

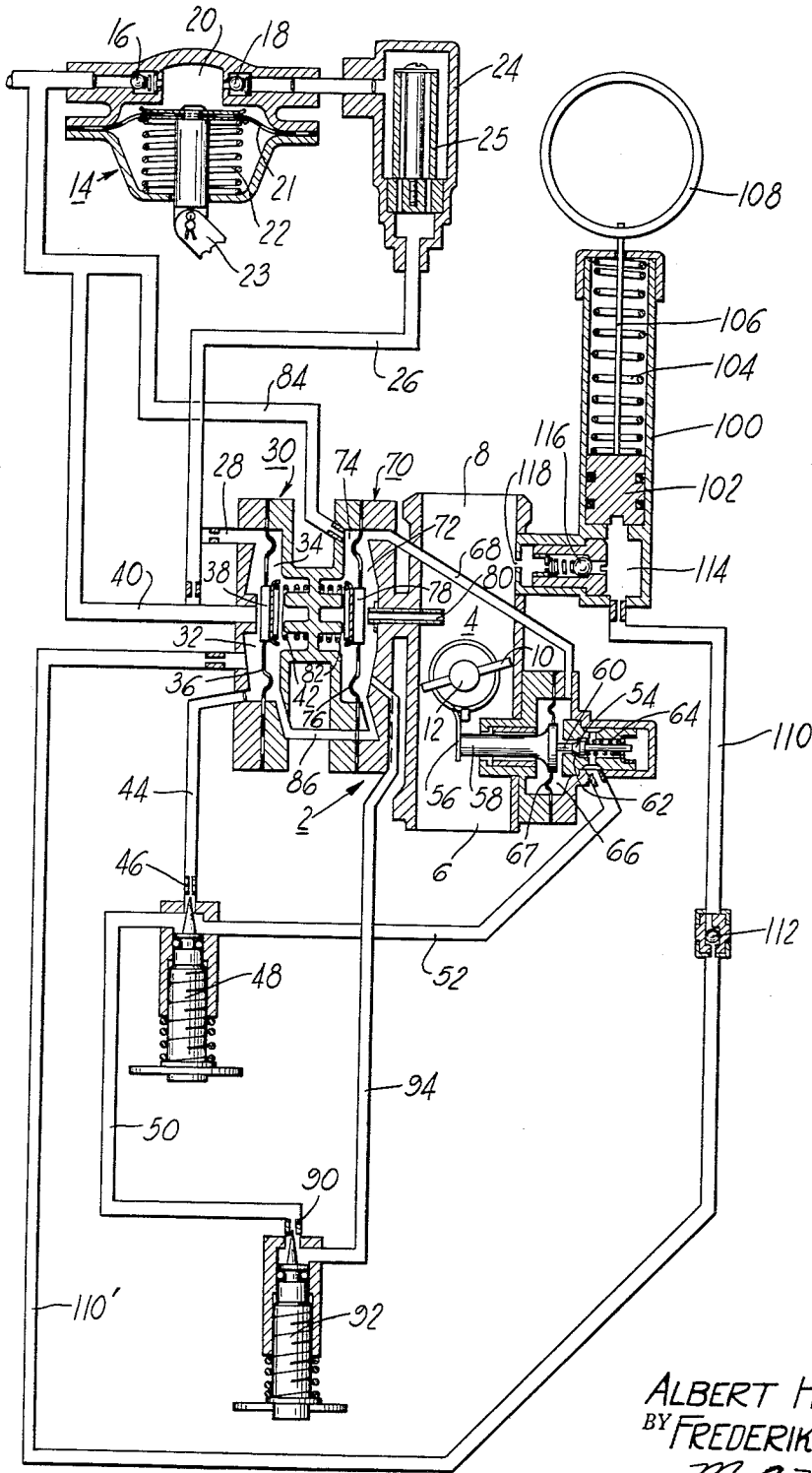
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A. H. WINKLER ET AL

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FUEL METERING SYSTEM

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INVENTORS
ALBERT H. WINKLER
BY FREDERIK BARFOD
m a Hobbs
ATTORNEY

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FUEL METERING SYSTEM

Albert H. Winkler, Elmira, N. Y., and Frederik Barfod, South Bend, Ind., assignors to Bendix Aviation Corporation, South Bend, Ind., a corporation of Delaware

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The present invention relates to a fuel system for internal combustion engines, particularly engines of the small portable type.

