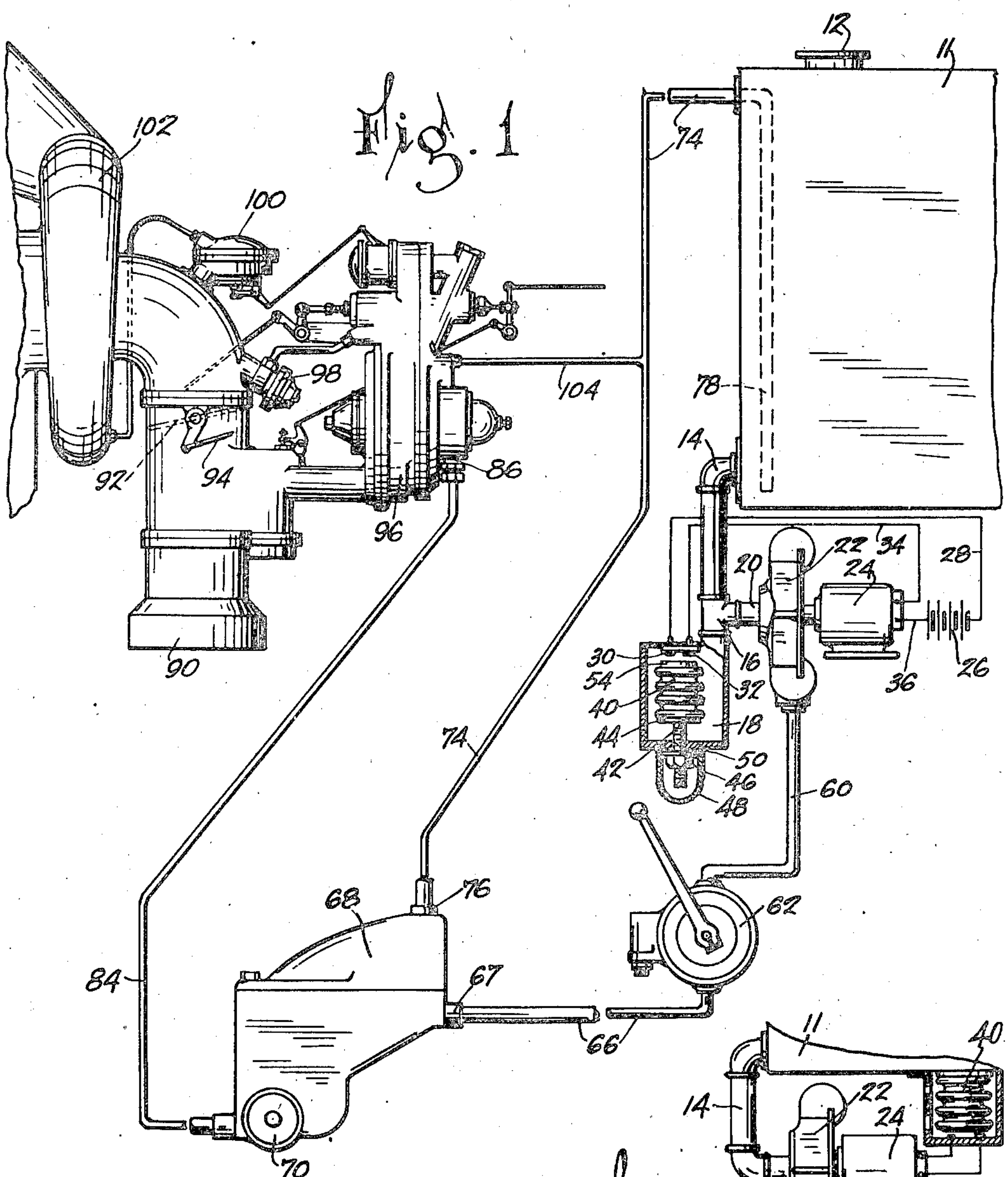
Jan. 14, 1947. F. C. MOCK 2,414,158

FUEL SUPPLY SYSTEM WITH VAPOR SEPARATOR AND BOOSTER PUMP

Filed Aug. 18, 1939 2 Sheets-Sheet 1



