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Phelps

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[54] **FUEL SUPPLY SYSTEM**

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[52] **U.S. Cl.** ..... **261/27**, 123/139 AW

[51] **Int. Cl.** **F02m 69/02**

[58] **Field of Search** ..... 261/27, 39 D, 51, 261/69 R, 67, 34 A; 123/139 AW, 119 R

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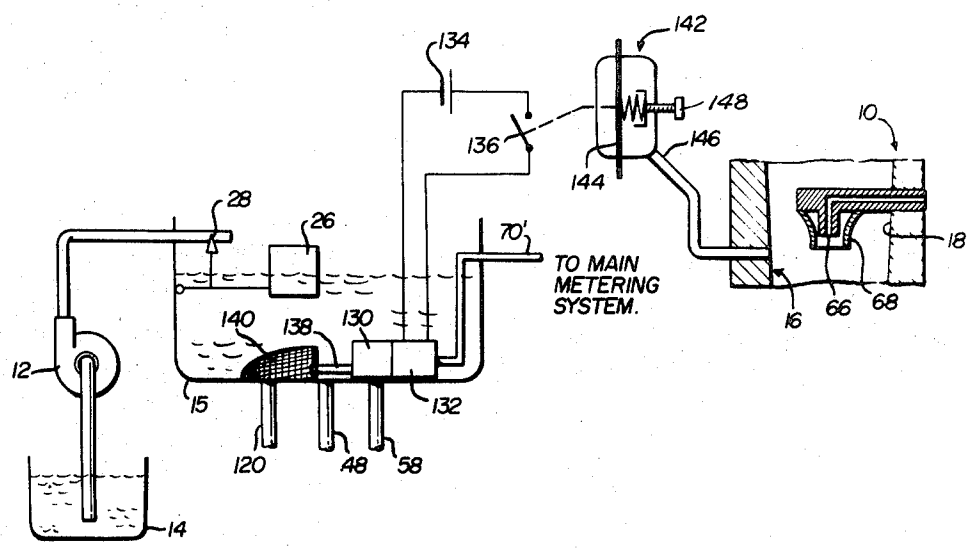
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[57] **ABSTRACT**

A fuel supply system incorporating a downdraft carburetor having an idle metering system and also an enrichment valve that causes both the engine speed to increase and an enriched air-fuel mixture to be supplied to the engine for cold engine operation. The carburetor has a main metering system that has its main metering valve element mechanically linked to the throttle valve, a restrictor valve that prevents overcharging during acceleration and an accelerating pump, and a positive displacement pump to avoid pulsations in the fuel being supplied.