Although the volumetric efficiency of any internal combustion engine gradually decreases throughout most of the engine operating range, particularly at higher engine speeds, this factor is usually not of serious importance, particularly on engines equipped with the float type carburetor which inherently meters the fuel directly in response to the mass air flow to the engine. The float type carburetor, however, is rather unsatisfactory for small portable engines used on equipment which is inverted or turned to various off-level positions during operation. For this type of equipment, a fuel system in which the fuel is metered and delivered to the engine under positive pressure is preferred, but the relatively high cost of such systems for small engines and the failure of some of these systems to respond to changes in volumetric efficiency has prevented their widespread use on this type of engine, which often has rather low volumetric efficiency at the higher speeds. It is, therefore, one of the principal objects of the present invention to provide a relatively simple metering system for small internal combustion engines in which fuel is metered and delivered to the engines under positive pressure.

Another object of the invention is to provide a pressure type fuel system designed especially for small engines in which the volumetric efficiency decreases appreciably with increases in engine speed.

Further objects and advantages of the invention will become apparent from the following description and accompanying drawing, in which is shown a schematic view of our fuel system, the elements thereof being rearranged to more clearly show their functional relationship to one another.

Referring more specifically to the drawing, numeral 2 designates the main body of the fuel metering device, 4 designates an induction passage in the main body, 6 an air inlet, 8 a mixture outlet, and 10 a throttle valve mounted on a throttle valve shaft 12 in said induction passage. A pump generally shown at numeral 14 is provided to deliver fuel at a substantially constant pressure from a tank (not shown) to the metering unit and consists of fuel inlet and outlet check valves 16 and 18, respectively, a fuel chamber 20, a flexible diaphragm 21, a calibrated spring 22 for urging the diaphragm in the fuel delivery direction, and a linkage 23 operatively connecting said diaphragm to a cam or the like (not shown) for actuating the pump. In the operation of the pump, downward movement of diaphragm 21 draws fuel from the tank through valve 16 into chamber 20 and upward movement of the diaphragm under the pressure of spring 22 feeds the fuel through valve 18 to member 24 containing a filter element or strainer 25.

After passing through the member 24, the fuel flows through conduits 26 and 28 to a pressure control unit 30 consisting of a chamber 32 for unmetered fuel and a

chamber 34 for metered fuel separated from one another by a flexible diaphragm 36 which carries a valve 38 for controlling the inlet to a fuel return line 40 connecting chamber 32 with the pump inlet or fuel tank. Diaphragm 36 is urged in the direction to close the inlet of line 40 by a calibrated spring 42 reacting between said diaphragm and a fixed wall of chamber 34. The fuel, on entering chamber 32 from the pump, tends to move diaphragm 36 and valve 38 away from the inlet to line 40 and when the pressure in the chamber reaches a predetermined value, for example about four pounds, valve 38 unseats and permits the fuel in excess of that required to maintain the desired pressure to return through line 40 to the source, so that a substantially constant pressure is maintained in chamber 32 and in an outlet conduit 44 posterior to a metering orifice 46, throughout normal operation of the fuel system.

The fuel, on passing through the metering orifice 46 which is controlled by a manually adjustable metering pin 48, is divided into two portions, one portion flowing through conduit 50 of the idle system and the other portion flowing through conduit 52 of the main discharge system. The metered fuel flowing from conduit 52 passes through a cut-off valve 54 which is controlled by the throttle valve actuated mechanism to interrupt the flow of fuel through the main discharge system whenever the throttle valve is in closed or partially closed position, as shown in the drawing. A lever 56 secured to the throttle valve shaft 12 rotates counterclockwise as the throttle valve is opened and moves longitudinally a shaft 58 and valve stem 60, lifting valve 54 from its seat 62 in opposition to a relatively light spring 64 tending to close said valve. The fuel flows through chamber 66, which is sealed on the side adjacent shaft 58 by a flexible diaphragm 67 to permit free movement of the shaft through said chamber, and thence passes through a conduit 68 to fuel discharge unit 70 which consists of a chamber 72 for metered fuel and a chamber 74 for unmetered fuel, said chambers being separated by a flexible diaphragm 76 carrying a valve member 78 and urged in the direction to seat said valve member over the entrance to a discharge nozzle 80 by a calibrated spring 82 reacting between the diaphragm and a fixed wall of chamber 74. The fuel, on entering chamber 72, tends to move diaphragm 76 and valve 78 in the direction to open the entrance to discharge nozzle 80 which delivers the fuel to the induction passage 4 on the engine side of the throttle valve. The unmetered fuel is transmitted to chamber 74 through conduit 84 which connects said chamber with conduit 40 which in turn is connected with the pump inlet or fuel tank. The two units 30 and 70 are connected by a conduit 86 which transmits the metered fuel pressure in chamber 72 to chamber 34 so that any accidental increase in pressure in chamber 72 will cause a corresponding rise in the pressure throughout the system to maintain the desired metering head across orifice 46.