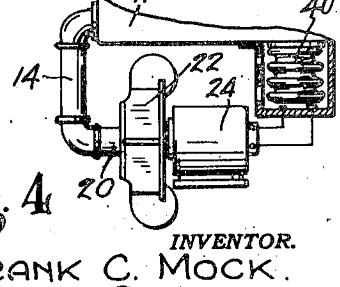


Fig. 4

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Fig. 2

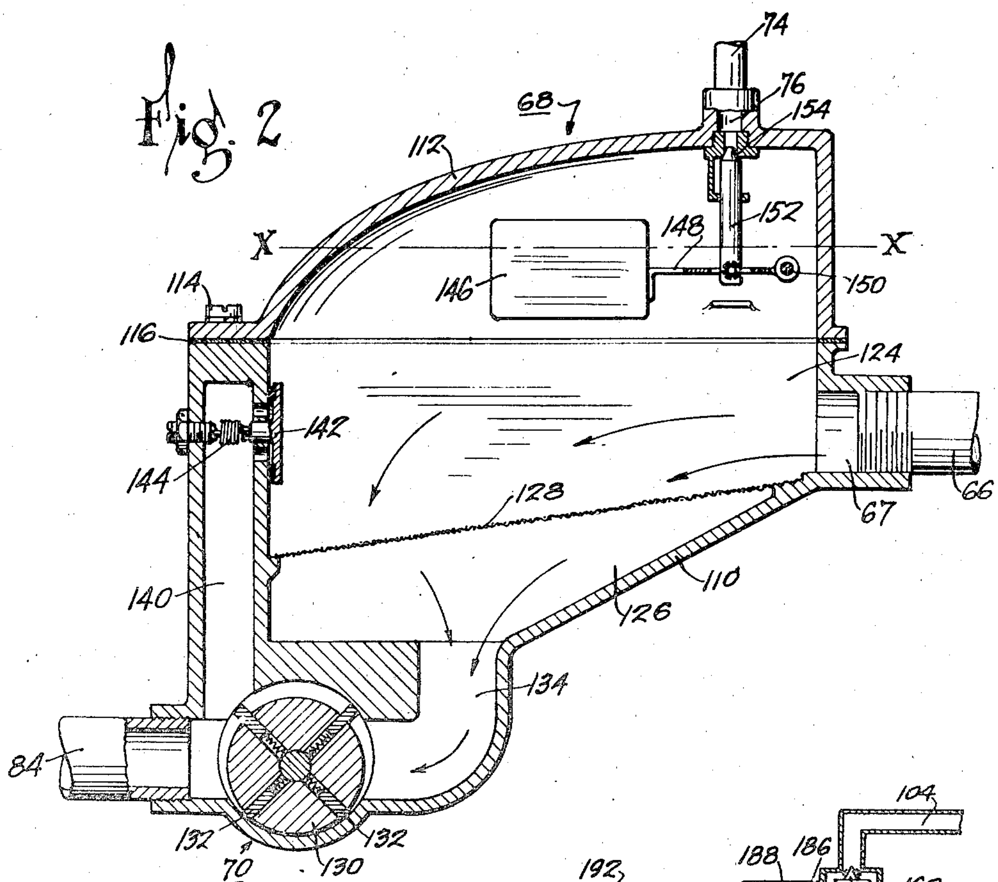
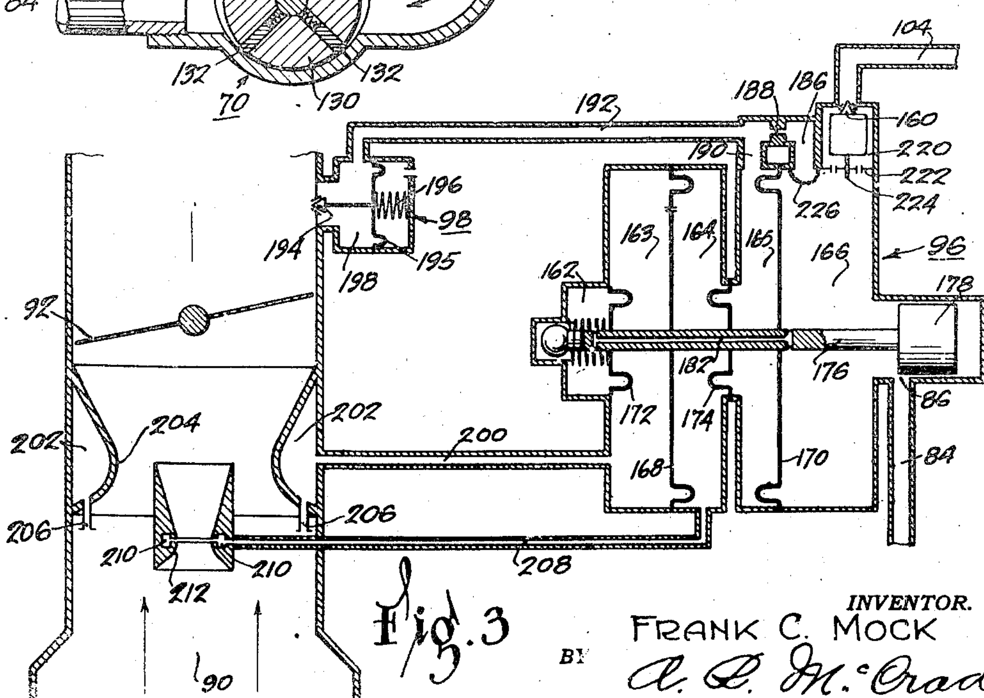