6 Claims, 3 Drawing Figures



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SHEET 1 OF 2

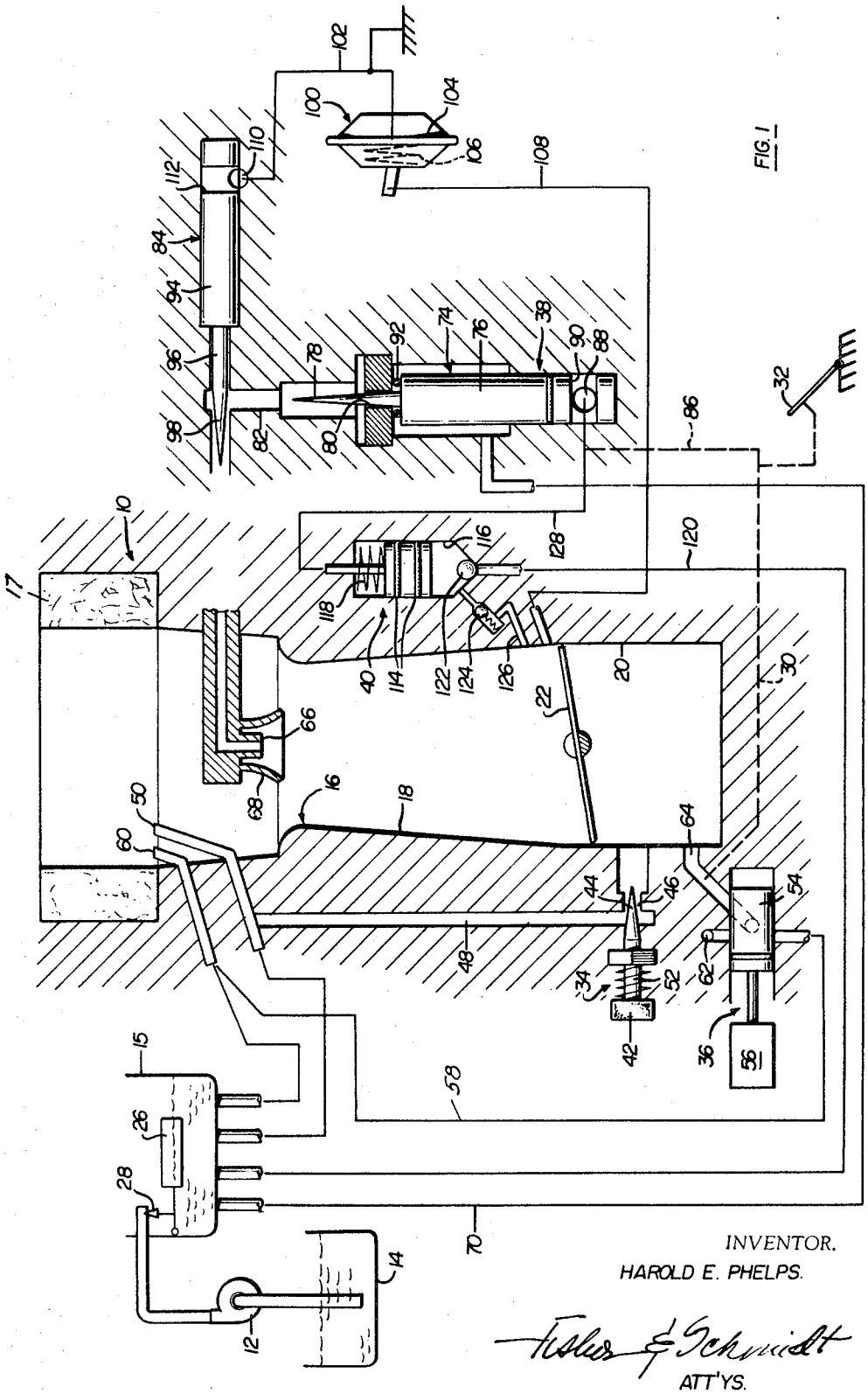


FIG. 1

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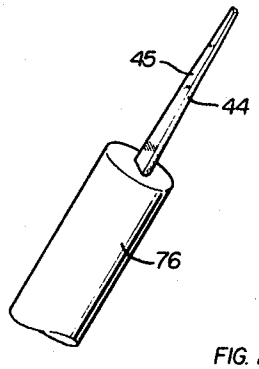
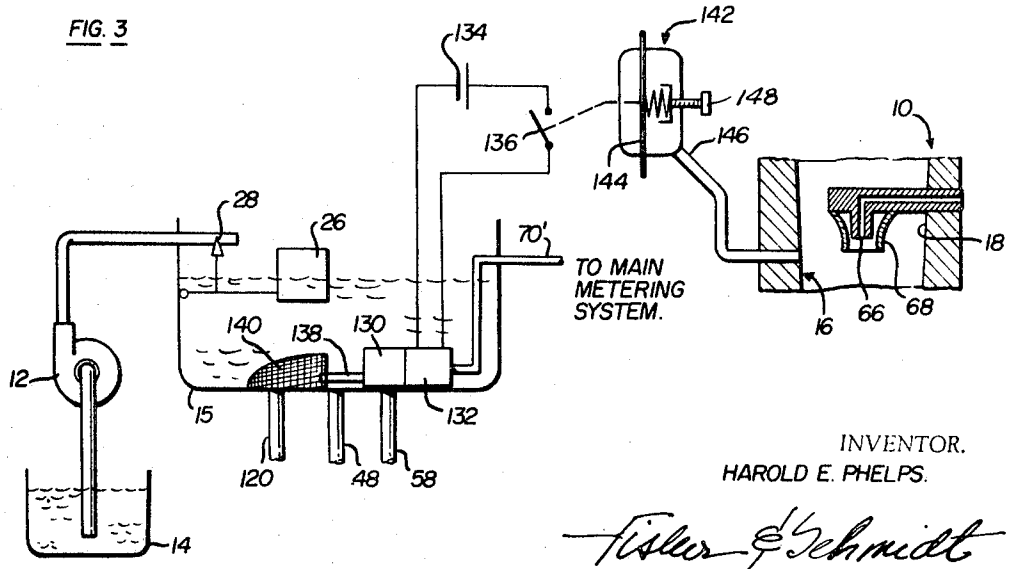


