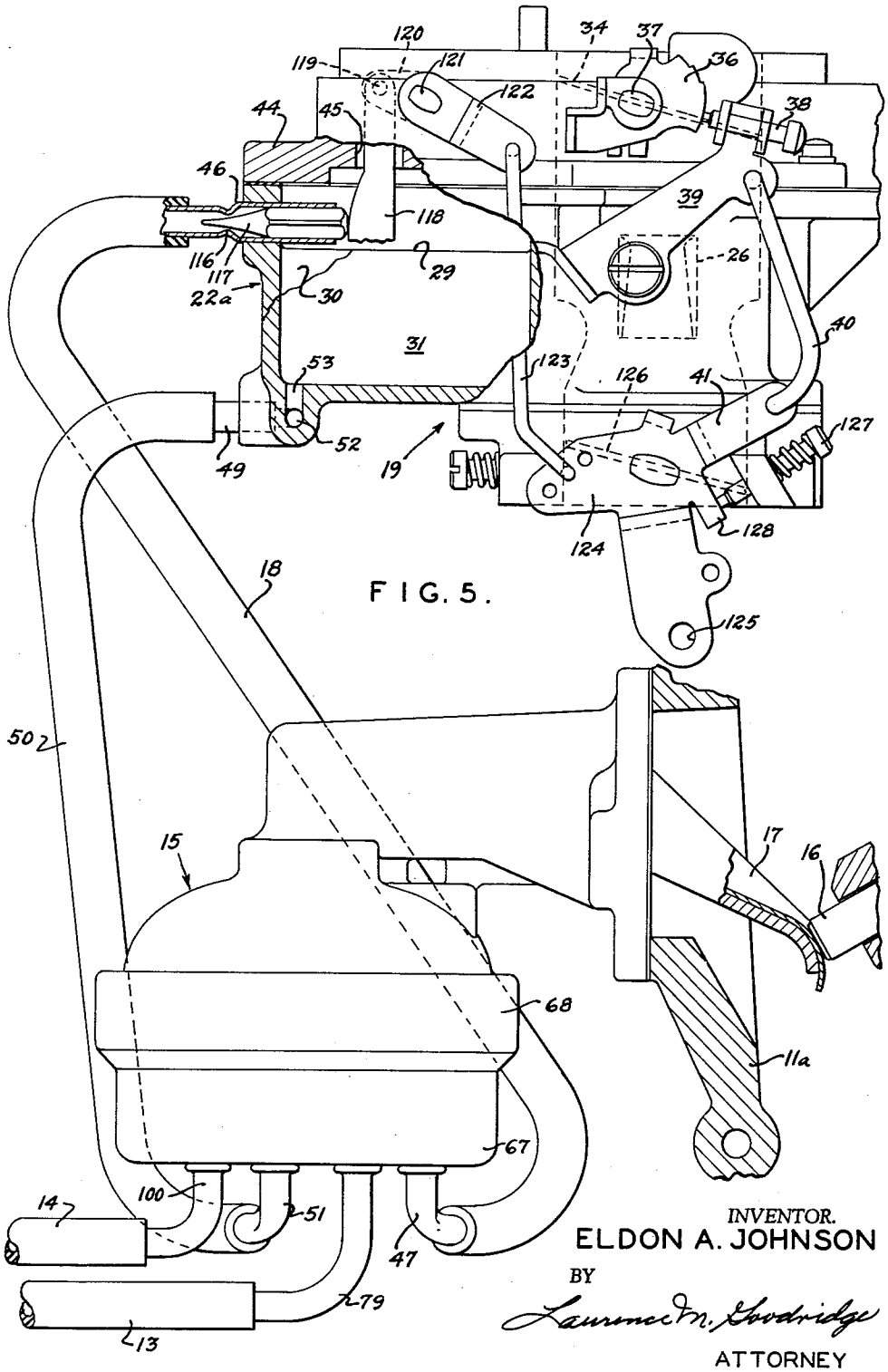


FIG. 5.

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FUEL SUPPLY FOR INTERNAL COMBUSTION ENGINE

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4 Claims. (Cl. 261—36)

This invention relates to fuel supply systems for internal combustion engines and consists particularly in novel means for preventing excessive pressure build up in the fuel pump and supply lines, while providing for adequate fuel delivery and efficiency of the pump, improved metering characteristics of the carburetor, and a considerably simplified and therefore less expensive carburetor construction.

