

Feb. 8, 1966

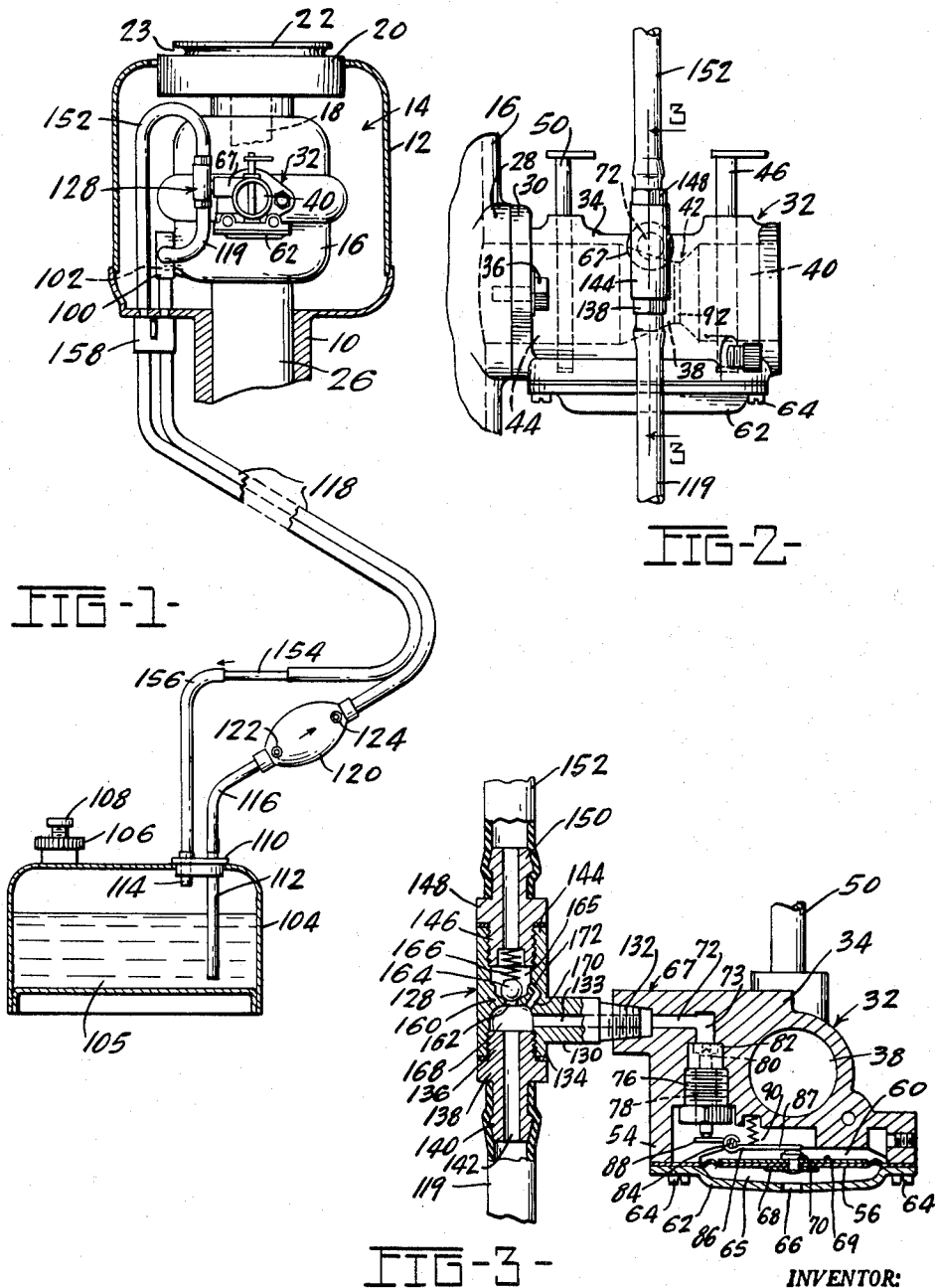
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3,233,652