The fuel in conduit 50 of the idle system passes through a metering orifice 90 controlled by a manually adjustable metering pin 92 and flows through conduit 94 into discharge chamber 72 and thence through the discharge nozzle 80 into the induction passage for supplying the fuel to the engine for idling. The idling system remains in full effect throughout the entire operation of the engine and supplements the main discharge system at all times while said main system is in operation.

A priming system is also included in the present metering unit and consists of a cylinder 100 in which is mounted a reciprocable piston 102 urged in the direction to discharge fuel by a spring 104. The piston is manually actuated through a rod 106 and handle 108 secured to the end of said rod. The cylinder 100 is connected

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with chamber 32 of the fuel metering unit 30 by conduits 110 and 110', check valve 112 and a chamber 114 and with the induction passage on the engine side of the throttle valve through chamber 114, a check valve 116 and a discharge port 118. When the piston is manually raised through handle 108 and rod 106, fuel is drawn from chamber 32 through conduits 110, 110', check valve 112 and chamber 114 into cylinder 100. When the handle is released, spring 104 urges piston 102 downwardly, discharging the fuel from cylinder 100 through chamber 114, check valve 116 and port 118, giving an excessively rich mixture for starting a cold engine.

In the operation of the present metering device, the fuel is delivered by pump 14 through member 24, conduits 26 and 28 to chamber 32 adjacent diaphragm 36 which regulates the pressure in said chamber to maintain it at a substantially constant value. If the pump should deliver an excess amount of fuel so that there would be a tendency for the pressure in chamber 32 to increase, valve 38 carried by diaphragm 36 moves away from the entrance to conduit 40, permitting the excess fuel to return to the tank or pump inlet. The unit 30 maintains a constant pressure in conduit 44 so long as the pressure in the system and posterior to the metering orifice remains substantially constant. If there should be an increase in pressure in the system posterior to the metering orifice, the increase in pressure is transmitted to chamber 34 through conduit 86, urging diaphragm 36 toward closed position and thereby increasing the pressure in chamber 32 so that a substantially constant head is maintained across the normally fixed metering orifice 46 to provide a substantially constant fuel delivery to the engine. As the throttle valve is opened, the cut-off valve 54 is opened immediately to substantially its full capacity so that it has little effect thereafter on the quantity of fuel delivered to the engine. The fuel thence flows through conduit 52 through valve 54 and conduit 68 to chamber 72 from which it discharges into the induction passage through nozzle 80. When the throttle valve is again closed and the engine is idling, the fuel flows at a constant rate through conduit 50, orifice 90 and conduit 94 into chamber 72 and discharges through nozzle 80 into the induction passage.

Although only one embodiment of our fuel metering device has been shown and described herein, modifications and various arrangements of the elements thereof may be made to suit requirements.

We claim:

1. A fuel metering device for an engine having an induction system, comprising an unmetere fuel chamber, a metered fuel chamber, a diaphragm separating said chambers, a second metered fuel chamber, a second unmetere fuel chamber, a diaphragm separating said second chambers, a conduit adapted to connect the first unmetere fuel chamber with a source of fuel under pressure, a conduit connecting the first unmetere fuel chamber with the second metered fuel chamber and having a metering orifice therein, a passage connecting said second metered fuel chamber with said induction system, a passage adapted to connect said first unmetere fuel chamber with the source of fuel for returning excess fuel delivered to said chamber, a valve actuated by said first mentioned diaphragm for controlling said second mentioned passage, and a valve actuated by said second mentioned diaphragm for controlling said first mentioned passage.

2. A fuel metering device for an engine having an induction system with a throttle therein, comprising an unmetere fuel chamber, a metered fuel chamber, a diaphragm separating said chambers, a second metered fuel chamber, a second unmetere fuel chamber, a diaphragm separating said second chambers, a conduit adapted to connect the first unmetere fuel chamber with a pump, a conduit connecting the first unmetere fuel chamber with

the second metered fuel chamber and having a metering orifice therein, a passage connecting said second metered fuel chamber with said induction system, a passage adapted to connect said first mentioned fuel chamber with the inlet side of said pump for returning excess fuel delivered to said chamber, a spring-loaded valve actuated by said first mentioned diaphragm for controlling said second mentioned passage, and a spring-loaded valve actuated by said second mentioned diaphragm for controlling said first mentioned passage.