In my co-pending application, Serial No. 739,267 filed June 2, 1958, now Patent No. 3,003,753 dated October 10, 1961, and Serial No. 739,268 filed June 2, 1958, there are illustrated and claimed various fuel supply systems for internal combustion engines utilizing carburetors with constant level chambers of the overflow type and fuel pumps incorporating scavenger pumps for evacuating the overflow chambers. Thus, even during engine idling, a constant supply of liquid fuel is circulated from the pump through the carburetor bowl, thence back to the scavenger pump. The scavenger pump is operated by a liquid link from the main pump and during periods of low fuel consumption, 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 produce the recirculating action of the scavenger pump. In those devices, means are provided for applying back pressure upon the pump chamber in accordance with the delivery pressure of the scavenger pump so as to limit the pump delivery in accordance with fuel demands of the engine.

It is the main object of the present invention to provide a recirculating fuel system incorporating other, somewhat simplified means for adjusting the pump delivery in accordance with the engine fuel supply demands, while insuring a continuous, minimum supply of liquid fuel through the system, even at periods of idling and low load operation of the engine.

Another object is to provide means for restricting the fuel delivery from the pump to the carburetor substantially in proportion with engine load and, therefore, fuel demands.

Another object is to provide means for restricting the fuel connection between the pump and carburetor substantially in accordance with engine fuel demand as sensed by the position of the throttle, so that the fuel line and throttle will be in restricting positions and vice versa at substantially the same times.

Still another object is to provide means for restricting the fuel connection between the pump and carburetor under conditions of low load operation of the engine, as sensed by a device which responds to manifold suction.

These objects are accomplished in the present invention which embodies a more or less conventional main fuel pump of the engine-charged, spring-discharged type and also including a scavenger pump which is hydraulically operated from the main pump. The carburetor has a constant level fuel bowl of the overflow type having an inlet which is connected to the outlet of the main fuel pump, the overflow portion of the bowl being connected by a duct to the inlet of the scavenger pump. A tube connected to the scavenger pump outlet returns the recirculated fuel to the fuel tank. A restricting valve is provided in the bowl inlet capable of limiting, but not completely cutting off, the fuel supply connection to the bowl.

The valve may be operated by any device which senses engine load and fuel requirements, in the present instance, either in accordance with throttle position, or with manifold suction conditions.

In the accompanying drawings which illustrate the invention,

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 FIG. 3 with the bowl cover removed.

FIG. 3 is a somewhat schematic vertical sectional representation of the fuel pump device and carburetor.

FIG. 4 is a detail section taken on line 4—4 of FIG. 3.

FIG. 5 is a side view of a pump and carburetor assembly illustrating a modification, portions of the carburetor being broken away and sectioned.

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 and return tubes **13** and **14** to a mechanical fuel pump **15** mounted at the side of crankcase **11***a* of the engine and operated from the engine camshaft (not shown) as by a push rod **16** and pivoted lever **17** (FIG. 5). The pump is connected by supply tubing **18** to the carburetor **19** mounted on the engine intake manifold **20** in the customary manner. An engine exhaust manifold is shown at **21**. The carburetor bowl **22** (FIGS. 1, 2 and 3) is connected to the intake manifold by a tube **23**, to be further described hereafter.

The carburetor, which is the same in both forms, except for the fuel inlet portion, and is most completely shown in FIGS. 2 and 5, has a pair of down draft mixture conduits **25**, each including an inner venturi tube **26** into which discharges a main fuel supply nozzle **27**. At the side of the carburetor is the fuel supply bowl, generally indicated at **22** in FIG. 3 and **22***a* in FIG. 5, having parallel partitions or weirs **29**, forming a central, constant level chamber **30** and side 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. Pivotally mounted in the upper part of the mixture conduit structure, is a butterfly choke valve **34** for which suitable control mechanism (not shown) is provided. A fast idle cam **36** is carried at the end of the choke shaft **37** for cooperation with an abutment screw **38** on pivoted lever **39** linked to the throttle valve **126** by elements **40** and **41**.