FUEL FEED SYSTEM FOR CHARGE FORMING APPARATUS

Filed June 18, 1962

3 Sheets-Sheet 1



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3 Sheets-Sheet 2

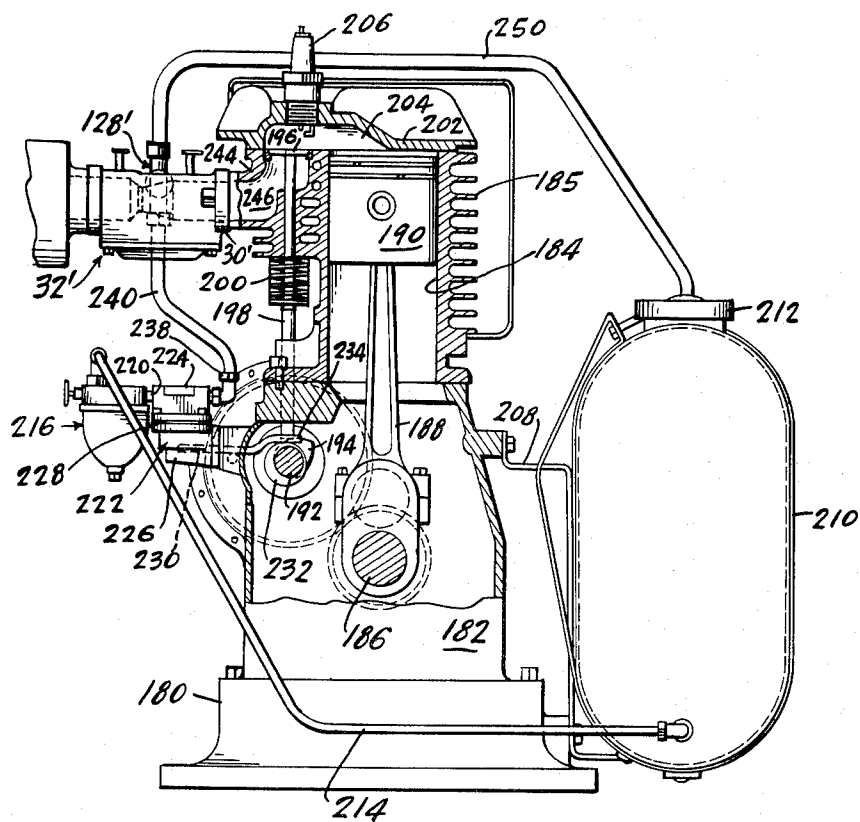


FIG-4-

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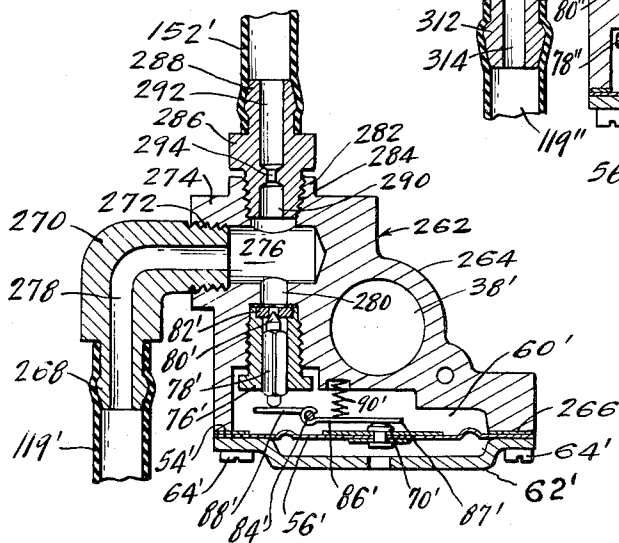
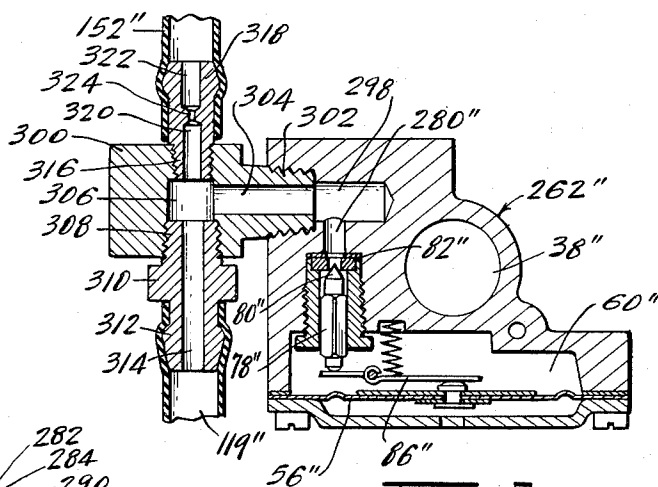
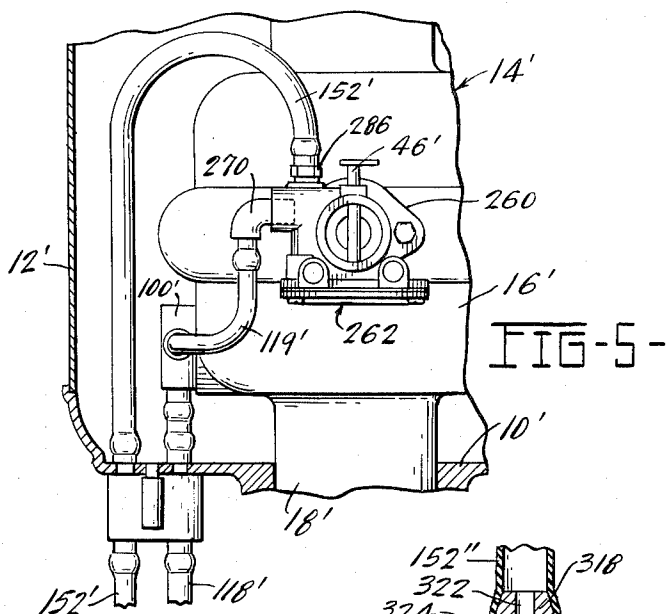
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FUEL FEED SYSTEM FOR CHARGE FORMING APPARATUS

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3 Sheets-Sheet 3



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3,233,652 FUEL FEED SYSTEM FOR CHARGE FORMING APPARATUS

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Filed June 13, 1962, Ser. No. 263,157

6 Claims. (Cl. 158—36.4)

This is a continuation-in-part of my application Serial No. 8,448, filed February 12, 1960, now abandoned.

This invention relates to a fuel feed system especially usable for supplying liquid fuel to a charge forming apparatus or carburetor and which is inclusive of an arrangement for preventing the transmission of an abnormal or excessive fuel pressure to fuel inlet means of the charge forming apparatus.

In the use of both two cycle and four cycle types of internal combustion engine, fuel pumps have been utilized to deliver liquid hydrocarbon fuel under pressure to a valved inlet port of a carburetor or charge forming device particularly in installations where the fuel supply receptacle or tank is disposed beneath or at a lower level than the carburetor. Diaphragm fuel pumps have been used with two cycle engines actuated by varying pneumatic or fluid pressure, as for example, by a connection from the pumping chamber or pumping means with the crankcase of a two cycle engine to set up a pumping action of a diaphragm for delivery of liquid fuel to a carburetor.

Installations of this character are particularly usable with marine engines where the fuel supply tank is disposed below the carburetor or charge forming apparatus, and it has been conventional practice to pressurize the fuel tank by the use of a hand pump.

If the hand pump generates an excess pressure of a magnitude to overcome the bias maintaining the fuel inlet valve of the carburetor in closed position, then flooding of the carburetor ensues.

In internal combustion engines where a mechanically actuated pump is employed, such as a cam driven diaphragm pump on a four cycle engine, means is provided for normally interrupting the mechanical operation of the pump to prevent the transmission of excessive fuel pressure to the carburetor. Such arrangements as have been heretofore used have several disadvantages and have no venting or overflow means to avoid the transmission of abnormal fuel pressure at the carburetor inlet valve means.

The present invention embraces a system for conveying liquid fuel to a charge forming apparatus or carburetor embodying an arrangement for avoiding or preventing the transmission of fuel under excessive pressures to a charge forming apparatus or carburetor and for returning excess fuel to the fuel supply receptacle or tank.

An object of the invention embraces a system for conveying fuel to a carburetor wherein the system embodies a pumping means and an arrangement for returning excess fuel to the fuel supply receptacle wherein the latter is under atmospheric pressure.

Another object of the invention resides in the provision of a by-pass and valve arrangement associated with a fuel conveying system for a carburetor wherein minor overflow of excess fuel is accommodated by the by-pass and wherein a substantial amount of excess fuel under pressure is effective to open a relief valve to facilitate return flow of the excess of fuel under pressure to the supply tank.