FIG. 2

FIG. 3



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FUEL SUPPLY SYSTEM

This is a division of U. S. patent application Ser. No. 843,384, filed July 22, 1969, in the name of Harold E. Phelps and entitled "Fuel Supply System" now U.S. Pat. No. 3,645,256.

This invention relates to improvements in fuel supply systems adapted for use, although not exclusively, with internal combustion engines.

Carburetion for an internal combustion engine must generally provide a relatively rich air-fuel mixture for cold operation, a relatively lean air-fuel mixture for normal power operation, and a somewhat richer air-fuel mixture for maximum power operation. Usually the enriched mixture for cold engine operation is provided by a choke valve and the idle and main metering systems combine to provide the mixing for normal and high power operation. There is necessarily a compromise required, such that often during high power operation the mixture is too rich and there is an overcharging. This can also happen during low power operation; e.g., during coast. Any overcharging results in an excessive use of fuel and also results in undesired emission of contaminates due to the over enrichment and the resultant lack of complete combustion of the fuel.

With the foregoing in mind, the invention contemplates a new and different fuel supply system in which the main metering system has a direct connection to the throttle so as to achieve operation that is closer to the optimum over a wider power range, that provides positive shut off when the main metering system is not to be used, and that provides improved metering operation with a simplified structure.

Also contemplated is a fuel supply system in which the supply of fuel by the main metering system is controlled so as to avoid overcharging.

The conventional choke valve, which is used for cold engine operation, is operated by linkage that tends to become misaligned, and then the engine is either under choked or over choked. This same linkage is used to adjust a cam that increases the engine idle speed during cold operation and if misaligned, the engine idling speed can be either too fast or too slow. If too slow, the cold engine tends to stall. If too fast, fuel is wasted. Also the choke valve itself, over a period of time becomes coated and tends to stick open or closed. Obviously, with an improperly operating choke valve, the engine can fail to start when cold or the choke valve can remain partially closed so as to overly enrich the air-fuel mixture resulting not only in the waste of fuel but also the emission into the air of undesired contaminates.

Therefore, also contemplated by this invention is a carburetor which has no choke and utilizes a unique and enriching provision that is responsive to the ambient temperature and causes both the engine idling speed to increase and an enriched mixture to be supplied to the engine for cold operation.

Another objective of the invention is an enriching provision that is relatively simple in construction, that has no moving parts within the mixing chamber of the carburetor and that does not rely upon linkages.

A more specific objective is a novel provision that increases the idle speed of the engine without any mechanical connections with the throttle valve.

There is a tendency at low engine RRM's with conventional fuel systems for pulsations to develop in the fuel being supplied to the carburetor. These pulsations

in turn cause fluctuations in the emission of contaminates and thus their control is rendered difficult. Efforts to reduce these pulsations can result in undesired flooding of the engine.

Accordingly, another objective is a fuel supply system in which the emission of contaminates is minimized.

A more specific objective is a fuel system in which fuel pulsations are eliminated, particularly at low engine speeds and without incurring flooding.

The foregoing and other objects of this invention will become apparent from the following description and from the accompanying drawings, in which:

FIG. 1 is a diagrammatic sectional view of a carburetor incorporating the principles of the invention;

FIG. 2 is a perspective view of a needle used by the various metering valves in the carburetor; and

FIG. 3 is a partial diagrammatic sectional view of a modification of the FIG. 1 carburetor.