At the bottom of constant level chamber **30** are a pair of main 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. Bowl cover **44** is provided with a vent opening **45**, which may be connected to a balance tube opening into the air horn, or to the atmosphere outside the air horn, as desired. An inlet fitting **46** (FIG. 5) is mounted in the sidewall of the bowl and is connected by means of a tube **18** to main discharge fitting **47** of fuel pump **15**. At the bottom of the bowl is a second fitting **49** connected by a tube **50** to inlet fitting **51** leading to the scavenging portion of the pump, to be described hereafter. Fitting **49** is connected by a cross passage **52** to ports **53** opening into the bottoms of overflow chambers **31**. Distinguishing features of the carburetor bowl shown in FIG. 3 will be described hereafter.

The pump, which is identical in both forms and best shown in FIG. 3, consists of a pair of casing members **56** and **57**, having flanges **58** and **59** with inclined, abutting faces which clamp the periphery of main pumping diaphragm **60**. The diaphragm is centrally clamped between

washers 61 and 62, which are shaped at their peripheries to maintain the free flexing portion of the main diaphragm between the washers and casing flanges in a loop or bight 63 extending into the main pumping chamber 64, as covered in Johnson and White Patent No. 2,840,003. An actuating stem 65 is centrally secured to the pumping diaphragm and its clamping washers and connected by lever 17 and push rod 16 to the engine cam for causing intermittent motion of the diaphragm in the upward or charging direction. The intervening pumping strokes of the diaphragm are produced by expansion of coiled compression spring 66, which bears against the upper surface of diaphragm clamping washer 62. This type of pump actuating means serves to limit discharge pressure of the pump, while varying the discharge volume thereof substantially in inverse relationship to the back pressure in the pump outlet for moderate rates of diaphragm reciprocation.

Diaphragm clamping flanges 58 and 59 are themselves clamped together and about the main pumping diaphragm by a sheet metal cup 67 which underlies pump body member 56 with intervening gasket 67*a* and is formed in its upper portion, as at 68 to embrace and permanently secure together the pump casing flanges and diaphragm. Lower pump body part 56 has transverse apertures 70 and 71, respectively, receiving outlet check valve 72, biased by coil spring 73 seating on a collar 74, and inlet check valve 75, biased by coil spring 76 seating on a collar 77. Outlet check 72 cooperates with a seat forming ridge on the periphery of main pump discharge port 78, while inlet valve 75 cooperates with a similarly formed seat at the inner extremity of inlet passage 71. Discharge fitting 47 is sealingly secured within an opening in clamping cup 67 aligned with discharge passage 70 in the pump body. Inlet fitting 79 is similarly secured within an opening in the clamping cup aligned with inlet passage 71. Fitting 79 is connected by tube 13 to the remote fuel tank.

Pump body 56 has a generally cylindrical recess 82 at one side which is inwardly concaved at the top, as at 83, to form pulsator chamber 84 of the scavenging pump, which is connected by ample passages 85 to main pumping chamber 64. A scavenger diaphragm 86 traverses pulsator chamber 84 and its periphery is clamped against the upper wall of body recess 82 by means of a generally cylindrical body sub-member 87 flanged, as as 88, for attaching screw 89 which assists clamping cup 67 in maintaining the assembly. Body sub-member 87 has cross passages 90 and 91, respectively, receiving inlet check valve 92, biased by coil spring 93 seated on collar 94, and outlet check valve 95 biased by a coil spring 96 seated on a collar member 97. Inlet check valve 92 cooperates with a ridged seating annulus formed on inlet passage or port 90, while spring seating collar 94 is centrally apertured to connect passage 90 to scavenger pumping chamber 98 beneath scavenger diaphragm 86. Outlet check valve 95 cooperates with a seating ridge on discharge port 99 also communicating with the scavenger pump chamber. Fitting 51 is sealingly secured in an opening in clamping cup 67 aligned with inlet passage 90, while fitting 100 is similarly secured in an opening in cup 67 aligned with inlet passage 91. Fitting 51 is connected by tube 50 to overflow drain fitting 49 at the bottom of the carburetor bowl. Fitting 100 is connected to previously-mentioned tube 14 which returns the overflow to the fuel tank.