Another object of the invention is the provision of a fuel conveying system and apparatus for a carburetor embodying a pressure relief associated with a chamber disposed to collect or accumulate bubbles of volatilized

fuel or gas that may be formed or entrained in the liquid fuel transmitted to the carburetor whereby bubble-free fuel is delivered to the carburetor.

Another object of the invention is the provision of a fuel feed system especially usable with diaphragm type carburetors, the system embodying an arrangement for priming the fuel pumping means in conjunction with an excessive pressure relief means to avoid transmission of fuel under excess pressure to the carburetor, the arrangement including means for visually indicating operative condition of the fuel feed system.

Still another object of the invention resides in the provision of a pressure relief and excess fuel return for a fuel feed system for a carburetor in which the fuel pumping means maintains a bubble-free supply of liquid fuel at the inlet region of the carburetor and a circulation of fuel in the return tube to the fuel tank to promote cooling of the fuel, thus minimizing tendency for vapor-lock in the fuel feed system when operating in warm temperatures.

Another object of the invention is the provision of a fuel conveying system and apparatus for a carburetor embodying means arranged to separate and convey away bubbles of volatilized fuel or gas that may be formed or entrained in the liquid fuel whereby bubble-free liquid fuel is delivered to the carburetor.

Further objects and advantages are within the scope of this invention such as relate to the arrangement, operation and function of the related elements of the structure, to various details of construction and to combinations of parts, elements per se, and to economies of manufacture and numerous other features as will be apparent from a consideration of the specification and drawing of a form of the invention, which may be preferred, in which:

FIGURE 1 is a semidiagrammatic illustration of the fuel feed system of the invention associated with an internal combustion engine of the two cycle type;

FIGURE 2 is an elevational view of the carburetor or charge forming device shown in FIGURE 1;

FIGURE 3 is a transverse sectional view taken substantially on the line 3—3 of FIGURE 2;

FIGURE 4 is an elevational view of a four cycle engine, certain parts being shown in section, illustrating the fuel feed system and arrangement of the invention associated therewith;

FIGURE 5 is an elevational view of a carburetor and fuel conveying system illustrating a modified form of the invention;

FIGURE 6 is a vertical sectional view through the carburetor illustrated in FIGURE 5, and

FIGURE 7 is a sectional view illustrating a further form of the invention.

While the fuel feed system and arrangement of the invention has particular utility in combination with a charge forming device or carburetor of the diaphragm type employed in conjunction with both two cycle and four cycle engines, it is to be understood that the fuel feed system and arrangement of the invention may be utilized with charge forming devices or carburetors of the float type wherein a float controlled valve means regulates the flow of liquid fuel into the carburetor.

FIGURE 1 of the drawings illustrates in semidiagrammatic form the apparatus of the system of the invention utilized with a carburetor or charge forming device of the diaphragm type employed for delivering a mixture of hydrocarbon liquid fuel and air into the crankcase of an internal combustion engine of the two cycle type usable for propelling small boats or other engines of this type where it is usual for the fuel tank or fuel receptacle to be disposed or positioned beneath the carburetor and

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requiring fuel pumping means to deliver fuel from the tank or receptacle to the carburetor.

With particular reference to FIGURE 1, there is illustrated a support 10 upon which is mounted a sheet metal housing or closure 12. Disposed within the housing 12 is an engine 14 of the two cycle or two stroke type, the crankcase 16 of the engine being illustrated in FIGURE 1. The crankshaft 18 of the engine is disposed vertically and is provided at its upper end with a fly wheel 20. The fly wheel may be equipped with an extension 22 fashioned with a peripheral groove 23 adapted to receive a starting cord or other means for starting the engine in conventional manner.

A cylinder (not shown) is associated with a crankcase 16 in which is mounted a reciprocable piston connected to the crankshaft by means of a usual connecting rod, the crankshaft extending downwardly through a tubular extension 26 of the crankcase and is associated with power transmission gearing or means for driving a propeller where the engine is employed for marine use. The crankshaft of the engine may be connected with other mechanism to be driven thereby where the engine is used for other purposes.

As particularly shown in FIGURE 2, the crankcase 16 is provided with a boss portion 28 adapted to mate with a mounting flange 30 of a carburetor or charge forming device 32, the flange 30 being integrally formed with the body 34 of the carburetor. The flange 30 is secured to the crankcase 16 by means of securing bolts 36, one of which is shown in FIGURE 2 extending through openings in the flange and threaded into bores formed in the boss 28 on the crankcase.

The carburetor body 34 is formed with a mixing passage 38 which includes an air inlet region 40, a Venturi construction 42 and a mixture outlet passage 44 which registers with a passage provided in the boss 28 on the crankcase. A shaft 46 extends across the air inlet passage 40 and is equipped with a conventional disk type choke valve (not shown) for use in restricting the air inlet during engine starting operations. The mixture outlet passage is provided with a disk type throttle valve (not shown) of conventional construction mounted upon a throttle operating shaft 50, the shafts 46 and 50 being journaled in bores provided in the walls of the carburetor body 34.

The charge forming device or carburetor 32 illustrated in FIGURES 1 through 3 is of the diaphragm type. With particular reference to FIGURE 3 it will be seen that the carburetor body 34 is formed with a circular portion 54 engaged by a diaphragm 56 of impervious material such as nylon fabric impregnated with a synthetic rubber-like material or resin which is not subject to deterioration by contact with hydrocarbon liquid fuels.

The diaphragm is highly flexible and forms a wall of an unvented fuel chamber or diaphragm chamber 60 adapted to receive fuel from a supply as hereinafter described. A circular cover or closure 62 is secured to the annular portion 54 of the carburetor body by means of screws 64, the central zone of the closure 62 being recessed to provide a clearance space 65 to accommodate flexing movements of the diaphragm. The clearance space 65 is vented to the atmosphere through an opening 66, or it may be vented to the air inlet region 40.

The carburetor body is provided with a boss 67 bored to provide a fuel inlet passage 72 which intersects a fuel passage 73 as shown in FIGURE 3. The body 34 is provided with a threaded bore accommodating a fitting or valve cage 76 which is bored to accommodate a valve member 78 of triangular or polygonal cross-section provided with a tapered valve portion 80 which extends into a port provided by an annular valve seat 82 of synthetic rubber or other material resistant to hydrocarbon fuels. The valve seat 82 is supported in a recess formed in the upper end of the fitting 76.

