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FUEL SUPPLY SYSTEM

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FIG. 1

FIG. 2

FIG. 3

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FUEL SUPPLY SYSTEM

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The present invention relates to fuel supply systems for internal combustion engines, burners or the like and more particularly to a fuel system wherein liquid fuel is delivered to the engine under superatmospheric pressure.

An object of the present invention is to provide a fuel supply system for an internal combustion engine or the like wherein the ratio of fuel-to-air mixture delivered to the engine is determined by certain engine operating variables.

Another object of the invention is to provide a fuel supply system for internal combustion engines in which the quantity of fuel delivered to the engine is regulated by the same engine operating variables as those controlling the quantity of air entering the engine.

Another object is to provide a simple though highly reliable fuel metering device for an engine in which a controlled supply of fuel to the engine is obtained by regulating the effective fuel metering head across a metering jet in accordance with variations in engine speed and throttle position.

Further objects and advantages will be apparent to those skilled in the art from the following description of our invention in its broader aspects and in a specific detailed embodiment thereof. Although the drawings and detailed description disclose but one specific embodiment of our fuel metering device, it is to be understood that many variations in structure and in arrangement of elements comprising our device are possible without departure from the invention and we contemplate the use of any such variations that properly fall within the scope of the appended claims.

The foregoing objects and advantages are accomplished by including in a fuel supply system a gear pump and associated by-pass valve adapted to deliver fuel at a substantially constant pressure, a centrifugal pump driven at a speed relative to engine speed for receiving fuel from the gear pump and delivering it at an increased pressure to a metering unit having a series of metering orifices therein, at least one of which is controlled by a manually actuated valve; and a valve controlled nozzle regulated by variable fluid pressures for controlling the discharge of fuel into the air stream entering the induction passage of the engine. A manually actuated three-way valve is also included in the system to provide a means for idle cut-off and for enriching the fuel-to-air mixture while the engine is being started.

While the present fuel metering device may be used to supply combustible mixtures to a variety

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of fuel consuming devices, for example, burners and internal combustion engines, for convenience of description the word "engine" will be used hereinafter in referring to these devices collectively and is intended to embrace any or all devices in which it is desirable to meter fuel in accordance with air flowing thereinto. The term "induction passage" as used throughout the specification and in the appended claims includes any or all passageways leading to the engine through which air or air-fuel charging mixtures flow during operation of the engine.

In Figure 1 of the drawings, the present fuel metering device with the various elements so arranged as to clearly illustrate the operating relationship existing therebetween is shown diagrammatically.

In Figure 2, the main fuel control valve is shown in idle cut-off position.

In Figure 3, the main fuel control valve is shown in engine starting position.

Shown generally at 10 in Figure 1 is a carburetor body having an induction passage 12 there-through and a throttle valve 14 disposed therein for controlling the quantity of air admitted into an internal combustion engine or other fuel consuming device, not shown. A controlled supply of liquid fuel is delivered to said induction passage by a fuel metering assembly, broadly consisting of a pump 16 provided with a valve controlled by-pass 18 for delivering fuel at a substantially constant pressure, a centrifugal pump 20, a manual mixture control valve unit 22 through which fuel from said centrifugal pump is delivered to a fuel metering jet or orifice 24, and a pressure responsive fuel discharge valve unit 26 for discharging metered fuel into induction passage 12 in accordance with the speed of the centrifugal pump 20 and with the position of throttle valve 14.

Although pump 16 may be any well known type, as shown in the drawings it is a gear pump having intermeshing gears 30 and 32 mounted on shafts 34 and 36 respectively which are journaled in pump housing 38, the gears being driven by the engine through shaft 36 and any suitable driving means connected to or mounted on the free end of shaft 36. In the operation of pump 16, fuel is drawn from inlet conduit 40 and discharged into conduit 42 which communicates with centrifugal pump 20 through conduit 42', a three-way valve 44 and conduit 46. The pressure of the fuel delivered to the centrifugal pump is maintained at a substantially constant value by a valve controlled pump by-pass 18 which

communicates with outlet conduit 42 of gear pump 16 and inlet conduit 40. The valve 18 for controlling the pressure in said by-pass includes a beveled disc 50 adapted to seat over orifice 52, a valve stem 54 slidably received in valve stem guide 56 for supporting disc 50 and a calibrated spring 58 on stem 54 adapted to react between disc 50 and guide 56 and to urge disc 50 to its closed position over orifice 52.