Referring now to FIG. 1 of the drawings, the fuel system displayed includes a carburetor **10** of the downdraft type, which is supplied with fuel by a suitable fuel pump **12.** The pump **12** may be of the conventional diaphragm type having a drive connection with the engine (not shown) or may be electrically operated or may be of some other type. Fuel from a reservoir or fuel tank **14** is supplied by the pump **12** to a float chamber **15** for the carburetor **10.** From the chamber **15,** the fuel goes to a mixing chamber shown generally at **16,** for the carburetor **10.** At the top, the mixing chamber **16** is connected to an air supply through a conventional filter **17.** Unless a super-charger is employed, the mixing chamber **16** is connected through the filter **17** directly to atmosphere. The mixing chamber **16** has a narrow venturi section at **18,** and an exit at **20** to the usual engine intake manifold (not shown). Just above the exit **20** is pivotally mounted a throttle valve **22** of the usual butterfly type. The number of exits **20,** i.e., whether there is **1, 2, 3** or more barrels and throttle valves **22,** will be determined by the application of carburetor **10.**

In the float chamber a float **26** in a well known way, operates a valve **28** to admit more fuel as the level of the fuel in the float chamber **24** decreases.

When the throttle valve **22** is operated through the agency of linkage **30** by a drive operated accelerator pedal **32** in the usual manner, fuel flows from the float chamber **15** to the carburetor's various systems including an idle metering system denoted generally at **34,** an enrichment valve **36,** a main metering system shown generally at **38,** and accelerating pump **40.**

Considering first, the idle metering system **34,** an idle metering valve element **42** is threadedly attached to the carburetor **10** and has an elongated end **44** that presents a variable cross-sectional area and is constructed as shown in FIG. **2.** The elongated end **44** as viewed in FIG. **2** is generally circular in cross-section throughout its extent except that it has a flat tapered surface **45** along all or part of its length. This construction is preferred to the usual needle type configuration which is circular and gradually diminishes in cross-sectional area to a point. With this FIG. **2** construction stock with a round cross-section can be easily machined with this tapering flat without the usual concerns encountered when generating a cone for the needle type configuration. The elongated end **44** extends into a metering orifice **46** which communicates with the mixing

chamber 16 at a point below the throttle valve 22 when in the illustrated closed position.

An idle metering supply passage at 48, which includes a vent 50 positioned in the entrance to the mixing chamber 16, connects the orifice 46 to the float chamber 24. By rotating the idle metering valve element 42, the effective area of the orifice 46 can be varied by the elongated end 44 and correspondingly the air-fuel mixture from the idle metering supply passage 48. For example; as the effective size of the metering orifice 46 is decreased, the air-fuel mixture will corresponding become leaner. Conversely, when the effective size is increased, the air-fuel mixture becomes richer. The setting of the idle metering valve element 42 is maintained by a coil spring 52 which is normally compressed, so as to resist any unwanted rotation of the valve element 42 once adjusted.

The idle metering system 34 is effective when the engine is operating with throttle valve 22 in the closed or nearly closed position. Consequently, there is a pressure differential across the metering orifice 46 such that fuel will be drawn from the float chamber 15 and mixed with a portion of air determined by the adjustment of the idle metering valve element 42, and the size of the vent 50. The amount of the mixture will be related to the pressure differential and will be delivered to the mixing chamber 16 downstream from the throttle valve 42. This mixture, which is relatively rich operates the engine in the idle speed range.

It is well known that when an engine is cold more fuel must be supplied than under normal operating conditions to insure that the air and the fuel properly mix so that there is adequate vaporization. If there is no vaporization, there is no burning and the undesired emission of unburned fuel results. This has been the function of the standard choke valve, i.e., to enrich the mixture to insure adequate vaporization for cold engine starting. To avoid all of the aforementioned problems with choke valves, the novel enrichment valve 36 is employed for cold operation.

The enrichment valve 36 has a valve element 54 and a temperature responsive actuator 56 which maneuvers the valve element 54. This temperature responsive actuator 56 responds to the ambient temperature and may be of any known type, by way of example; the type 42–120 made by the Dole Valve Company and referred to as a power element. The enrichment valve element 54 controls communication between an enrichment valve supply passage 58, which receives air by way of a vent 60 at the entrance to the mixing chamber 16, an air vent 62 and an outlet passage 64. The outlet passage 64 opens into the mixing chamber 16 downstream from the throttle valve 22 so as to be effective with a closed or nearly closed throttle valve 22. The air vent 60 can also extend to the entrance of the mixing chamber 16 to receive filtered air if preferred.