The position of a valve 80 with respect to the port in

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the seat 82 controls the admission of fuel or fuel flow into the diaphragm chamber 60. Pivotaly supported by a pin or fulcrum 84 carried by the body 34 is a lever 86, the long arm 87 of the lever being in contact with the head of the rivet 70, the short arm 88 of the lever contacting the end of the valve body 78. The lever 86 is biased under the influence of a spring 90 in a direction to engage the arm 87 of the lever with the rivet head 70 whereby flexure or relative movement of the diaphragm 56 effects movement of the valve member 78.

A main nozzle or fuel discharge orifice 92 is in communication with the chamber 60 through a suitable duct provided with a manually adjustable metering needle or valve (not shown) for regulating delivery of fuel through the main nozzle 92. The aspiration or reduced pressure in the mixing passage 38 set up by reduced pressure in the crankcase 16 of the engine 14 effects delivery of fuel from the diaphragm or fuel chamber 60 through the nozzle 92 into the mixing passage where it is mixed with incoming air to form a combustible mixture delivered into the engine crankcase.

The amount of fuel is increased as the engine speed increases, the reduced pressures in the mixing passage influencing the diaphragm 56 to be flexed in a direction to open the inlet valve 80 to admit fuel in accordance with requirements of the engine. A low speed and idle system (not shown) of conventional character may be embodied in the carburetor 32 through the addition of an idle orifice and a low speed orifice (not shown) opening into the mixing passage for engine idling and low speed purposes.

A suitable fuel pump 100, which as illustrated in FIGURE 1 is secured to or mounted by the engine crankcase 16 for pumping fuel to the inlet passages 72 and 73 in the carburetor body. The pump may be of any suitable type and one form of diaphragm actuated pump is illustrated in my Patent 2,796,838, granted June 25, 1957. A pump of the character shown in my patent is actuated by varying pressures in the engine crankcase.

Where the pump 100 is of the diaphragm type, the pumping chamber of the pump may be connected with the engine crankcase through a passage 102 in communication with the crankcase whereby the pump diaphragm is actuated by varying crankcase pressures to effect pumping of fuel to the carburetor from the fuel tank or fuel receptacle 104 disposed in a region below the carburetor.

When it is desired to start the internal combustion engine 14 and little or no fuel is contained in the fuel chamber 60 of the carburetor, a priming means is essential in order to initially lift fuel from the fuel tank 104 to the pump. As illustrated in FIGURE 1, the fuel receptacle 104 is disposed beneath the carburetor 32 and contains a supply of liquid hydrocarbon fuel 105. The receptacle or tank 104 is provided with a filler opening normally closed by a filler cap 106 which may be removed to replenish the supply of fuel in the tank 104. The cap 106 is provided with a vent opening of conventional character which may be closed by a manually operable valve 108 threaded into the vent opening in the cap 106.

The upper wall of the receptacle or tank 104 is provided with a fitting 110 fixedly sealed in an opening in the wall of the receptacle. The fitting 110 accommodates a tube 112 which terminates at the lower region of the tank and is adapted to convey fuel out of the tank. The fitting 110 accommodates a second tube 114 for returning excess fuel into the tank 104. In the embodiment illustrated in FIGURE 1, two sections 116 and 118 of flexible tubing are adapted to convey fuel from the tube 112 to the fuel chamber in the fuel pump 100.

Disposed between the adjacent ends of the tubes 116 and 118 is a priming means by which fuel may be elevated from the tank 104 to the pump 100 by manual operation. In the form of priming means illustrated in

FIGURE 1, an oval shaped bulb or member 120 of

flexible synthetic rubber or other material which is not effected by hydrocarbon fuels is interposed between adjacent ends of the tubes 116 and 118. Disposed in the respective end regions of the bulb 120 are check valves 122 and 124 at the inlet and outlet ends of the bulb respectively.

The bulb 120 is of conventional construction and upon repeated squeezing of the bulb, fuel is elevated at each pulsation or squeezing action of the bulb 120 in a direction to elevate fuel through the tubes 112, 116 and 118 to the fuel chamber of the pump 100, the valves 122 and 124 being arranged so as to effect flow of fuel only in the direction to supply fuel to the pump 100.

The fuel feed system of the invention includes an arrangement for returning excess fuel into the fuel tank 104 and preventing excessive fuel pressure on the inlet valve 80 in the carburetor. Mounted at the fuel inlet region of the carburetor 32 is a T-shaped member or fitting 128, the stem or branch 130 of the T-shaped fitting being provided with a threaded portion 132 which is received in a threaded entrance formed in the carburetor in registration with the fuel inlet passage 72.

An arm 134 of the T-shaped fitting is interiorly threaded to receive a threaded spigot 136 of a coupling 138, the latter being provided with a nipple portion 140 over which the end region of the tube 119 is telescoped as shown in FIGURE 3. The coupling or member 138 is provided with a passage or duct 142 which is in communication with a duct 133 formed in the branch 130 of the T-shaped fitting. The tube 119 connects the outlet of the fuel pump with the coupling 138.

The other arm 144 of the fitting 128 is provided with an interiorly threaded bore to receive a threaded spigot 146 of a second coupling 148, the latter having a nipple portion 150 over which is telescoped the end of a tube 152 which forms a component of a fuel return line. The section 152 of flexible tubing may be connected with a sight glass or tubular member 154, the latter being connected by a second tubular section 156 which is connected with the tube 114 extending into the tank 104.

The sight glass or transparent tube 154 provides a convenient means for visually indicating to an operator that a priming operation has been completed and, during engine operation, that fuel is being delivered to carburetor in excess of the engine requirements, the excess fuel being returned to the receptacle through the tube sections 152 and 156, the tubular sight glass 154 and the tube 114. A suitable grommet 158 may be employed where the tubes 118 and 152 pass through an opening in the cover mounting portion of the support 10 as shown in FIGURE 1.

As particularly shown in FIGURE 3, the T-shaped fitting is formed with a partition 160 provided with a port or opening 162 which is normally closed by a valve means 164 such as a ball shaped valve, the latter being contained in a compartment 165 and is biased toward closed position under the influence of an expansive coil spring 166. The interior surface of the partition portion 160 spaced from the end of the tenon 136 of the fitting 138 is of generally partial spherical shape providing a semi-spherically shaped chamber 168, the spherically shaped wall portion thereof being above the entrance region of the duct 133 with the carburetor disposed in a substantially horizontal position as shown in FIGURE 3.