Centrifugal pump 20 which is adapted to receive fuel from conduit 46 and to discharge it at an increased pressure into conduit 60 leading to control valve 22 consists of an impeller 62 having blades 64 disposed in chamber 66 and mounted on shaft 68 which is journaled in pump housing 38 and connected directly to one end of shaft 36 of gear pump 16. Said impeller is driven by the engine through shafts 36 and 68 at a speed directly proportional to the R. P. M. of the engine to build up an outlet pressure for the metering head across metering jet 24, the effective metering head being the difference between fuel pressures in conduit 60' and chamber 70, the latter of which is controlled either by the inlet pressure of the centrifugal pump or that of the gear pump, as will be fully explained hereinafter.

Manual mixture control valve unit 22 which is shown mounted on carburetor body 10 adjacent the throttle valve consists of a chamber 72 adapted to receive fuel from conduit 60 and an orifice 74 for admitting fuel at a reduced pressure into chamber 76. A tapered valve 78 joined to or formed integrally with a fluted valve stem 80 slidably received in valve guide 82 controls the effective size of orifice 74. In the present embodiment of the invention, valve 78 is regulated by the throttle valve actuating mechanism, not shown, mounted on the free end of a throttle valve shaft 84 and operatively connected to said mechanism through valve stem 80 and cam 86 mounted on the end of throttle valve shaft 84 and rigidly secured thereto by nut 88. Fuel impermeable diaphragm 90 which is constantly urged in the direction to open valve 78 by the pressure of the fuel admitted through orifice 74, forms one wall of chamber 76 and is marginally clamped between two sections of the control valve unit. The diaphragm 90 is provided with stiffening members 92 and 94, both of which have their edges turned outwardly relative to diaphragm 90 to prevent injury to said diaphragm by any rough edges or burrs on said members. The end of valve stem 80 is riveted around centrally located apertures through the two stiffening members, diaphragm 90 and a stiffening disc 96 placed on stiffening member 92 to rigidly secure the valve stem thereto. Chamber 76 communicates through conduit 60' and calibrated metering orifice 24 with chamber 70 in discharge valve unit 26.

Although in the embodiment shown in the drawings two metering orifices in series are included, only one metering orifice regulated by a suitable valve for varying the effective size thereof is essential to the present metering device. The two orifices have been provided, however, to make possible the use of a valvular controlled orifice of a diameter much larger than that required for metering in order to achieve greater accuracy in the metering of the fuel. Further, it is often necessary in adjusting a fuel metering device to change the metering jet, and in the present modification of the invention, this can readily be done by changing orifice 24, whereas if only the valvular controlled orifice were em-

ployed, the orifice and valve or the entire mixture control unit 22 would have to be changed.

The discharge valve unit 26 is adapted to maintain the pressures therein at substantially constant predetermined values and is provided with a discharge nozzle 97 for discharging liquid fuel into the induction passage posterior to throttle valve 14. The discharge of fuel through the nozzle is controlled by valve 98 which is formed integrally with a fluted or flat sided valve stem 102 slidably received in guide 104 and is adapted to seat over orifice 100 in said nozzle. The end of stem 102 opposite the valve is attached to a fuel impermeable diaphragm 106 which is marginally clamped between two sections of the casing comprising the discharge unit 26, and is adapted to fluctuate in response to any changes in pressure however small on either side thereof. The fluctuation of diaphragm 106 causes valve 98 to vary the effective size of orifice 100 and consequently to vary the discharge of fuel therethrough so that the pressure in chamber 70 is maintained substantially constant and equal to the fluid pressure and effective force of spring 107 in chamber 108 on the opposite side of diaphragm 106. Said diaphragm is provided with stiffening members 110 and 112 secured in place on either side of the diaphragm by riveting the end of reduced portion 114 of stem 102 extending through centrally located holes in said members and in a stiffening disc 116. It is noted that stiffening members have their edges turned outwardly relative to the diaphragm to provide a smooth corner over which said diaphragm may bend. Chamber 108 communicates through conduit 118, restriction 119 and valve 44 with either the fuel passageway 42' between gear pump 16 and centrifugal pump 20 for periods of normal operation or with the fuel passageway 120 anterior to the gear pump during other periods, as in starting. The pressure in chamber 108, therefore, will be equal to the pressure in conduit 42' during normal operation of the engine and equal to the pressure in conduit 120 during starting. Inasmuch as the pressure in conduit 42' is maintained at a substantially constant value by pump by-pass valve 50, the pressure of the fuel in chamber 108 will remain substantially constant during normal operation of the engine, and the total effective force tending to close valve 98 will be sum of the forces exerted by the fluid pressure in chamber 108 and by spring 107 reacting between stiffening member 112 and spring retainer 124 secured to the end of screw 126. The effective force of spring 107 may be adjusted to any desired amount by screw 126, though it is generally desirable to provide only sufficient force by the spring to close orifice 100 when the engine is not running to prevent the discharge of fuel through the nozzle. After adjustment of screw 126 is made, said screw is locked in position by nut 128.