When the ambient temperature is cold and an enriched mixture is required by the engine, the temperature responsive actuator 56 will be response to the cold temperature, move the valve element 54 leftwardly as viewed in FIG. 1 and connect the air vent 62 and the supply passage 58 to the outlet passage 64. Consequently, there will be an increased supply of air to the engine and this will cause the engine to speed up. Also the engine will receive the needed enriched mixture. Therefore, both a fast idle and an enriched mixture for cold engine operation are achieved. When the ambient temperature rises, the actuator 56 responds and returns the valve element 54 to the illustrated position to close the outlet passage 64.

The valve element 54 may have various forms as those skilled in the art will appreciate. As shown, the air vent 62, the outlet passage 64 and the supply passage 58 are all in the same plane and spaced around the circumference of the valve element 54 so that they all are closed and opened together.

Describing now the main metering system 38, which is effective for other than idling speeds, e.g., above 15 miles per hour, the system 38 supplies an air-fuel mixture to a discharge nozzle 66, which is positioned within the mixing chamber 16. The exit of the discharge nozzle 66 is at the throat of a venturi 68, i.e., at the narrowest section of the venturi 68. The exit from the venturi 68 is, in turn, positioned so as to be at the narrowest part of the venturi section 18 of the mixing chamber 16. Fuel for the main metering system 38 is derived from a main metering supply passage 70. The main metering supply passage 70 connects a main metering valve assembly, shown generally at 74, to the float chamber 15. Alternatively the passage 70 can be connected between the fuel pump 12 and the float chamber 15.

The main metering valve assembly 74 has a valve element 76 provided with an elongated end 78 constructed similar to the elongated end 44 shown in FIG. 2 for the idle metering valve element 42. This elongated end 78 adjusts the effective area of a metering orifice denoted at 80, which communicates with a passage 82 to a restrictor valve assembly, designated generally by the numeral 84. The movement of the valve element 74 is by a linkage arm 86, which has a cam 88 slidably positioned with a slot 90 formed in an end of the valve element 76. The linkage arm 86 is connected to the linkage 30 so as to be operated by the accelerator pedal 32 and will, when the accelerator pedal 32 is depressed, pivot so as to move the main metering valve 76 downwardly as viewed in FIG. 1. This downward movement increases the effective area of the metering orifice 80. Hence, more fuel will be supplied to the discharge nozzle 66 for increasing the speed of the engine. When the accelerator pedal 32 is released to the closed throttle position, the linkage arm 86 will move the main metering valve element 76 upwardly to decrease the effective area of the metering orifice 80 and finally to the closed position. In this closed position, an O-ring type seal 92 positioned on the elongated end 78 engages the metering orifice 80 and completely closes it so that no fuel can leak past this point and to the nozzle 66. This further enhances the carburetor's ability to control emissions because the leakage fuel which could ultimately be emitted to the atmosphere in the form of unburned contaminates is not possible with this positive shut-off.

The restrictor valve assembly 84 as will become apparent, also facilitates emission control. The restrictor valve assembly 84 has a movable valve element denoted at 94. This valve element 94 has an elongated end 96 shaped as the previously discussed end 44 in FIG. 2. This elongated end 96 varies the effective area of a metering orifice 98 in the passage 82 and therefore, further controls the supply of fuel to the discharge nozzle 66.

The movements of the restrictor valve element 94 is by a vacuum actuator 100 and linkage 102. The va-

cuum actuator 100 is of conventional construction with a flexible diaphragm 104 which is biased to a released position by a spring 106. The diaphragm 104 is connected to the linkage 102, hence when flexed will move the linkage 102. The spring side of the vacuum actuator 100, communicates with the mixing chamber 16 through a vacuum pressure supply passage 108 that is connected to the mixing chamber 16 at a point just above or upstream from the closed throttle valve 22. Consequently, when the throttle valve 22 is in its closed position, there will be no vacuum pressure or suction acting on the diaphragm 104. The spring 106, therefore, will dominate and through the linkage 102, which has a cam end 110 slidably fitted in a slotted receiving end 112 of the valve element 94, will move the restrictor valve element 94 leftwardly and to a position in which the area of the metering orifice 98 is minimum. This minimum opening is adequate to supply enough fuel to operate the vehicle by way of example only, at 30 to 40 miles per hour.