Fig. 3



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2,414,158

FUEL SUPPLY SYSTEM WITH VAPOR SEPARATOR AND BOOSTER PUMP

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Application August 18, 1939, Serial No. 290,730

28 Claims. (Cl. 158—36.4)

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This invention pertains to fuel supply systems for internal combustion engines and more particularly to a fuel system adapted to supply fuel under pressure to an aircraft engine.

The fuel system herein disclosed is adapted for use in aircraft engine installations particularly when the engine is equipped with a charge forming device of the pressure feed type such as, for example, is disclosed in my copending application, Serial Number 202,206, filed April 15, 1938 and which became Patent No. 2,390,658, on Dec. 11, 1945. With carburetors of this or similar types in which the carburetor fuel system is entirely closed, as contrasted to a float bowl type of carburetor having a free fuel surface, any vapor which is delivered to the carburetor will, unless vented, eventually pass through the metering jet in the form of bubbles, producing a temporary deficiency in the weight of the fuel being supplied to the engine. If the bubbles reaching the metering jet are small and infrequent the effect is merely a slight leaning of the mixture; however, if the volume of any one bubble is too great or if the bubbles are too frequent the engine will misfire and may cease running altogether.

Another difficulty resulting from vapor formation is sometimes referred to as a vapor lock of the fuel pump and is experienced when a considerable amount of vapor is present in the pump intake line. Under these conditions the pump, although handling its normal volume of fuel, is receiving so much vapor that the weight of fuel delivered to the carburetor is reduced below that required at the existing engine operating conditions. The resulting leanness of the mixture causes loss of power and overheating which may damage the engine.

Since aviation fuels vaporize at temperatures and pressures not far removed from those normally prevailing at sea level, the reduction in atmospheric pressure accompanying a rapid ascent often results in the fuel in the fuel supply tanks becoming highly charged with vapor. Although part of the vapor which should form under the existing conditions of pressure and temperature will form and collect as bubbles which rise through the fuel in the tanks and escape through the tank vent, a considerable portion will remain as liquid until agitated as in passing through the fuel supply line or until the pressure is further reduced as it is in the suction intake line of the fuel pump. As a result, a considerable amount of vapor is formed in the line leading from the tank to the carburetor and unless eliminated will interfere with the normal operation of the engine as hereinabove noted.

In early airplanes the rate of climb was sufficiently low that the decreasing temperature experienced as altitude was attained cooled the fuel in the supply tanks. The vapor forming

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tendency resulting from a decreased barometric pressure was therefore at least partially compensated for by the decreased fuel temperature.

Modern high-powered airplanes, however, have such a rapid rate of climb that they can attain anp altitude of 20,000 feet, at which the atmospheric pressure is approximately one-half of that at sea level, before the fuel in the supply tanks has cooled more than a few degrees. It is obvious that a maneuver such as this will greatly aggravate the fuel vapor problem.

An object of the present invention is to provide an improved means for supplying fuel to an internal combustion engine while eliminating fuel vapors therefrom.

Another object of the invention is the provision of means within the carburetor anterior to the metering jet for eliminating any vapor which is delivered to or formed within the carburetor.

A further object is to provide a novel arrangement of fuel pumps, with a vapor venting means associated therewith.

A further object is to provide an altitude responsive means for controlling a fuel pump.

A further object of the invention is the provision of two fuel pumps, the operation of one of the pumps to be controlled by an element responsive to the temperature and absolute pressure of the fuel supply.

Other objects and advantages of the invention will appear more fully from the following description, taken in connection with the accompanying drawings, in which:

Figure 1 is a diagrammatic partial view showing the application of my invention to an engine equipped with a carburetor of the type disclosed in my copending application, Serial Number 202,206, filed April 15, 1938, which became Patent No. 2,390,658 on December 11, 1945;

Figure 2 is an enlarged sectional view of the vapor venting chamber and the engine driven fuel pump;

Figure 3 is a diagrammatic view of the primary metering system of the carburetor showing the carburetor vapor vent valve;

Figure 4 is an alternative means for controlling the operation of the auxiliary fuel pump.