The partition portion 160 of the fitting 128 is also fashioned with a by-pass channel around the port 162 and the check valve 164 and establishing communication between the chamber 168 and the compartment or chamber 165. As shown in FIGURE 3, the by-pass means includes a first channel 170 opening into the semi-spherically shaped chamber 168 and a second channel 172 of lesser cross-sectional area than the by-pass channel 170 and in communication therewith.

The second by-pass channel 172 is of comparatively small cross-sectional area to provide a restriction limiting

the flow rate of fuel under normal operating conditions into the return tube 152. If excess fuel pressure is developed by squeezing the priming bulb 120, the excess pressure elevates the ball valve 164 to facilitate increased fuel flow through the port 162.

The operation of the arrangement illustrated in FIGURES 1 through 3 is as follows: In initially operating the engine where the diaphragm chamber or fuel chamber 60 contains little or no fuel, the vent valve member or screw 108 is rotated in a direction to open the vent in the cap 106 on the receptacle.

The operator then manually exerts successive squeezing pressures on the priming bulb 120 which elevates fuel from the tank 104 through the tubes 112 and 116, the priming bulb 120 past the check valves 122 and 124 and through the tube 118 into the fuel chamber of the fuel pump 100 thence through the tube 119 into the fitting 128 filling the ducts 133, 72 and 73 providing fuel at the port in the valve seat 82 for admission into the carburetor fuel chamber 60.

The spring 166, which biases the valve 164 toward closed position, is calibrated or fashioned to be compressed under a predetermined fuel pressure, as for example, five pounds per square inch, to avoid excess pressure being transmitted to the inlet valve 80 to avoid opening the valve 80 which would cause fuel flow into the carburetor chamber 60 and cause flooding of the chamber and fuel flow into the mixing passage 38 before the internal combustion engine is started.

Thus if the priming bulb 120 is vigorously activated by the operator setting up substantial pressure in the chamber 168, the spring 166 will be compressed by fluid pressure acting through the port 162 on the valve 164 elevating the valve to facilitate flow of excess fuel into the return line or tube 152 and into the fuel tank 104.

Return flow of fuel may be observed through the sight glass tube 154 indicating to the operator that the fuel feed arrangement has been primed viz that the supply tubes 116, 118 and 119 and the fuel chamber of the pump 100 are filled with liquid fuel.

The engine may then be started in the normal manner by rotating the fly wheel 20. As soon as the cranking of the engine is begun, the fuel pump 100 is activated to continue to supply fuel through the inlet tubes through the fitting 128 and through the ducts or passages 133, 72, 73. The valve 80 is opened by reason of the upward flexure of the diaphragm 56 under the influence of reduced pressure or aspiration in the mixing passage 38. The mixture is thereby formed by delivery of fuel from the chamber 60 through the main orifice 92 or through the idle or secondary orifice system (not shown) that may be embodied in the carburetor.

The fuel pump 100 normally supplies an amount of fuel greater than the requirements of the engine. When the throttle of the engine is only partially opened or the fuel demand on the carburetor is comparatively small under light loads, the fuel consumption may be so reduced that fuel pressure set up by the fuel pump becomes excessive. If the by-pass channels 170 and 172 are insufficient to accommodate return flow of the excess fuel into the fuel tank, the pressure in the chamber 168 elevates the valve 164 to increase flow of fuel into the return line 152 and thereby relieve the passages conveying fuel to the carburetor inlet valve 80 from excessive fuel pressure.

When fuel consumption of the carburetor is high as at high speeds or under substantial loads, the valve 164 may remain in closed position where the by-pass channels 170 and 172 are adequate to convey excess fuel into the return line. The restricted by-pass channel 172 is comparatively small in cross-sectional area so that under normal operation it effects only a small reduction in the maximum pumping capacity of the fuel pump.

Where the arrangement of internal combustion engine and fuel feed system of the invention is utilized in powering small boats or in installations where the components are subjected to elevated temperatures by the sun's rays or

inadequately vented regions, the heating of the tubular components conveying fuel from the fuel tank 194 to the pump 100 may cause vapor bubbles to form in the fuel and, if the same are not eradicated, may cause "vapor-lock" and impair the flow of liquid fuel into the inlet passages of the carburetor thus impairing or interrupting the operation of the carburetor.

The semi-spherically shaped chamber 163 provides a region in which the bubbles of vapor or volatilized fuel are collected and dispersed through the by-pass channels 170 and 172 and through the return line 152 into the fuel tank 194. Through this arrangement the vapor is diverted from the fuel so that a continuous supply of bubble-free liquid fuel to the carburetor is assured by diverting the vapor into the return line.

Another advantage of the system ensuing through the continuous pumping of fuel slightly in excess of the requirements of the carburetor is that the increased fuel moving through the pump absorbs heat from the pump transmitted to the pump from the engine crankcase which is dissipated into the fuel tank by the return of fuel in the line or tube 152. The heat absorbed into the fuel and carried by the fuel through the return line into the tank 194 is more readily cooled in the fuel tank by reason of the large surface area of the tank. Through this arrangement the fuel pump is maintained at a reduced temperature.

While the arrangement illustrated in FIGURE 1 is associated with a carburetor of the diaphragm type wherein the aspiration or reduced pressure in the mixing passage controls the fuel flow rate through the carburetor, it is to be understood that the fuel feed system and apparatus of the invention may be employed with carburetors of the so-called float type wherein a float-controlled inlet valve regulates the fuel flow into the carburetor dependent upon variations in the level of fuel in a bowl or fuel chamber in the body of the carburetor.

FIGURE 4 illustrates the arrangement of fuel feed system utilized in conjunction with an engine of the four cycle or four stroke type embodying a mechanically operated pump for conveying liquid fuel to the carburetor. The internal combustion engine construction of the four cycle type illustrated in the drawing is inclusive of a stationary base 180, a crankcase 182 and a cylinder 184, the latter being provided with cooling fins 185, the engine being of the air cooled type.

A crankshaft 186 is journaled for rotation in the crankcase 182 and a crankportion of the crankshaft connected by a connecting rod 188 with a piston 190 reciprocable in the cylinder 184. A camshaft 192 is journally supported in the crankcase 182 and is driven by means (not shown) connected with the crankshaft at one-half crankshaft speed in the conventional manner. The camshaft 192 is provided with cams for operating the inlet and exhaust valves of the engine, the cam 194 for operating the mixture inlet valve 196 being shown in FIGURE 4.