In the form of carburetor shown as FIGS. 2 and 3, main pump discharge tube 18 is connected to fitting 105 opening into inlet port 106 formed in a boss 107 on the side of carburetor fuel bowl 22. Port 106 communicates through a valve seat restriction 108 with a chamber 109 beneath a flexible diaphragm 110 normally biased downwardly by a coiled spring 111 seating against the upper wall of a chamber 112 in cap 113 above the diaphragm. Diaphragm 110 is suitably clamped between boss 107 and cap 113 as by machine screws in bolting flanges provided on the boss and cap. A pin 114, centrally secured to diaphragm 110, carries a valve 115 at its lower extremity for controlling valve seat restriction 108. Chamber 109 communicates with the interior of constant level chamber portion 30 of the fuel bowl through passages 120. Tube 23 connects a fitting 24 opening into pressure chamber 112 above diaphragm 110 with intake manifold 20 (FIG. 1). Valve seat restriction 108 is fluted, as at 108*a* (FIG. 4), so that when valve 114 is seated, or in its most restricting position, the restriction is not fully closed, but merely reduced to its mniimum effective size. If desired, the same function may be accomplished by limiting the upward stroke of diaphragm, as by a suitable stop.

During operation of the engine, main pumping diaphragm 60 will be caused to reciprocate by the alternate, opposing actions of cam-actuated push rod 16 and coil spring 66. During the upward or charging stroke of the diaphragm, caused by cam action, fuel will be drawn from tank 12 past inlet check 75 into main pump chamber 64. During the downward or discharge action of the main diaphragm, caused by expansion of spring 66, this fuel will be forced out through port 78 past discharge check 72 and through supply tube 18, port 106, valve seat restriction 108, chamber 109, and passages 120 into constant level fuel chamber 30. This fuel will be available for supply through metering orifice elements 42, passages 43 and main nozzles 27 to the carburetor, where it is mixed with air and thence delivered by induction through intake manifold 20 to the engine firing chambers. When liquid fuel in constant level 30 chamber reach the top of baffles or weirs 29, the fuel overflows into overflow chambers 31.

Pumping action of main diaphragm 60 also acts, by means of the hydraulic link formed in passages 85 and pulsator chamber 84 to reciprocate scavenging diaphragm 86. During the upward, charging stroke of main diaphragm 60, a scavenging diaphragm 86 is also drawn upwardly so as to draw fluid through overflow return tube 50 and past inlet check 92 into scavenging chamber 98. Upon the downward or discharge stroke of main diaphragm 60, the scavenging diaphragm is caused to move downwardly so as to force fuel drawn into chamber 98 on the previous stroke outwardly through tube 14 for return to the tank. Inlet control valve 115 and valve seat restriction 108 are designed, when valve 115 is drawn fully upwardly under maximum intake manifold suction conditions, to provide sufficient fuel for idling operation of the engine, together with a surplus which passes through the overflow chambers and return tube 50 into the scavenging pump and thence is returned to the tank. Thus a constant, cooling circulation of liquid fuel is maintained through the pump and carburetor even at periods of lowest engine fuel consumption.

Spring 111 acting on valve diaphragm 110 is calibrated to permit downward or valve opening movement of the diaphragm as the intake manifold suction decreases in correspondence with increasing power demands on the engine, as accompanied by increasing opening of the throttle valve or increasing speed of the engine. When the power demands on the engine are greatest so as to require maximum fuel delivery, valve 115 will be in its lowermost or least restricting position to provide maximum effective clearance through valve seat restriction 108 for adequate supply of fuel to the carburetor.

During low speed—low power demand—low fuel demand operation of the engine, when intake manifold suction is greatest, i.e., at lowest pressure, valve 115, being in its most restricted position, will create sufficient back pressure within main pump chamber 64 to limit the discharge action of main diaphragm 64 just sufficiently to produce a full stroke of scavenger diaphragm 86 and to supply slightly in excess of the fuel consumed by the engine to maintain the liquid fuel circulation referred to above. On the other hand, when the engine power and fuel demands are increased, as sensed by decreased mani-

fold suction (increased pressure) the restriction of valve seat **108** around valve **115** will be reduced and the back pressure within main pump chamber **64** correspondingly reduced to permit an increased stroke of the main pump and consequent increased fuel delivery.

Since a portion of the main pump capacity is utilized in actuating the scavenger pump and further, in view of the restriction of the supply to the carburetor at times of low fuel demand, the efficiency of the main pump may be increased without unduly increasing the fuel supply to the bowl and upsetting metering. In the usual pump carburetor float bowl installation, the float actuated needle valve controlling the constant lever chamber can resist limited pressure in the fuel supply line. Supply pressures above that limit tend to unseat the float valve so as to excessively raise the fuel level and abnormally enrich the fuel mixture delivered by the carburetor or even cause flooding and stalling. This condition is eliminated in the present invention. The increased efficiency of the main pump permits the better handling of vapors and easier priming of the pump. Such improved efficiency may be achieved either by increasing the size or stroke of the diaphragm (displacement), or increasing the effective size of the intake and discharge ports and valves of the pump. Thus, the main pump can more readily purge itself of air or vapors.