With specific reference to Figure 1, there is shown a fuel supply tank **11** having a filler and vent cap generally indicated at **12**. A fuel line **14** connects the tank **11** near the bottom thereof with a T fitting **16**, one outlet of which leads to a closed chamber **18** and the other to the inlet **20** of a centrifugal pump **22** which, as shown, is arranged to be driven by an electric motor **24**. A source of electrical energy diagrammatically indicated at **26**, which is preferably the generator-battery system of the engine, supplies current to the motor by means of a circuit comprising the source **26**, conductor **28**, a switch having terminals **30** and **32**, conductor **34**, motor **24**, conductor 36 and source 26. The terminals may be insulated from each other and from the chamber 18 in any known manner.

A bellows 40 positioned within the chamber 18 is adjustably connected at its lower end to the wall of chamber 18 by means of the threaded extension 42 of the bellows closure plate 44. The bellows may be locked in place and leakage past the threads prevented in any known manner such as, for example, the lock nut 46, sealing cap 48 and gasket 50. A metallic bar 54 is carried by the closure plate of the free end of the bellows and is arranged to contact the terminals 30 and 32 to close the motor circuit when the bellows expands to a predetermined position. Suitable snap mechanism of known construction may be substituted for the arrangement shown, if desired.

The bellows 40 is partially evacuated and hence is responsive both to the temperature and absolute pressure of the fuel entering the pump 22. By controlling the degree of evacuation of the bellows, or by using a given amount of volatile liquid within the bellows, its responsiveness to changes in pressure and temperature can be so correlated that the pump motor circuit will be completed when the vapor forming tendency of the fuel reaches a predetermined degree, irrespective of whether the tendency to form vapor is brought about by decrease in barometric pressure, increase in fuel temperature, or a combination of the two.

A discharge conduit 60 of the pump 22 leads to the inlet of a hand operated pump 62, of any conventional design, which is generally mounted in the pilot's cockpit. Where the charge forming device is of the pressure feed type in which the fuel is delivered to the induction passage of the engine under superatmospheric pressure, a hand pump is generally required for creating sufficient fuel pressure to accomplish delivery of fuel to the engine during the cranking operation. With some types of charge forming devices sufficient fuel for starting is drawn into the engine manifold from the fuel reservoir of the device merely by the suction created during cranking, in which case the hand pump 62 may be eliminated. The pump 62 preferably includes check valve means (not shown) whereby very little resistance is offered to the flow of fuel therethrough once the engine is started and the fuel is being supplied by an engine driven pump.

A conduit 66 connects the outlet of pump 62 with the inlet 67 of a vapor venting chamber indicated generally at 68 which is here shown integral with the casing of an engine driven fuel pump 70. A vapor conduit 74 leads from an outlet 76 in the uppermost portion of chamber 68 to the fuel supply tank, passing through the wall thereof near the top of said tank and extending downwardly within the tank as at 78 to a point near the bottom thereof. Details of the chamber 68 and pump 70 are described more fully hereinafter.

A fuel conduit 84 leads from the discharge side of the pump 70 to a fuel inlet 86 of the charge forming device, which device comprises an induction passage having an air inlet 90, a throttle 92 controlled by the rod 94 extending from the pilot's cockpit, a fuel metering unit 96, a pressure responsive fuel discharge nozzle 98, and an economizer 100. The induction passage of the charge forming device leads to the inlet of a supercharger 102 of an engine not shown. The details of construction and method of operation of the charge forming device here depicted are completely described in my copending application Serial Number 202 206 above referred to and which became Patent No. 2,390,658 on Dec. 11, 1945, but the essential features thereof are shown at Figure 3 and described below.

A conduit 104 connects the fuel metering unit with the vapor conduit 74 for removal of vapor from the metering unit as will be described hereinafter.

The chamber 68, shown in Figure 2, consists of a main body 110 and a cover 112 tightly secured thereto by means of bolts 114 and gasket 116. The interior of chamber 68 is divided into two compartments 124 and 126 by a relatively fine mesh screen 128 which is positioned below the fuel inlet 67.

The engine driven fuel pump 70, comprising rotor 130 and sliding vanes 132, is positioned in the bottom of main body 110 of the chamber 68 and receives fuel from compartment 126 through passageway 134 and delivers it under substantial pressure to the conduit 84. A bypass passage 140 is provided from the discharge side of the pump to the fuel compartment 124 above the screen 128. A valve 142, urged against its seat by the tension spring 144, variably controls the bypass passage 140 to maintain a substantially constant fuel pump discharge pressure in the known manner.