The valve 196 is of the poppet type actuated by a tappet 198 which is elevated by the cam 194, an expansive coil spring 200 normally biasing the valve toward closed position. The cylinder 184 is equipped with a head 202 providing a combustion chamber 204, a spark plug 206 being provided for igniting the mixture in the combustion chamber 204, the expansion of the burning gases in the chamber 204 effecting reciprocation of the piston 190.

Secured to a bracket 208 mounted upon the crankcase 182 is a fuel tank or receptacle 210 provided with a vented filler cap 212. Connected with the lower region of the fuel tank 210 is a fuel conveying pipe or tube 214 adapted to convey fuel to a fuel strainer unit 216 of conventional construction. The fuel strainer or filter unit 216 is provided with a fitting 220 connected with the fuel chamber of a diaphragm type fuel pump 222 of the mechanically operated type. The fuel pump unit

222 is of conventional construction and is inclusive of a member 224 and an enclosure 226, a flexible diaphragm or membrane 228 being disposed between the members 224 and 226.

An operating lever 230 is fulcrumed within the housing member 226 and is mechanically connected to the diaphragm 228 in a conventional manner to effect reciprocation of the diaphragm through oscillating movements of the actuating lever 230. The camshaft 192 is provided with a cam 232 engaging the pad portion 234 of the lever 230. Rotation of the camshaft 192 and cam 232 effects swinging or oscillatory movements of the pump actuating lever 230, the latter effecting flexure of the diaphragm 228 to establish pumping strokes of the diaphragm to elevate fuel from the fuel receptacle 210.

The member 224 of the fuel pump unit is provided with inlet and outlet valves to effect pumping of fuel in one direction through the pumping unit. The member 224 of the fuel pump unit is equipped with a fitting 238 which is connected with the T-shaped unit 128' by means of a tube or pipe 240. The unit or component 128' illustrated in FIGURE 4 is of the same construction as the unit 128 illustrated in detail in FIGURE 3. The unit 128' is connected with the charge forming device or carburetor 32' in the same manner as illustrated in FIGURE 3.

The mounting flange 30' of the carburetor 32' is secured to a mixture intake manifold 244 cast integrally with the cylinder construction 184, the passage 246 provided by the manifold 244 conveying fuel and air mixture from the carburetor 32' into the combustion chamber 204 when the inlet valve 196 of the engine is opened during engine operation. The unit 128' is connected with a return tube or line 250 to the upper region of the fuel tank or receptacle 210 and corresponds to the return tube or line 152 in the arrangement illustrated in FIGURE 1.

The operation of the carburetor 32' and the unit 128' of the fuel feed system illustrated in FIGURE 4 are substantially the same as the operation of the arrangement shown in FIGURE 1. During operation of the four cycle internal combustion engine illustrated in FIGURE 4, the rotation of the camshaft 192 continuously oscillates the diaphragm actuating lever 230 to effect a pumping action of the diaphragm 228 of the pump unit 222 whereby fuel is being continuously elevated from the fuel tank 210 through the supply tube 214 and fuel continuously delivered through the outlet tube 240 to the unit 128' which is secured to the carburetor 32'.

The excess of fuel supplied to the unit 128' is returned into the fuel tank through the return pipe or tube 250 in the same manner as hereinbefore explained in connection with the form of the invention shown in FIGURES 1 through 3. It is to be understood that the fuel feed system and arrangement of the invention may be employed with any type of fuel pump.

As the internal combustion engine shown in FIGURE 4 continuously and mechanically operates the lever 230 to effect reciprocation or flexure of the diaphragm 228, liquid fuel is always maintained in the pump and filter units and hence a priming means is not required with the arrangement or system illustrated in FIGURE 4. While the engines illustrated in FIGURES 1 and 4 are of the single cylinder type, it is to be understood that the fuel feed system and arrangement of the invention is usable with multi-cylinder engines.

FIGURES 5 and 6 illustrate a modified form of arrangement for providing for returning excess fuel to the fuel supply receptacle and for venting or bleeding off vapor or bubbles of gaseous fuel or air in the fuel to provide bubble-free liquid fuel to the carburetor. The arrangement shown in FIGURE 5 is similar to a portion of FIGURE 1 and includes a support 10' upon which is mounted a housing or closure 12'. Disposed in the housing is an engine 14' having a crankcase 16', the

crankshaft extending through a tubular extension 18' thereof extending through the support 10'.

The crankshaft may be provided with a fly wheel similar to that shown in FIGURE 1. The engine 14' is of the reciprocable piston type and the engine illustrated is of the two cycle type. The crankcase 16' is provided with a boss portion of the character shown in FIGURE 2 and the mounting flange 260 of the carburetor or charge forming device 262 is secured thereto by suitable bolts.

The carburetor 262, as shown in FIGURE 6, is formed with a body 264 provided with a mixing passage 38', a Venturi construction and a mixture outlet passage of the character illustrated in FIGURE 2 registering with a passage provided in the boss of the crankcase supporting the carburetor through which mixture is delivered to the engine. The carburetor shown in FIGURE 5 is of the same general character as that illustrated in FIGURE 2 and includes a choke valve mounted upon a shaft 46' journaled in suitable bores formed in the carburetor body 262. The carburetor shown in FIGURE 5 is also provided with a conventional throttle means.

As shown particularly in FIGURE 6, the carburetor is of the diaphragm type, the body 264 being formed with a circular boss portion 54' engaged by a flexible diaphragm 56' of impervious material. The diaphragm forms a wall of the fuel chamber or diaphragm chamber 60' which is adapted to receive fuel from a supply. The circular cover 62' accommodates screws 64', which extend through registering openings in the cover 62', the diaphragm 56' and a gasket 266, securing the diaphragm to the carburetor body 264.

The carburetor body is fashioned with a threaded bore accommodating a fitting or valve cage 76' having a bore accommodating a slidable inlet valve member 78' provided with a conically-shaped valve portion 80' which cooperates with an annular valve seat 82' to meter or control fuel flow into the chamber 60'. A lever 86' is fulcrumed on the body by a pin 84', the long arm 87' of the lever being arranged for engagement with the head of a rivet 70' carried by the diaphragm 56', the short arm 88' of the lever contacting the end of the valve body or member 78'.

The lever 86' is biased under the influence of a spring 90' in a direction to engage the arm 87' of the lever with the rivet 70' carried by the diaphragm whereby relative flexure or movements of the diaphragm 56' are transmitted to the valve member 78' to control the position of the valve member.