This condition also occurs when the throttle valve 22 is in the so-called full throttle position for again the suction acting on the diaphragm 104 will be slight. Consequently, the restrictor valve element 94 will be in the restricting position in which the area of the orifice 98 is minimum. At this time the main metering valve element 74 is in its wide open position with the effective area of its metering orifice 80 maximum to provide correspondingly maximum fuel for full throttle operation. The restrictor valve assembly 84, therefore, prevents at full throttle, the overcharging in the supplying of too much fuel to the discharge nozzle 66, by reducing the effective area of its orifice 98. One should be mindfull that although the suction reduces to a minimum when the full throttle condition is first initiated, thereafter even though the full throttle condition is maintained, the suction will nevertheless commence rather quickly to increase from this minimum. As soon as the suction commences to build up again, the vacuum actuator 100 will move the restrictor valve element 94 back to the non-restricting position and increase the effective size of orifice 98. Again this prevention of overcharging facilitates control of emissions of unburned contaminates into the air.

To provide additional fuel for rapid acceleration, the accelerating pump 40 is employed. The accelerating pump 40 has a pump piston 114 which reciprocates in the accelerating pump chamber 116 when the piston 114 is moved upwardly against the bias from a coil spring 118. Fuel is drawn from the float chamber 15 by way of an accelerating pump supply passage 120 past an inlet check valve 122 which unseats and into the pump chamber 116. When the pump piston 114 is thereafter moved downwardly, this fuel is in the chamber 116 is forced past an outlet ball check valve 124 and into an outlet passage 126 which communicates with the mixing chamber 16 at a point just upstream from the throttle valve 22 so as to be ineffective when the throttle valve 22 is closed or nearly closed. The reciprocation of the pump piston 114 is through a linkage 128 which can be adjustable and has an end connected to the opposite end of the linkage arm 86. Thus, when the accelerator pedal 32 is depressed and with reference to FIG. 1, the linkage arm 86 rotates clockwise to move the main metering valve element 76 downwardly and the linkage 128 upwardly so as to then move the pump piston 114 downwardly and force additional fuel into the mixing chamber 16 for acceleration purposes.

Briefly summarizing the operation, before starting the engine and assuming that the engine is cold, the enrichment valve 36 will be opened because the temperature responsive actuator 56 will have moved the enrichment valve element 54 leftwardly as viewed in FIG. 1 to connect the air vent 62 and the enrichment valve supply passage 58 to the outlet passage 64. During starting, fuel also will be derived from the idle metering system. The enrichment valve outlet passage 64 as the idle metering orifice 44 exits below the throttle valve 22, thus the mixture is enriched for starting and running the engine while still cold. The air vent 62 for the enrichment valve 36 provides additional air which causes the engine to run at a slightly faster idling speed. This further prevents the tendency for the engine to stall when cold. As soon as the engine warms, the enrichment valve 36 closes the outlet passage 64.

Assuming next, that the vehicle is being operated at a speed that renders the main metering system 38 effective, the throttle valve 22 will have a corresponding opening and the idle metering system 34 will become ineffective once the pressure differential across the idle metering valve orifice 40 is not great enough to draw any of the fuel from the float chamber 15 through the idle metering orifice 44. Because of the direct connection of the linkage 30 and the linkage arm 86 with the main metering valve 74, the effective area of the main metering system's metering orifice 80 will have been increased and correspondingly the fuel supply to build up to and maintain a speed of say, 25 miles per hour. At this time, the open throttle valve 22 will expose the vacuum pressure supply passage 108 to a suction great enough to act on the vacuum actuator 100 and through the linkage 102, move the restrictor valve 84 to its non-restricting position in which the effective area of the restrictor valve metering orifice 98 is maximum. Therefore, the restrictor valve 84 is not effective during normal operation.

If, with the vehicle being operated at the 25 mile per hour speed, the throttle valve 22 is closed to commence decelerating the vehicle, the restrictor valve assembly 84, because the vacuum pressure supply passage 108 will have only a slight suction applied to it, will be moved by the vacuum actuator 100 back to the restricting position in which the effective area of the metering orifice 80 is minimum. Also, the main metering valve element 76 will be moved up to its closed position with the O-ring seal 92 preventing any communication between the main metering valve supply passage 70 and the passage 82.