A float 146 having a lever 148 rigidly attached thereto and pivoted at 150 to the cover 112 controls a valve 152 which cooperates with a seat 154 provided in the vapor outlet 76. The float and valve are arranged to close off the conduit 74 when the fuel level is approximately at the line X—X. Collection of vapor within the chamber 68 will obviously result in a lowering of the fuel level thereby permitting valve 152 to open and allowing the excess vapor to escape through the vapor vent conduit 74. A float stop and a valve guide may be provided to maintain the valve 152 in alignment with seat 154 at such times as the level is below the line X—X.

Because of surface tension, a relatively fine mesh screen will offer considerable resistance to the passage therethrough of a bubble of vapor, hence screen 128 will effectively prevent vapor delivered with the fuel through the inlet 67 from reaching the intake passage 134 of the pump 70.

In order to provide a further precaution against vapor reaching the metering jet of the charge forming device, a float valve 160 controlling the vapor vent conduit 104 is provided in the fuel metering unit 96 as shown in Figure 3, the basic elements of the charge forming device being diagrammatically shown. The conduit 104 and valve 160, though an additional safeguard, may be eliminated if desired.

The metering unit is divided into five compartments 162, 163, 164, 165 and 166 by the large diaphragms 168, 170 and the small diaphragms 172, 174. The diaphragms are secured to the casing at their outer peripheries and to a control rod 176 at their flat central portions. A slide valve 178 attached to the control rod 176 controls by means of its axial position the effective area for fuel flow from the supply conduit 84 into the unmetered fuel chamber 166.

Unmetered fuel chamber 166 communicates with chamber 162 by means of the passage 182 in the control rod 176 and with the metered fuel chamber 165 by means of the passage 186, metering jet 188 and passage 190.

The metered fuel chamber communicates with the fuel discharge nozzle 98 by means of passages 190 and 192. The fuel nozzle is comprised of a valve 194 attached to the diaphragm 195 and urged toward closed position by compression spring 196. Fuel under superatmospheric pressure delivered to the nozzle fuel chamber 198 exerts a force on the diaphragm thereby opening the valve and permitting the fuel to discharge into the induction passage posterior to the throttle 92. It is obvious that the fuel discharge pressure can be controlled by varying the design of spring 196.

The chamber 163 communicates by means of passage 200, annular chamber 202 provided in the large venturi 204, and tubes 206 with the air entrance 90. Chamber 163 is therefore subjected to the pressure of the air entering the induction passage. Chamber 164 communicates by means of passage 208 with an annular chamber 210 opening into the throat of the small venturi 212.

The operation of this type of charge forming device does not enter into the present invention and need not be further discussed since it is fully presented in my above identified copending application.

In the uppermost portion of unmetered fuel chamber 166 there is provided a vapor collecting chamber 220 in which the float operated valve 160 is located, being maintained in position by the spider 222 cooperating with the float pin 224. The float valve 160 will rise to close off the vapor conduit 104 at such times as the fuel in chamber 220 reaches a predetermined level. Any vapor which is delivered to, or formed in, the unmetered fuel chamber 166 will rise and collect in chamber 220 thereby displacing the fuel therein and permitting the float valve 160 to open and allow the escape of vapor. A screen 226 is preferably provided at the entrance to passage 186 to prevent any vapor bubbles present in chamber 166 from entering the passage 186.

During periods of operation when the fuel temperature and pressure are such as to preclude the formation of fuel vapor the motor circuit will be broken by the bellows operated switch and hence the pump 22 will be inoperative. Under these conditions fuel will be drawn into chamber 68 by the normal intake suction of pump 70 in installations having the fuel supply tank 11 below the level of the pump and will flow in under the force of gravity in installations having the tank above the pump. In the former case suction created in the chamber 68 may draw fuel through the vapor vent conduit 74 as well as through the normal inlet conduit 66. It is essential therefore that the vapor conduit extend downwardly into the fuel tank as indicated at 78 to insure that fuel rather than air will be so drawn into chamber 68. It is obvious that check valve means could be placed in the conduit 74 to prevent flow in the direction of chamber 68 in which case the conduit 78 could terminate above the level of the fuel in the tank, if so desired.

When the fuel temperature and pressure are of such value as to close the motor circuit, the pump 22 will deliver fuel to the chamber 68 under some relatively low pressure. Under these conditions any unstable vapor-forming constituents in the fuel will be converted to vapor by the agitation or beating action of the pump 22, and the vapor so formed will collect in the uppermost portion of chamber 68. When the vapor here collected exceeds a predetermined amount the float operated valve 152 will open and permit the vapor to be forced through the conduits 74, 78 into the fuel tank where it will rise and escape out the tank vent.

Any vapor which does reach the unmetered fuel chamber 166 of the charge forming device will collect in chamber 220 and be forced therefrom through the vapor conduits 104, 74, 78 whenever the quantity of vapor in chamber 220 equals or exceeds the amount at which the valve 160 opens.