The carburetor body 264 is provided with a main nozzle or fuel discharge orifice (not shown) in communication with a suitable duct provided with an adjustable metering or needle valve (not shown) for metering delivery of fuel through the main orifice into the mixing passage 38'.

The aspiration or reduced pressure in the air and fuel mixing passage 38', established by reduced pressure in the crankcase 16' of the engine 14', effects delivery of fuel from the chamber 60' into the mixing passage, the air and fuel mixture being delivered into the crankcase. The reduced pressures in the mixing passage influence the diaphragm 56' to be flexed in a direction and to an extent to open the inlet valve 80' to admit fuel in accordance with the requirements of the engine.

The carburetor embodies a secondary fuel delivery system (not shown) of conventional character for delivering fuel into the mixing passage for low speed and idling operation of the engine. A suitable fuel pump 100' which is preferably of the diaphragm type actuated by varying pressures in the engine crankcase functions to provide a supply of fuel to the carburetor during engine operation. A fuel supply tube 118' is connected with the fuel pump 100' and with the fuel tank or receptacle of the character illustrated at 104 in FIGURE 1. It is to be understood that other types of fuel pump, such as piston or gear pumps, may be employed in the system.

The fuel feed system of the invention embodies an arrangement for bleeding off or returning fuel delivered by the pump in excess of the requirements of the carburetor and prevents excessive fuel pressure building up which might otherwise overcome the spring pressure 90' acting on the lever 86' and open the valve 80' and thereby impair the metering function of the carburetor diaphragm 56' as well as to vent the system of vapor or gas bubbles in the liquid fuel so that bubble-free liquid fuel is delivered to the carburetor.

With particular reference to FIGURE 6, the end region of the fuel supply tube 119' is telescoped over a nipple portion 268 of an elbow-shaped fitting or coupling 270. The elbow 270 is formed with a threaded end region 272 which is threaded into a bore formed in a boss 274 provided on the carburetor body 262. The carburetor is fashioned with a fuel passage or chamber 276 which is in communication with the fuel conveying tube 119' by a hollow interior or passage 278 provided in the L-shaped fitting or coupling 270.

The passage or supplemental chamber 276 in the carburetor is in communication with the port in the annular valve seat 82' by a duct or passage 280. A boss 282, extending upwardly from the body 262 of the carburetor, is provided with a threaded opening accommodating a threaded portion 284 of a fitting or coupling 286. The fitting 286 is provided with a nipple portion 288 to receive an end region of the flexible tube 152'.

The fitting 286 is provided with passages 290 and 292 which are interconnected by means of a restricted passage 294 of preferably lesser cross-sectional area than the passages 290 and 292 to restrict the flow of fuel from the passage or supplemental chamber 276 into the fuel return tube 152', which may be formed of metal or nonmetallic material.

It is to be understood that in lieu of the restricted passage 294, the passages 290 and 292 may be of a cross-sectional area providing a restriction to limit or restrict return flow of fuel into the fuel tank through the return tube 152'. However, the arrangement of coupling 286 illustrated in FIGURE 6 with a restriction 294 is preferred as the restriction 294 may be varied in size to thereby regulate or limit the flow rate of fuel into the return line or tube 152' as may be required for a particular carburetor or dependent upon output of the fuel pump.

It should be noted that the passage or supplemental chamber 276 formed in the carburetor body 262 is of substantial size and that the passage 290 is directly above the supplemental chamber 276 when the carburetor is in normal upright position as viewed in FIGURE 6, this arrangement providing for bleeding off any bubbles of vapor or gas caused by emulsion of the fuel so that only liquid fuel is delivered through the inlet port in the seat 82' past the valve 80' into the carburetor.

Bubbles of gas or air entering with the fuel would impair the normal metering function of the diaphragm 56' and thereby adversely effect the operation of an engine connected with the carburetor.

Through this arrangement any bubbles of gas in the fuel entering chamber 276 will be bled off or vented through the passage means in the coupling or fitting 286 into the return line 152'.

The restriction 294 provides a relief vent to bleed off excess fuel which may be supplied to the chamber 276 by the fuel pump and thereby prevent excessive pressure being built up in the fuel chamber 276 which might otherwise exert pressure on the valve 80' sufficient to cause the valve to be opened and thereby impair the normal operation of the carburetor.

FIGURE 7 illustrates a modified arrangement of the invention. The carburetor illustrated in FIGURE 7 is substantially the same as that shown in FIGURE 6. The carburetor 262'' is fashioned with a mixing passage 38'' and a fuel chamber 60'', one wall of which is formed by the flexible metering diaphragm 56''. The carburetor is

provided with an inlet valve body 78" having a valve portion 80" cooperating with an annular valve seat 82", the port of which is in communication with a supplemental chamber 298 through a connecting passage 280".

The relative position of the valve member 80" is controlled by movements of the diaphragm 56" transmitted through the medium of a lever 86" in the same manner as in the arrangement shown in FIGURE 6. The arrangement of FIGURE 7 is inclusive of a fitting 300 fashioned with a threaded projection 302 which extends into a threaded opening in the body 262" in communication with the supplemental chamber or passage 298.

The fitting 300, including the portion 302, is provided with a fuel passage 304 which is in communication with the fuel chamber 298 and in communication with a region, passage or chamber 306 provided in the fitting 300.

The fitting 300 is formed with a threaded bore accommodating a threaded projection 308 formed on a fitting 310, the latter having a nipple portion or projection 312 to accommodate the end region of the fuel conveying tube 119" connected with the fuel pump such as the fuel pump 100" shown in FIGURE 5. The fitting 310 is provided with a central fuel passage 314 to admit fuel into the intermediate fuel chamber or region 306 for delivery through passages 304 and 298 into the carburetor when the fuel inlet valve 80" is opened under the influence of the diaphragm 56".

The region of the fitting 300 directly above the chamber 306 is formed with a threaded bore accommodating a threaded projection 316 of a fitting or nipple 318. The end region of the return tube 152" is telescoped over the nipple 318. The central region of the nipple 318 is fashioned with passages 320 and 322 which are connected by a restricted opening or passage 324 of lesser cross-sectional area than the passage 320.

It is imperative that the fitting or nipple 318 be disposed above the chamber 306 in the normal position of the carburetor, as shown in FIGURE 7, so that gas bubbles or air bubbles in the liquid fuel flowing into the chamber 306 will be bled off or vented through the passage 320 past the restriction 324, thence through passage 322 into the line 152" which returns them into the fuel tank.