The main control valve generally shown at 44 consists of a housing 128, a rotatable valve cylinder 130 having a large peripheral slot 132 and a smaller peripheral slot 134, which are adapted to establish communication between the various fuel conduits as indicated in Figures 1, 2 and 3 of the drawings. In Figure 1, the large peripheral slot is shown connecting the gear pump discharge conduit 42' with the impeller intake conduit 46 and the control pressure conduit 118. In this position, the large peripheral slot connects the conduits required for normal engine operation while the small peripheral slot does not connect any of the conduits controlled by the valve. In

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Figure 3, the valve is shown in position for cold starting wherein large peripheral slot 132 connects control pressure in conduit 118 with the fuel pressure in conduit 120 anterior to the gear pump, and smaller peripheral slot 134 connects conduit 42' posterior to the gear pump 18 with conduit 46 anterior to the impeller. In this position, the valve permits a decrease in the pressure in chambers 108 and 70 on either side of diaphragm 106 and consequently an increase in the differential across metering jet 24 and the flow of fuel therethrough. Valve 98 shifts to the left to increase the effective size of orifice 100 to permit the additional fuel to discharge through nozzle 97. In Figure 2, the valve is in the idle cut-off position, the fuel pressure in conduit 42' communicating with conduit 120 anterior to the gear pump, conduits 46 and 118 being completely cut off from a source of fuel. The position of valve cylinder 130 may be controlled by lever 136 mounted on a shaft journaled in housing 128 of pump 44; however, any other suitable means may be substituted for lever 136 to control the position of said valve cylinder.

Operation

In the normal operation of the present fuel metering device, fuel is drawn by gear pump 18 from the source of supply through conduit 40 and discharged under pressure into conduit 42, the pressure in the latter conduit being maintained at a substantially constant value by the spring loaded valve 58 in pump bypass 18 connecting pump outlet conduit 42 with the inlet conduit 40. From gear pump 18 and passage 42' the fuel passes through the large peripheral slot 132 in the cylinder 130 of three-way valve 44 to impeller 62 of centrifugal pump 20 and is discharged at an increased pressure into the unmetered fuel passage 60 from which it flows through valve controlled orifice 74, conduit 88', metering jet 24 and chamber 70 into nozzle 97 and is discharged therefrom into the induction passage 12. With three-way valve 44 in the normal operating position as shown in Figure 1, fuel from passage 42' flows through restriction 110 into conduit 118 and chamber 108 behind diaphragm 106, and, in conjunction with spring 107, urges valve 98 toward its closed position. The pressure of the fuel in chamber 108 remains substantially equal to the pressure in passage 42' posterior to the gear pump 18, and since the latter pressure is maintained at a substantially constant value, the fluid pressure urging valve 98 to its closed position remains constant. The total pressure urging the valve closed may be modified by the adjustment of screw 126 to vary the tension on spring 107.