Although the operation of the pump 22 is herein described as being controlled by an element responsive to the temperature and absolute pressure of the fuel, it is to be understood that other means could be utilized such as a manual switch operable at the will of the operator; or, as shown in Figure 4, the pressure and temperature responsive element could be merely exposed to the atmosphere; or the motor could be arranged to operate whenever the engine is operating, in which case the pressure and temperature responsive switch would be eliminated.

It is also pointed out that although an electric motor is herein shown and described for operating the pump 22 other means are equally applicable, such as a hydraulic motor operated by a motivating fluid under pressure, or even a remote type of mechanical drive from the engine itself. The pressure and temperature responsive element could be utilized to operate a valve controlling the flow of the motivating fluid in the former case or a clutch member in the latter.

While I have illustrated and described only a few embodiments of my invention, many others will be apparent to those skilled in the art and I contemplate the use of any which properly falls within the scope of the appended claims.

I claim:

1. In a fuel feeding system for an internal combustion engine, a charge forming device, a fuel supply tank, a vapor eliminating chamber having an inlet and an outlet, a low pressure fuel pump positioned below the level of the fuel in the fuel supply tank receiving fuel therefrom and delivering it to said inlet, and a high pressure fuel pump receiving fuel under pressure from said outlet and delivering it to the charge forming device, said chamber including a previous partition between said inlet and outlet, a vapor outlet anterior to said partition and means responsive to the fuel level in the chamber for closing said vapor outlet.

2. The invention defined in claim 1 together with a conduit connecting said vapor outlet to the fuel supply tank.

3. The invention defined in claim 1 comprising in addition means responsive to changes in altitude for controlling the operation of one of said pumps.

4. In a fuel feeding system for an internal combustion engine, a fuel supply tank, a charge forming device, and means for supplying liquid fuel free of vapor and air to said device from the tank comprising a separating chamber having an inlet, a liquid fuel outlet, and a vapor outlet, means responsive to the level of fuel within the chamber for controlling the vapor outlet, a conduit from the tank to said inlet including a centrifugal pump adapted to agitate the fuel received to convert unstable liquid fuel to vapor and deliver the liquid fuel and vapor to said chamber under an increased pressure to thereby prevent the vaporization of additional fuel, and a fuel passage from said fuel outlet to the charge forming device including a fuel pump adapted to deliver fuel under a relatively higher pressure to the charge forming device.

5. The invention defined in claim 4 wherein the centrifugal pump is of a type permitting rela-

tively free flow of fuel therethrough during periods of inoperation of the centrifugal pump and means for rendering said centrifugal pump inoperative during some periods of engine operation.

6. The invention defined in claim 4 wherein the centrifugal pump is of a type permitting free flow of fuel therethrough during periods of inoperation of the centrifugal pump and means responsive to variations in barometric pressure for controlling the operation of said centrifugal pump.

7. In a fuel feeding system for an aircraft engine, a fuel supply tank, a charge forming device, a fuel pump positioned adjacent and below the fuel tank to receive fuel therefrom under a gravity head, said pump being of a type adapted to permit relatively free fuel flow therethrough during periods of inoperation, a vapor separating chamber receiving fuel from said pump, a conduit from said chamber to the tank adjacent the bottom thereof for transmitting vapor separated from the fuel back to the tank, and an engine driven pump receiving fuel from said chamber and delivering it to the charge forming device.

8. The invention defined in claim 7 comprising means responsive to variations in barometric pressure for controlling the operation of the first mentioned pump.

9. In a fuel feeding system for an aircraft engine, a fuel supply tank, a charge forming device, means for supplying fuel from the tank to the charge forming device comprising a pair of fuel pumps, one of said pumps being of the centrifugal type and adapted to permit free fuel flow therethrough during periods of inoperation thereof, and means responsive to variations in barometric pressure for controlling said centrifugal type pump.

10. In a fuel feeding system for an aircraft engine, a fuel supply tank, a charge forming device, means for supplying fuel from the tank to the charge forming device comprising a pair of fuel pumps, and means responsive to variations in the temperature and absolute pressure of the fuel in the supply tank for controlling one of said pumps.

11. In a fuel feeding system for an internal combustion engine, a fuel supply tank, a charge forming device, and means for supplying liquid fuel free of vapor to said device from the tank comprising a conduit leading from the tank to the device, a centrifugal pump in the conduit adjacent its inlet, said pump being of a type adapted to permit free fuel flow therepast during periods of inoperation of the pump and adapted to agitate the fuel received thereby during periods of operation of the pump to beat out bubbles of vapor from the fuel and to discharge the fuel into the conduit under an increased pressure to thereby prevent the vaporization of additional fuel, means for passing back to the tank the vapor beat out by the centrifugal pump, and an engine driven pump in the conduit receiving fuel from the centrifugal pump and adapted to deliver the same under a relatively higher pressure to the charge forming device.