Next, if the engine is operating at 25 miles per hour and full throttle operation is wanted, the accelerator pedal 32 is depressed to its maximum extent and will open the throttle valve 22 correspondingly to its maximum extent. The linkage arm 86 will, therefore, move the main metering valve element 74 downwardly so that the area of the metering orifice 80 is maximum. There will be a decrease in the suction in the mixing chamber 16 and therefore vacuum actuator 100 will move the restrictor valve assembly 84 to the restricting position. This prevents the mentioned overcharging condition or the supply of too much fuel, when the main metering valve element 76 is wide open at full throttle. As explained whether or not the full throttle condition is maintained the suction with the mixing chamber 16 will start to build up, and when it does, the

vacuum actuator 100 will return the restrictor valve assembly 84 to its non-restricting position to again increase the effective area of its metering orifice 98.

During full throttle operation, the accelerating pump 40 becomes operative and its pump piston 14 through linkage arm 86 and the linkage 128 is moved downwardly to force the fuel from the chamber 116, through the outlet passage 126, and into the mixing chamber 16 to insure that there is adequate fuel for the desired acceleration.

In the FIG. 3 modification the main metering system 38 is provided with a positive displacement pump denoted generally by the numeral 130. This pump 130 is positioned in the float chamber 15 and can be in many different forms; e.g., be either of the gear or turbine type, both of which are well known and is driven by any conventional D.C. motor 132. The D.C. motor 132 can receive power from the vehicle battery shown at 134 whenever a control switch 136 is closed. When this control switch 136 is closed, the motor 132 will drive the pump 130 and fuel will be drawn through an inlet 138, which can have a suitable filter 140 if needed and supplied to the outlet, which is connected to a main metering supply passage 70'. The pump 130 is shown submerged in the fuel but it need not be as long as there is proper communication between its inlet 138 and the fuel in the chamber 15.

The control switch 136 is operated by a vacuum motor of any suitable kind and is designated generally at 142. The motor 142 illustrated, has a flexible diaphragm 144 appropriately connected to the control switch 136. The diaphragm 144 is connected by a control passage 146 to the carburetor mixing chamber 16 so as to respond to the pressure at approximately the narrowest part of its venturi section 18. An adjustment is provided, such as the depicted spring bias adjusting screw 148 for varying the response of the motor 142 so that the control switch 136 will close at different selected pressures.

For exemplary purposes only, the adjustment of the vacuum motor 142 is set so that at approximately 1,000 R.P.M. of the engine the velocity of the air being drawn through the venturi section 18 will result in a vacuum in the control passage sufficient to draw the flexible diaphragm 144 rightwardly to close the control switch 136. This will result in energization of the D.C. motor 132 and the pump 130 will commence operating to supply the main metering system. With this arrangement, the tendency for pulsations to occur in the main metering supply passage 70 in the FIG. 1 system is eliminated by the positive displacement pump 130 which, in effect, pushes the fuel to the discharge nozzle 66. The pulsations at these low engine speeds result in fuel waste and of course, fluctuation in the undesired emission of contaminates. Furthermore, with the pump 130 positioned at this point in the system, i.e., in the float chamber 15, the fuel is pushed a shorter distance and thus the usual vapor problem is substantially eliminated.

This 1,000 R.P.M. speed selected is the speed at which it is desired for the main metering system 38 to become operative in the aforedescribed way and hence, can be varried by adjusting the screw 148 to suit each particular application of the system.

From the foregoing, it will be appreciated that a carburetor 10 has been provided which does not have a linkage operated choke valve, but a much simplified enrichment valve 36 for achieving both the enriched mixture and the fast idle for cold engine operation as well as improved emission control when the engine is cold. Also, the carburetor 10 can, by the direct connection between the main metering valve element 76, the accelerator pedal 32 and the throttle valve 22, provide a better overall range of operation without compromises as to whether at low speeds the mixtures are made too rich to insure that at higher speeds the mixtures are not too lean. Also, overcharging and leakage from the main metering system is avoided as are pulsations so as to achieve better emission control from the main metering valve system.