3. A fuel metering device for an engine having an induction system with a throttle valve therein, comprising an unmetere fuel chamber, a metered fuel chamber, a diaphragm separating said chambers, a second metered fuel chamber, a second unmetere fuel chamber, a diaphragm separating said second chambers, a conduit adapted to connect the first unmetere fuel chamber with a source of fuel under pressure, a conduit connecting the first unmetere fuel chamber with the second metered fuel chamber and having a metering orifice therein, and a fuel cut-off valve downstream from said orifice adapted to be closed only when the throttle valve is in closed or nearly closed position, a passage connecting said second metered fuel chamber with said induction system, a passage connecting said first unmetere fuel chamber with the source for returning excess fuel delivered to said chamber, a valve actuated by said first mentioned diaphragm for controlling said second mentioned passage, a valve actuated by said second mentioned diaphragm for controlling said first mentioned passage, springs urging each of said diaphragms in the direction to close said valves, and a passageway for idling fuel connecting the first unmetere fuel chamber with the second metered fuel chamber and adapted to provide a constant flow of fuel throughout the operation of said engine.

4. A fuel metering device for small engines having an induction passage with a throttle therein, comprising an unmetere fuel chamber, a metered fuel chamber, a diaphragm separating said chambers, a second metered fuel chamber, a second unmetere fuel chamber, a diaphragm separating said second chambers, a conduit adapted to connect the first unmetere fuel chamber with a pump, a conduit connecting the first unmetere fuel chamber with the second metered fuel chamber and having a metering orifice therein and a fuel cut-off valve downstream from said orifice adapted to be closed only when the throttle is in closed or nearly closed position, a passage connecting said second metered fuel chamber with said induction passage on the engine side of the throttle valve, a passage connecting said first unmetere fuel chamber with the inlet side of said pump, a valve actuated by said first mentioned diaphragm for controlling said second mentioned passage, a valve actuated by said second mentioned diaphragm for controlling said first mentioned passage, a spring urging each of said diaphragms in the direction to close said valves in opposition to the fuel pressure in the first unmetere and the second metered fuel chambers, and a passageway for idling fuel connecting the first unmetere fuel chamber with the second unmetere fuel chamber and being adapted to deliver a constant supply of fuel throughout the operation of the engine.

5. A fuel metering device for an engine having an induction system comprising an unmetere fuel chamber, a metered fuel chamber, a diaphragm separating said chambers, a second metered fuel chamber, a second unmetere fuel chamber, a diaphragm separating said second chambers, a conduit adapted to connect the first unmetere fuel chamber with a source of fuel under pressure, a conduit connecting the first unmetere fuel chamber with the second metered fuel chamber and having a metering orifice therein, a passage connecting said second metered fuel chamber with said induction system, a passage connecting said first unmetere fuel chamber with the source for returning excess fuel delivered to said

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chamber, a spring loaded valve actuated by said first mentioned diaphragm for controlling said second mentioned passage, a spring loaded valve actuated by said second mentioned diaphragm for controlling said first mentioned passage, a passageway for idling fuel connecting the first unmetered fuel chamber with the second metered fuel chamber, and a manually actuated pump connected by a conduit with the first unmetered fuel chamber and by another conduit with the induction system.

6. A fuel metering device for an engine having an induction system, comprising an unmetered fuel chamber adapted to be connected to a source of fuel under pressure, a metered fuel chamber connected to said unmetered fuel chamber and having a movable wall, a second metered fuel chamber connected to said first metered fuel chamber, a movable wall separating said unmetered fuel chamber from said second metered fuel chamber, a passage connecting said first metered fuel chamber with the induction system, a passage adapted to connect said unmetered fuel chamber with said source of fuel for returning the excess fuel delivered to said chamber, a valve actuated by said second mentioned movable wall for controlling said second mentioned passage, and a valve actuated by said first mentioned movable wall for controlling said first mentioned passage.

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7. A fuel metering device for an engine having an induction system, comprising a conduit for supplying fuel from a source under pressure to the induction system, a normally fixed metering orifice in said conduit, a valve in said conduit anterior to said orifice, a chamber, a movable wall in said chamber responsive to unmetered and metered fuel pressure for controlling said valve, a valve in said conduit posterior to said orifice, a second chamber, and a movable wall in said second chamber responsive to metered and unmetered fuel pressure for controlling said second mentioned valve, whereby a substantially constant fuel flow is maintained through said orifice throughout normal operation of the engine.

References Cited in the file of this patent

UNITED STATES PATENTS

2,277,930	Mock et al. -----	Mar. 31, 1942
2,343,451	Garretson -----	Mar. 7, 1944
2,414,322	Mock -----	Jan. 14, 1947
2,416,906	Chandler -----	Mar. 4, 1947
2,416,907	Chandler -----	Mar. 4, 1947
2,422,808	Stokes -----	June 24, 1947
2,447,793	Bolt et al. -----	Aug. 24, 1948