12. The invention defined in claim 11 comprising in addition means for rendering said centrifugal pump inoperative during some periods of engine operation.

13. The invention defined in claim 11 comprising in addition means responsive to variations in the pressure and temperature of the fuel supplied to the centrifugal pump for rendering said

centrifugal pump operative or inoperative during periods of engine operation.

14. In a fuel feeding system for an aircraft engine, a fuel supply tank, a fuel conduit leading from the tank for supplying fuel to the engine, a pump in the conduit of a type adapted to permit relatively free flow of fuel therepast during periods of inoperation of the pump, means for rendering said pump operative or inoperative during periods of engine operation, means responsive to variations in altitude for controlling said last named means, and a second pump in the conduit posterior to the first named pump and adapted to operate during all periods of engine operation.

15. The invention defined in claim 14 wherein said controlling means is also responsive to variations in the temperature of the fuel.

16. In a high altitude fuel system for an aircraft engine, the combination comprising a fuel tank, a pump driven by the aircraft engine, a discharge line extending from said pump to said engine, a suction line extending from said pump to said tank, an auxiliary pump in the suction line at the end near the tank, means for driving the auxiliary pump, and automatic means operable by a change in atmospheric pressure to control said driving means.

17. In a high altitude fuel system for an aircraft engine, the combination comprising a fuel tank, a pump, means for conveying fuel under pressure from said pump to said engine, a suction line extending from said pump to said tank, an auxiliary pump in the suction line near the tank, an electric motor for operating said auxiliary pump, and an automatic switch, operative upon a change in atmospheric pressure, for controlling said motor.

18. In a fuel feeding system for an aircraft engine, a fuel supply tank, a charge forming device, a centrifugal type pump positioned closely adjacent the fuel tank and receiving fuel therefrom, said pump being of a type adapted to permit free flow of fuel therethrough during periods of inoperation of the pump, an auxiliary motor for driving said pump, means for rendering said pump operative or inoperative during periods of engine operation, an engine driven pump adapted to operate during all periods of engine operation and receiving fuel from the first named pump and delivering it to the charge forming device, and a sealed capsule responsive to variations in barometric pressure for controlling the said means for rendering the pump operative or inoperative.

19. In a fuel feeding system for an aircraft engine, a fuel supply tank, a fuel conduit leading from the tank for supplying fuel to the engine, a vane type of pump in the conduit adapted to permit free flow of fuel therethrough during periods of inoperation of the pump, means for driving said pump, means for rendering said driving means operative or inoperative during periods of operation of the engine, means responsive to fuel temperature for controlling the means for rendering the pump operative or inoperative, and an engine driven pump in the conduit adapted to operate during all periods of engine operation and receiving fuel from the first named pump and delivering it to the engine.

20. In a fuel feeding system for an aircraft engine, a fuel supply tank, a fuel conduit leading from the tank for supplying fuel to the engine, a vane type of pump in the conduit adapted to permit free flow of fuel therethrough during

periods of inoperation of the pump, means for driving said pump, means for rendering said driving means operative or inoperative during periods of operation of the engine, an engine driven pump in the conduit adapted to operate during all periods of engine operation and receiving fuel from the first named pump and delivering it to the engine, and a passage leading from the fuel conduit between the two pumps to the fuel supply tank before the level of the fuel therein.

21. In a high altitude fuel system for an aircraft engine, the combination comprising a fuel tank, a main engine-driven fuel pump having an inlet, a fuel metering device receiving fuel under a relatively high pressure from said main pump, and means for supplying pressurized liquid fuel free of vapor to said pump inlet including a conduit leading from the tank to the pump inlet comprising an auxiliary pump assembly adjacent the inlet to the conduit for agitating the fuel to beat out bubbles of gas and vapor from the fuel and for pressuring the liquid fuel supplied to the main pump inlet to prevent vaporization of additional portions of the liquid fuel, and means for passing back to the tank the vapor beat out by the auxiliary pumping assembly.

22. In a high altitude fuel system for an aircraft having a fuel tank, a fuel metering device, a conduit connecting the tank and device, and a main engine-driven fuel pump in the conduit: an auxiliary pump assembly adjacent the inlet of the conduit for agitating the fuel received thereby to beat out bubbles of gas and vapor from the fuel and for pressuring the liquid fuel toward the main engine-driven pump to prevent vaporization of additional portions of the liquid fuel, means defining a path for the flow of bubbles beat out by the auxiliary pump assembly back to the fuel tank, an electric motor for operating said auxiliary pump assembly, and a switch controlling the operation of the motor whereby the auxiliary pump assembly may be rendered inoperative during periods of operation of the aircraft when the vapor forming tendency of the fuel is low.