I claim:

1. In a fuel system for operating an engine in idling speed and driving speed ranges, the combination of an air supply, a fuel supply including a float chamber and a fuel pump having the outlet thereof communicating with the float chamber, mixing chamber for supplying a mixture of air and fuel to the engine, a throttle valve in the chamber for controlling the supply of the air-fuel mixture to the engine, and idle metering system communicating with the float chamber and the air supply and operative to supply an air-fuel mixture to the mixing chamber downstream from the throttle valve for operating the engine in the idling speed range, a main metering system communicating with the fuel supply and operative to supply fuel to the mixing chamber for operating the engine in the driving speed range, the main metering system including main metering valve means arranged to control the fuel supplied to the mixing chamber, a positive displacement pump having the inlet thereof communicating with the float chamber and the outlet thereof communicating with the main metering valve means, and means operative in response to a predetermined pressure within the mixing chamber corresponding to the pressure at the initiation of operation of the fuel system in the driving speed range for rendering the positive displacement pump effective to supply fuel from the float chamber to the main metering valve means.

2. A fuel supply system as described in claim 1, wherein the pump operating means includes motor means for driving the pump and control means responsive to the predetermined pressure within the mixing chamber for rendering the motor means operative.

3. A fuel supply system as described in claim 1, wherein the pump operating means includes electric motor means for driving the pump, control means for the motor means, the control means including a source of electric power and switch means operative in response to the predetermined pressure within the mixing chamber for connecting the electric power source to the motor means for rendering the pump operative.

4. A fuel supply system as described in claim 1, further including enrichment valve means responsive to ambient temperatures and operative in the idling speed range when the ambient temperature is below a predetermined value to supply both air from the air supply and an air-fuel mixture from the fuel supply to the chamber at a point downstream from the throttle valve for both increasing engine speed and for enriching the mixture supplied to the engine to facilitate cold engine starting.

5. A fuel supply system as described in claim 4, wherein the main metering system further includes restrictor valve means positioned between the main me-

tering valve means and the mixing chamber to further vary the supply of the fuel so that as the pressure within the mixing chamber approaches atmospheric pressure the supply of the mixture is reduced so as to prevent overcharging, and linkage means for connecting the throttle valve and the metering valve element for movement together.

6. In a fuel supply system for operating an engine in idling speed and driving speed ranges, the combination of an air supply, a fuel supply including a float chamber and a fuel pump having the outlet thereof communicating with the float chamber, a mixing chamber for supplying a mixture of fuel and air to the engine, a throttle valve in the chamber for controlling the supply of the mixture to the engine, an idle metering system communicating with the air supply and the float chamber and operative to supply an air-fuel mixture to the chamber downstream from the throttle valve for operating the engine in the idling speed range, and enrichment valve means responsive to ambient temperatures and operative when the ambient temperature is below a predetermined value to supply both air from the air supply and an air-fuel mixture from the fuel supply to the mixing chamber at a point downstream from the throttle valve so as to supplement the mixture supplied by the idle metering valve means and also to increase the air supply thereby increasing the engine speed and also enriching the air-fuel mixture supplied thereto to facilitate cold engine starting, a main metering system communicating with the fuel supply and operative to supply fuel to the mixing chamber for operating the engine in the driving speed range, the main metering system including a pump having an inlet thereof communicating with the float chamber and an outlet, main metering valve means including a main metering supply passage connecting the air supply and the outlet of the pump to the mixing chamber, a main metering orifice in the main metering supply passage, a main metering valve element maneuverable between open and closed settings for varying the effective size of the metering orifices and accordingly the air-fuel mixture supplied to the mixing chamber and restrictor valve means between the main metering valve element and the mixing chamber and operative in response to the suction pressure within the mixing chamber to reduce the supply of the fuel from the main metering supply passage when the suction pressure within the mixing chamber approaches atmospheric pressure so as to prevent overcharging, means operating the pump including electric motor means for driving the pump and control means for the motor means, the control means including a source of electric power and switch means responsive to a predetermined pressure within the mixing chamber corresponding to the pressure at the initiation of operation of the fuel system in the driving speed range for connecting the electric motor means to the power source so as to drive the pump.

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