The pressure in outlet passage 60 of centrifugal pump 20 will be greater than said pump inlet pressure by an amount which is directly proportional to the square of the speed of the pump and consequently directly proportional to the square of the engine speed. Inasmuch as the pressure of the fuel in chamber 70 is substantially equal to the pressure in chamber 108 which is in turn substantially the same as the impeller inlet pressure, the pressure of the unmetered fuel in passage 60' will be greater than the pressure of the metered fuel in chamber 70 by an amount directly proportional to the square of the speed of the engine for any given setting of valve 78. In the event the pressure in chamber 70 should tend to exceed the pressure in chamber 108 as a result of increased fuel flow through orifice 24, valve 98

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permit the escape of the additional fuel into the induction passage, thereby maintaining the pressures in chambers 70 and 108 substantially equal. Should the pressure in chamber 70 tend to decrease, valve 98 would be urged toward its closed position by the pressure in chamber 108, thereby permitting the pressure in chamber 70 to build up to equal that in chamber 108.

Inasmuch as the quantity of fuel which will flow through a given size metering orifice such as metering jet 24 varies in proportion to the square root of the differential in pressures on opposite sides of the orifice, and since this differential varies as the square of the engine speed, it can be seen that the quantity of fuel flowing through orifice 24 for a given setting of valve 78 will vary directly as the speed of the engine. Since the weight of the air flow into the engine at a given throttle setting varies substantially in direct proportion to the speed of the engine, the present metering device will deliver fuel to the engine in accordance with the weight of air flowing thereinto.

When the throttle valve is opened, the increase in fuel required to compensate for the increased air flow is provided by the enlargement of the effective area of orifice 74 by the withdrawal of tapered valve 78 from said orifice. The increased flow of fuel through orifice 74 increases the pressure in passage 60' and consequently the differential across jet 24, thus increasing the flow of fuel through said jet into chamber 70 through discharge nozzle 97 and into the induction passage 12; however, the pressure in chamber 70 is maintained substantially constant by the shifting of diaphragm 106 and valve 98 away from orifice 100 to permit the additional fuel to discharge. If the effective area of orifice 74 is decreased, as when the throttle valve is closed, the pressure in passage 60' and the differential in pressure across jet 24 will be reduced, and as a result, the discharge of fuel through said metering jet is likewise reduced. The diaphragm 106 and valve 98 will shift toward orifice 100 and limit the discharge of fuel into the induction passage to a rate such that the pressure in chamber 70 will be maintained equal to the pressure in passage chamber 108. By proper shaping of valve 78 or cam 86, the effective area of orifice 74 may be controlled so as to obtain the desired fuel-to-air relationship for various engine operating conditions. The variations such as power or idle enrichment may be accomplished by varying the contour of the valve 78 to give a proportionately greater increase in the flow of fuel through orifice 74 when the throttle valve is moved either to its wide open position or to its substantially closed position. Further, certain variations can also be accomplished by varying the contour of cam 86. For example, the cam can be provided with a peripheral depression at the point contacting the end of stem 80 when the throttle is moved to its wide open position, thus fully opening valve 78 and consequently increasing the pressure in passage 60' and the differential across metering jet 24. This, therefore, would cause an increase in the supply of fuel to the engine to provide a rich mixture while the engine is operating at high speed or pulling under heavy load.

In starting, the fuel-to-air mixture may be enriched by shifting the position of cylinder 130 so that conduit 118 leading to chamber 108 behind diaphragm 106 will communicate with passage 120 on the inlet side of gear pump 18, thereby causing the pressure in chamber 108 to be

come equal to the comparatively low pressure of the fuel from a source, such as a fuel tank, not shown. The pressure in chamber 70 will immediately decrease to become equal to the new pressure in chamber 108, thus causing a greater differential in pressure across metering jet 24 and consequently an increase in the flow of fuel through said jet. The position of cylinder 130 in valve 44 during the starting period is shown in Figure 3 wherein large peripheral groove 132 is shown connecting conduits 120 and 118, and small peripheral groove 134 connecting the outlet 42' of the gear pump 16 with conduit 46 leading to the centrifugal pump. After the engine has become warm, cylinder 130 may be shifted to the normal operation position shown in Figure 1.