Another advantage of the present invention lies in its anti-stall action. In case the engine speed should drop because of insufficient liquid fuel in bowl **30**, inlet control valve **115** will be moved to a less restricting position, because of the reduced manifold suction. This in turn tends to reduce the pump back pressure and increase the pump stroke and the rate of fuel delivery to the carburetor bowl to remedy the impending starving condition.

In the modification in FIG. 5, all parts identical with corresponding parts in FIG. 3 are given like reference numerals. Inlet fuel fitting **46** is provided with a valving restriction **116** with which a needle valve **117** cooperates. The needle valve, in turn, is urged inwardly or toward its restricting position by a camming element **118** which slides through vent **45** in bowl cover **44**, and at its upper extremity, is pivotally connected at **119** to an arm **120** rigid on a countershaft **121** rotatably supported above the bowl cover. At the end of shaft **121**, there is secured an arm **122** connected by a link **123** to throttle-operating crank **124**, which also includes the element **41** previously mentioned, connected to fast idle link **40**. Crank **124** has an apertured arm **125** for connection by suitable linkage to the usual throttle pedal in the driver's compartment. The normal idling position of throttle disc valve **126** is adjusted by means of a screw **127** which cooperates with the finger **128** formed on throttle crank **124**.

Inlet control valve **117** and its operating linkage is designed so that when the throttle valve is in its normal idling position, valve **117** will be pushed inwardly to its maximum restricting position in which, however, restriction **116** is not completely closed. Thus, when the engine is operating under low load, low fuel requirement conditions, as normally accompanied by a restricting position of the throttle valve, fuel delivery fitting **46** will also be restricted. This results in production of a back pressure in the main pumping chamber, as occurs in the previous form under high manifold suction conditions, so as to limit the stroke of the main pump to just sufficient length to provide slightly more fuel than is needed to satisfy the engine requirements. As the throttle valve opens, camming element **118** is lowered to permit rightward or opening movement of needle valve **117** so as to reduce the effective restriction at **116**, thereby resulting in a longer pumping stroke and greater pump delivery to satisfy the corresponding greater engine fuel demand.

In each form, the valve-controlled, carburetor fuel inlet restriction functions as a metering valve which adjusts the pump stroke in accordance with engine fuel demands. Thus, while a constant circulation of cooling liquid is maintained, pump action is not excessive so that long life of the pump is assured. Other means of restricting the fuel inlet, which are sensitive to engine fuel requirements, may be provided, such as a speed responsive device, for instance, of the fly ball or inertia type, or a device responding to generator output voltage. The details of the carburetor and pump construction may be altered in various ways, and these and other modifications may be made, as will occur to those skilled in the art. The exclusive use of all modifications as come within the scope of the appended claims is contemplated.

I claim:

1. In an internal combustion engine, an induction system with a throttle therein, a fuel bowl with an inlet for connection to a source of fuel, means for maintaining a constant head of fuel in said fuel bowl, a valve positioned in said inlet and movable from a partially closed position to an open position, a device responsive to pressure conditions in said induction system, and an operative connection between said device and said valve to shift said valve to said position.

2. The combination described in claim 1 in which said device responds to pressure conditions in said conduit posterior to said throttle, said operative connection causing restriction of said inlet by said valve as the induction conduit pressure drops, while reducing restriction of said inlet as said pressure increases.

3. For use with an internal combustion engine having an intake manifold, a fuel supply system comprising a pump, a carburetor having a constant level chamber of the overflow type with an inlet for attachment to a source of fuel, a valve in said inlet having structure for restricting said inlet, a device responsive to suction conditions in said manifold, and an operative connection between said device and said valve for shifting said valve to a restricting position as the manifold suction increases and opening said valve as the manifold suction drops.

4. The combination specified in claim 3 in which said pump is of the variable delivery-uniform pressure type whereby pump action and delivery of fuel are adjusted in accordance with fuel demands of the engine as sensed by said suction responsive device and said inlet valve.

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