The metering restriction 324 not only serves to vent off vapor or gas bubbles in the fuel but also provides a vent means through which liquid fuel may flow for return to the fuel tank should the fuel pump develop excessive pressure in the passage 298 and thereby prevent excessive fuel pressure building up which might otherwise open the fuel inlet valve 80" and interfere with the proper operation of the carburetor.

As explained in connection with the form shown in FIGURE 6, the passages 320 and 322 and restriction 324 may be of the same diameter to provide a restriction of a cross-sectional area equal to that of the restriction 324. However, it is to advantage that the restriction 324 be of substantial lesser cross-sectional area than the passages 320 and 322 so that the size of the restriction 324 may be varied depending upon the size of characteristics of the carburetor or fuel pump with which the fuel system may be utilized. It is to be understood that the fitting 310 may be disposed in other positions relative to the chamber 306 but that it is essential to the successful venting of bubbles from the liquid fuel to position the nipple fitting 318 substantially directly above the chamber 306.

The arrangement shown in FIGURES 5, 6 and 7 may be used with or without the priming means 120 shown in FIGURE 1. With certain types of fuel pump, the valve arrangement therein is such as to check the reverse flow of fuel in the supply line or tube 118 when the engine is stopped. Under these conditions fuel is maintained at the region of the fuel inlet valve of the carburetor rendering priming unnecessary for starting the engine.

It is to be understood that the arrangement illustrated in FIGURES 6 and 7 is usable with a four cycle engine of the character illustrated in FIGURE 4.

It is apparent that, within the scope of the invention, modifications and different arrangements may be made other than as herein disclosed, and the present disclosure is illustrative merely, the invention comprehending all variations thereof.

I claim:

1. A fuel feed system including a carburetor for use with an internal combustion engine, a fuel pump connected with a fuel supply tank, a fitting providing a first duct and a second duct, passage means establishing communication of the first duct with a valved fuel inlet channel of the carburetor and the fuel pump, tubular means establishing communication between the second duct and the fuel tank to accommodate fuel flow from the second duct to the fuel tank, manually operable means for priming the pump with liquid fuel from the fuel tank, a pressure relief means arranged to establish communication between said ducts under the influence of excessive fuel pressure set up by the fuel pump in said first duct, and a by-pass of comparatively small cross-sectional area providing a restricted passage between the ducts in the fitting.

2. A fuel feed system including a carburetor for use with an internal combustion engine, a fuel pump connected with a fuel tank, a member formed with a first chamber and a second chamber, passage means establishing communication of the first chamber with a valved fuel inlet channel of the carburetor and with the fuel pump, tubular means establishing communication between the second chamber and the fuel tank to accommodate fuel flow from the second chamber to the fuel tank, a pressure relief valve adapted to establish communication between said chambers under the influence of excessive fuel pressure in said first chamber, said first chamber being formed with a partial spherically shaped region, and a by-pass of comparatively small cross-sectional area in communication with the spherically shaped region of the first chamber and the second chamber to convey vapor in the liquid fuel into the second chamber for return through the tubular means to the fuel tank.

3. A fuel feed system including a carburetor, a tank adapted to contain liquid fuel, a fuel pump, a hollow member formed with a partition providing a first chamber and a second chamber, passage means establishing communication of said first chamber with a valved fuel inlet of the carburetor and the fuel pump, a first tubular means connecting the fuel pump with the fuel tank for conveying fuel to the fuel pump, a second tubular means connecting the second chamber with the fuel tank, a restricted by-pass of small cross-sectional area between said chambers through which vapor is returned to the fuel tank, pressure relief means in said hollow member adapted to be actuated by excessive fuel pressure in the first chamber to accommodate increased flow of fuel through the second chamber into the second tubular means, and a manually operable squeeze bulb of flexible material associated with the first tubular means for priming the fuel pump with liquid fuel from the tank.

4. A fuel feed system including a carburetor adapted to deliver a combustible mixture to an internal combustion engine wherein the carburetor is of the diaphragm type arranged to deliver fuel into a mixing passage under the influence of subatmospheric pressure in the mixing passage, a fuel pump, a fitting defining a first chamber and a second chamber, passage means connecting the first chamber with a valved inlet duct of the carburetor and with the fuel pump, a first tubular means connecting the fuel pump with the fuel supply tank, manually operable means connected with the first tubular means for priming the pump with liquid fuel, a second tubular means connecting the second chamber with the tank, a surface of the first chamber being curved providing a region to accommodate vapor bubbles in the liquid fuel, a restricted by-pass formed in said member for conveying vapor bubbles from the curved region into the second chamber for return through the second tubular

means to the fuel tank, a port formed in the partition, and resiliently biased valve means associated with the port to relieve excessive fuel pressure in the first chamber.

5 5. A fuel feed system including a carburetor adapted to deliver a combustible mixture to an internal combustion engine wherein the carburetor is of the diaphragm type arranged to deliver fuel into a mixing passage under the influence of subatmospheric pressure in the mixing passage, a fuel pump, means connected with the carburetor defining a first chamber and a second chamber, passage means connecting the first chamber with a valved inlet duct of the carburetor and with the fuel pump, a first tubular means connecting the fuel pump with the fuel supply tank, a second tubular means connecting the second chamber with the tank, a surface of the first chamber being curved providing a region to accommodate vapor bubbles in the liquid fuel, a restricted by-pass formed in said member for conveying vapor bubbles from the curved region into the second chamber for return through the second tubular means to the fuel tank, a port formed in the partition, and resiliently biased valve means associated with the port to relieve excessive fuel pressure in the first chamber, manually operable means for priming the pump with liquid fuel from the fuel tank, and means for visually indicating fuel flow in the system.

6. A fuel feed system including a carburetor having an unvented fuel chamber, an integral T-fitting having a first duct, a second duct, and a passage means for establishing communication of the first duct with a valved fuel inlet channel of the carburetor, a fuel pump connected to a fuel supply tank and to the first duct, a bubble collecting chamber formed in the fitting and in communication with the first duct and the passage means

so that the fuel passes from the first duct to the chamber before reaching the passage means, tubular means establishing communication between the second duct and the fuel tank, a by-pass of comparatively small cross-sectional area connecting the bubble chamber and the second duct, a relief valve in parallel with said by-pass, the by-pass positioned above and away from the passage means so that vapor bubbles and fuel vapor are conveyed therethrough for return to the tank.

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