When the engine is not running, the discharge of fuel is prevented by shifting the position of cylinder 130 so that conduit 46 leading to the centrifugal pump is cut off from the source of fuel. This is accomplished by turning cylinder 130 as shown in Figure 2 in which, not only is conduit 46 cut off from the source of fuel, but also the inlet and outlet passages of gear pump 16 are connected by the small peripheral groove 134. Conduit 118 is also cut off from both of the regulating pressures, as shown in Figure 2.

It is contemplated that other elements or devices than those shown in the drawing may be included in the present fuel system to obtain various desired fuel-to-air relationships under diverse engine operating conditions. The economizer for power enrichment, the acceleration device for giving temporary enrichment when the throttle is opened, and the temperature control for modifying the richness of the fuel mixture in accordance with temperature of the engine, all of which are shown and described in detail in our copending application Serial No. 607,290, filed July 27, 1945, may be included in the present fuel system either separately or together, or in any combination of the three devices, without departing from the scope of the present invention. Further, the fuel distributor and a plurality of fuel discharge nozzles such as those disclosed in our copending application Serial No. 609,230, filed August 6, 1945, may be substituted for the single nozzle arrangement shown in the present drawing. A priming means such as that shown in our copending application Serial No. 674,868, filed June 6, 1946, may also be included to assist in starting the engine.

A mechanism responsive to variations in atmospheric pressure for varying the speed of the impeller relative to the engine speed may also be included in combination with the fuel system to obtain a fuel leaning or enriching effect for maintaining proper fuel-to-air ratio under substantial variations in atmospheric pressure, such as those occurring as a result of changes in altitude. Mechanisms for conveniently obtaining variations in the speed of the impeller relative to engine speed are well known to those skilled in the art; for example, the impeller may be driven by the engine through a fluid drive or by variable speed pulleys.

From the foregoing description of the present invention it is apparent that a comparatively simple fuel feeding system has been developed to give, throughout the normal operating range, a substantially constant fuel-to-air mixture ratio subject to such modification as may be required to effect variations in said ratio for maximum economy and power and idle enrichment. Al-

though only one specific embodiment of the present invention has been given herein, it will be understood that many variations in our fuel metering device may be made without departing from the scope of our invention.

We claim:

1. A fuel supply device for an engine comprising a conduit for supplying fuel to the engine, a means for varying the pressure of the fuel in said conduit in accordance with engine speed, a means for supplying fuel to said pressure varying means, a plurality of metering orifices in series in said conduit posterior to said pressure varying means one of which is provided with a valve for controlling the effective size thereof, a discharge valve downstream from said orifices, and a means including a passageway communicating with said conduit anterior to said pressure varying means for controlling said discharge valve.

2. In a fuel supply system for an engine, a conduit for supplying fuel to the engine, a means for varying the pressure of the fuel in said conduit in accordance with engine speed, a means for supplying fuel to said pressure varying means at a substantially constant pressure, a plurality of metering orifices in series in said conduit posterior to said pressure varying means one of which is provided with a valve for controlling the effective size thereof, a discharge valve downstream from said orifices, a means including a passageway communicating with said conduit anterior to said pressure varying means for controlling said discharge valve, and a control valve for connecting said passageway with the conduit either anterior or posterior to said fuel supply means.

3. In a fuel supply system for an engine, a conduit for supplying fuel to the engine, a means for varying the pressure of the fuel in said conduit in accordance with engine speed, a plurality of metering orifices in series in said conduit posterior to said pressure varying means one of which is provided with a valve for controlling the effective size thereof, a discharge valve downstream from said orifices, and a means including a passageway communicating with said conduit anterior to said pressure varying means for controlling said discharge valve.

4. In a fuel supply system for an engine, a conduit for supplying fuel to the engine, a means for varying the pressure of the fuel in said conduit in accordance with engine speed, a plurality of metering orifices in series in said conduit posterior to said pressure varying means one of which is provided with a manually actuated valve for controlling the effective size thereof, a discharge valve downstream from said orifices, and a means including a passageway communicating with said conduit anterior to said pressure varying means for controlling said discharge valve.

5. A fuel supply device for an engine comprising a conduit for supplying fuel to the engine, a means for varying the pressure of the fuel in said conduit in accordance with engine speed, a metering orifice in said conduit posterior to said pressure varying means provided with a manually actuated valve for controlling the effective size thereof, a discharge valve downstream from said orifice, and a means including a passageway communicating with said conduit anterior to said pressure varying means for controlling said discharge valve.