23. In a fuel feeding system for an aircraft engine, a fuel supply tank, a charge-forming device, a fuel conduit leading from the tank to the charge-forming device, a vane-type pump in said conduit closely adjacent the tank and receiving fuel therefrom, said pump being of a construction to permit free flow of fuel therethrough during periods of inoperation thereof, power means for driving said pump, means for rendering said power means operative or inoperative during periods of engine operation, an engine-driven pump in said conduit in series with said first-named pump and adapted to operate during all periods of engine operation to deliver fuel under a predetermined pressure to the charge-forming device, and a manually-operable pump interposed in said conduit between said first and second-named pumps for pressuring fuel toward the engine driven pump under certain conditions, as in starting.

24. In a fuel feeding system for an aircraft engine, a charge-forming device, a fuel conduit leading from the tank to the charge-forming device, a centrifugal pump in said conduit closely adjacent the tank and receiving fuel therefrom, said pump being of a construction to permit free flow of fuel therethrough during periods of inoperation thereof, power means for driving said pump, means responsive to barometric pressure controlling the said power means, an engine-driven pump in said conduit in series with said first-named pump and adapted to operate during all periods of engine operation to deliver fuel under a predetermined pressure to the charge-forming device, and a manually-operable pump interposed in said conduit between said first and second-named pumps to assist in supplying fuel under pressure to the charge-forming device through the engine-driven pump under certain conditions of engine operation.

25. In a fuel feeding system for an internal combustion engine, a fuel supply tank, a charge forming device, and means for supplying liquid fuel free of vapor to said device from the tank comprising a conduit leading from the tank to the device, an auxiliary pumping assembly adjacent the inlet of the conduit, said assembly being of a type permitting free fuel flow therethrough during periods of inoperation of the auxiliary pumping assembly and agitating and pressuring the fuel received thereby during periods of operation of the auxiliary pumping assembly to convert unstable liquid fuel to vapor and to prevent the vaporization of additional portions of the liquid fuel by pressurizing the same, means for passing back to the tank the vapor formed by the auxiliary pumping assembly, and a main fuel pump in the conduit receiving the pressured fuel from the auxiliary pumping assembly and delivering the same under a relatively higher pressure to the charge-forming device.

26. The invention defined in claim 25 comprising in addition an electric motor for operating the auxiliary pumping assembly, and switch means controlling the operation of the motor for rendering the auxiliary pumping assembly inoperative during some periods of engine operation, such as when the vapor forming tendency of the fuel is low.

27. In a high altitude fuel system for an aircraft engine, the combination comprising a fuel tank, a main engine-driven fuel pump having an inlet, a fuel metering device receiving fuel under a relatively high pressure from said main pump, and means for supplying pressurized liquid fuel free of vapor to said pump inlet including a conduit leading from the tank to the pump inlet comprising an auxiliary pump assembly adjacent the inlet to the conduit for agitating the fuel to convert unstable liquid fuel to vapor and for pressuring the liquid fuel supplied to the main pump inlet to prevent vaporization of additional portions of the liquid fuel, and means for passing back to the tank the vapor formed by the auxiliary pumping assembly.

28. In a high altitude fuel system for an aircraft having a fuel tank, a fuel metering device, a conduit connecting the tank and device, and a main engine-driven fuel pump in the conduit: an auxiliary pump assembly adjacent the inlet of the conduit for agitating the fuel received thereby to convert unstable liquid fuel to vapor and for pressuring the fuel toward the main engine-driven pump to prevent vaporization of additional portions of the liquid fuel, means defining a path for the flow of bubbles formed by the auxiliary pump assembly back to the fuel tank, an electric motor for operating said auxiliary pump assembly, and a switch controlling the operation of the motor whereby the auxiliary pump assembly may be rendered inoperative during the periods of operation of the aircraft when the vapor forming tendency of the fuel is low.

FRANK C. MOCK.

Certificate of Correction

Patent No. 2,414,158. January 14, 1947.

FRANK C. MOCK

It is hereby certified that errors appear in the printed specification of the above numbered patent requiring correction as follows: Column 2, line 6, for "anp" read *an*; column 9, line 10, claim 20, for the word "before" read *below*; and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 20th day of July, A. D. 1948.

[SEAL]

THOMAS F. MURPHY,
Assistant Commissioner of Patents.