6. A fuel supply device for an engine having an

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induction passage with a throttle valve therein comprising a conduit for supplying fuel to the engine, a means for varying the pressure of the fuel in said conduit in accordance with engine speed, a means for supplying fuel to said pressure varying means, a plurality of metering orifices in series in said conduit posterior to said pressure varying means one of which is provided with a valve for controlling the effective size thereof, a means operated upon movement of said throttle valve for actuating the valve controlling one of the metering orifices, a discharge valve downstream from said orifices, and a means including a passageway communicating with said conduit anterior to said pressure varying means for controlling said discharge valve.

7. In a fuel supply system for an engine having an induction passage with a throttle valve therein, a conduit for supplying fuel to the engine, a means for varying the pressure of the fuel in said conduit in accordance with engine speed, a means for supplying fuel to said pressure varying means, a metering orifice in said conduit posterior to said pressure varying means provided with a valve for controlling the effective size thereof, a means operated by the movement of said throttle valve for actuating the valve controlling said metering orifice, a discharge valve downstream from said orifice, and a means including a passageway communicating with said conduit anterior to said pressure varying means for controlling said discharge valve.

8. In a fuel supply system for an engine having an induction passage with a throttle valve therein, a fuel conduit, a means for varying the pressure of the fuel in said conduit in accordance with engine speed, a plurality of metering orifices in series in said conduit posterior to said pressure varying means one of which is provided with a valve for controlling the effective size thereof, a means operated upon movement of said throttle valve for actuating the valve controlling one of the metering orifices, a discharge valve downstream from said orifices, and a means including a passageway communicating with said conduit anterior to said pressure varying means for controlling said discharge valve.

9. In a fuel supply system for an engine having an induction passage with a throttle valve therein, a conduit for supplying fuel to the engine, a means for varying the pressure of the fuel in said conduit in accordance with engine speed, a metering orifice in said conduit posterior to said pressure varying means provided with a valve for controlling the effective size thereof, a means operated upon movement of said throttle valve for actuating the valve controlling said metering orifice, a discharge valve downstream from said orifice, and a means including a passageway communicating with said conduit anterior to said pressure varying means for controlling said discharge valve.

10. In a fuel supply system for an engine having an induction passage with a throttle valve therein, a conduit for supplying fuel to the engine, a means for varying the pressure of the fuel in said conduit in accordance with engine speed, a means for supplying fuel to said pressure varying means, a plurality of metering orifices in series in said conduit posterior to said pressure varying means one of which is provided with a valve for controlling the effective size thereof, a means operated upon movement of said throttle valve for actuating the valve controlling one of said metering orifices, a discharge

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valve downstream from said orifices, a means including a passageway communicating with said conduit anterior to said pressure varying means for controlling said discharge valve, and a control valve for connecting said passageway with the conduit either anterior or posterior to said fuel supply means.

11. In a fuel supply system for an engine having an induction passage with a throttle valve therein, a conduit for supplying fuel to the engine, a means for varying the pressure of the fuel in said conduit in accordance with engine speed, a means for supplying fuel to said pressure varying means, a metering orifice in said conduit posterior to said pressure varying means provided with a valve for controlling the effective size thereof, a means operated upon movement of said throttle valve for actuating the valve controlling said metering orifice, a discharge valve downstream from said orifice, a means including a passageway communicating with said conduit anterior to said pressure varying means for controlling said discharge valve, and a control valve for connecting said passageway with the conduit either anterior or posterior to said fuel supply means.

12. A fuel supply system for an engine having an induction passage with a throttle valve therein comprising a conduit having a discharge nozzle in said induction passage for supplying fuel to the engine, a means for varying the pressure of the fuel in said conduit in an amount substantially proportional to the square of the engine speed, a plurality of metering orifices in series in said conduit posterior to said pressure varying means one of which is provided with a valve for controlling the effective size thereof, a means operated upon movement of said throttle valve for actuating the valve controlling one of said metering orifices, a discharge valve downstream from said orifices, a means including a passageway communicating with said conduit anterior to said pressure varying means for controlling said discharge valve.

13. A fuel supply device for an engine having an induction passage with a throttle valve therein comprising a conduit for supplying fuel to the engine, a means for varying the pressure of the fuel in said conduit in an amount substantially proportional to the square of the engine speed, a means for supplying fuel to said pressure varying means, at least one metering orifice in said conduit posterior to said pressure varying means, a valve for controlling the flow of fuel through a metering orifice, a means operated upon movement of said throttle valve for actuating said orifice control valve, a nozzle including a valve for discharging fuel from said conduit into said induction passage, a means including a passageway communicating with said conduit anterior to said pressure varying means for controlling said discharge nozzle valve, and a control valve for connecting said passageway with the conduit either anterior or posterior to said fuel supply means.

14. In a fuel supply system for an engine having an induction passage with a throttle valve therein, a means for varying the pressure of the fuel in said conduit in accordance with engine speed, at least one metering orifice in said conduit posterior to said pressure varying means, a valve for controlling the flow of fuel through a metering orifice, a means operated upon movement of said throttle valve for actuating said metering orifice control valve, a nozzle includ-

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ing a valve for discharging fuel from said conduit into said induction passage, and a means including a passageway communicating with said conduit anterior to said pressure varying means for controlling said discharge valve.

15. A fuel supply device for an engine having an induction passage therein comprising a centrifugal pump adapted to be driven by said engine for delivering fuel to said induction passage, a conduit connecting said centrifugal pump with said induction passage, at least one metering restriction in said conduit, a nozzle including a valve controlled by a pressure regulated member for discharging the fuel from said conduit into said induction passage, a conduit communicating with the inlet side of said centrifugal pump and with said pressure regulated member for regulating the discharge of fuel from said nozzle, and a valve for varying the effective size of a metering restriction upon variations in load resulting from variations in throttle position.

16. In a fuel system for an internal combustion engine having an induction passage with a throttle valve therein, a conduit for supplying fuel to said engine, a fuel supply pump in said conduit, a valve controlled pump by-pass around said pump for maintaining a substantially constant fuel delivery pressure, a centrifugal pump in said conduit for receiving fuel delivered by said supply pump and for discharging it at an increased pressure, a plurality of metering orifices in series in said conduit posterior to said centrifugal pump one of which is provided with a valve for controlling the effective size thereof, means operated by the movement of said throttle valve for actuating the valve controlling one of the metering orifices, a discharge valve downstream from said metering orifices, a control member including a passageway communicating with said conduit anterior to said centrifugal pump, and a control valve for connecting said passageway with the conduit either anterior to said supply pump or between said supply pump and said centrifugal pump.

17. In a fuel system for an engine having an induction passage with a throttle valve therein, a means for varying the pressure of the fuel in said conduit in accordance with engine speed, at least one metering orifice in said conduit posterior to said pressure varying means, a valve

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for controlling the flow of fuel through a metering orifice, a mechanism for actuating said metering orifice control valve, a nozzle including a valve for discharging fuel from said conduit into said induction passage, and a means including a passageway communicating with said conduit anterior to said pressure varying means for controlling said discharge valve.

18. In a fuel supply system for an engine having an induction passage with a throttle valve therein, a pump for varying the pressure of the fuel in said conduit in accordance with engine speed, a second pump for supplying fuel to said first mentioned pump, at least one metering orifice in the conduit posterior to said pumps, a valve for controlling the flow of fuel through a metering orifice, a mechanism for actuating said metering orifice control valve, a nozzle including a valve for discharging fuel from said conduit into said induction passage, and a means including a passageway communicating with said conduit anterior to said first mentioned pump for controlling said discharge valve.

19. In a fuel supply system for an engine having an induction passage with a throttle therein, a conduit for supplying fuel to the engine, a means for varying the pressure of the fuel in said conduit in accordance with engine speed, a metering orifice in said conduit posterior to said pressure varying means, a valve for controlling the effective size of said metering orifice, a linkage connecting the metering orifice valve with the throttle actuating mechanism for operating said valve in accordance with throttle position, and a discharge valve in the conduit downstream from said orifice for regulating the metered fuel pressure.

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