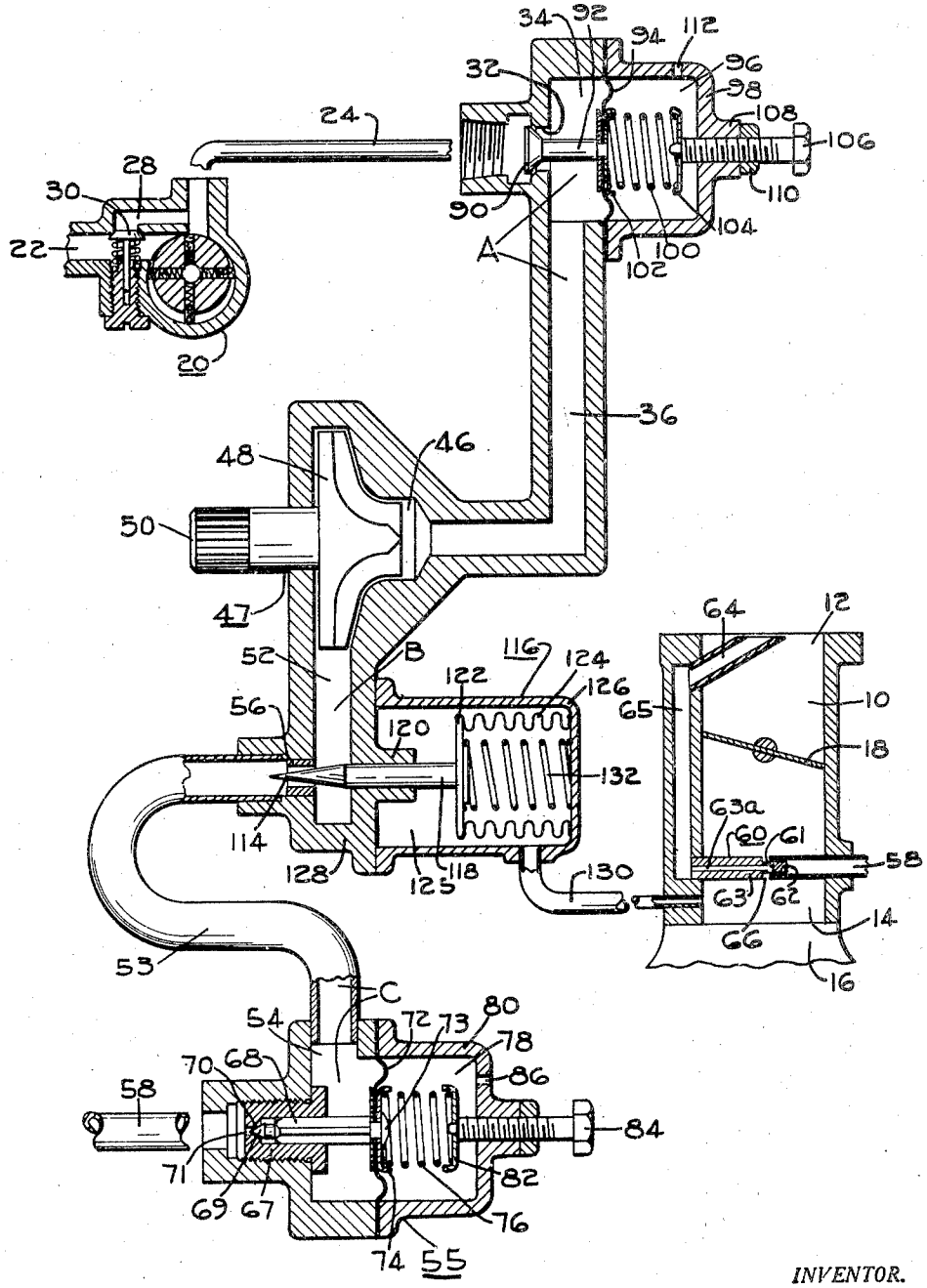
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FUEL SUPPLY SYSTEM

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FUEL SUPPLY SYSTEM

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This invention relates to fuel supply systems or devices for internal combustion engines and more particularly to devices or systems in which liquid fuel is supplied under positive pressure.

An important object of the invention is to provide a fuel feeding system in which the fuel flow is automatically regulated in accordance with certain engine variables such as, for example engine speed and engine charging pressure.

This fuel supply system, while especially applicable to fuel supply systems of the character hereinafter particularly described, is not limited to such uses, but is obviously available, with or without modification, in a great variety of cases where fuel is intended to be supplied under more or less analogous conditions in an internal combustion engine or other fuel consuming device.

Further objects and advantages of the invention will be apparent, to those skilled in the art, from the following detailed description, taken in connection with the accompanying drawing. Although but one embodiment is shown, skilled persons will understand that many variations may be made without departing from the principles disclosed, and I contemplate the employment of any structures, arrangements or modes of operation that are properly within the scope of the appended claims.

In the figure, which is a diagrammatic view of a fuel system embodying the present invention, there is shown an induction passage 10 having an air inlet 12, and a mixture outlet 14 connected to the intake manifold 16 of an internal combustion engine, not shown, or to a supercharger inlet, should a supercharger be used, the induction passage 19 being controlled by a throttle valve 18. A supercharger might alternately be connected to the inlet 12 or devices of this character might be connected to both the inlet 12 and the outlet 14. Liquid fuel is supplied by a pump, indicated generally at 20, which may be operated by the engine, or by any other suitable means, and is capable of supplying fuel under positive, preferably but not necessarily, substantially constant, predetermined pressure. This pump may be of any well known type but, as shown, is of the sliding vane type having an inlet 22 receiving fuel from a source, an outlet conduit 24 and a bypass 28 controlled by a pressure responsive valve 30. Fuel from the pump is delivered from the pump outlet conduit 24 through a valve port 32 which communicates with a chamber 34 connected with a conduit 36 leading to an impeller inlet chamber 46 of a pump, indicated generally at 47. The pressure of fuel in the conduit 36 is

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substantially the same as that in chamber 34 and said pressure will be hereinafter referred to as the inlet pressure or pressure A.

The pump 47, as shown, is of the centrifugal type which includes an impeller 48 driven by the engine through a shaft 50 which is suitably connected, by any well known means, with said engine which is not shown herein but which rotates said impeller in direct proportion to its R. P. M., said pump 47 being adapted to build up an outlet pressure which provides the metering head for the system.

The outlet of pump 47 is connected by fuel conduits 52 and 53 with a chamber 54 in a fuel outlet control device indicated generally at 55. A metering restriction or jet 56 is provided between the conduits 52 and 53, the pressure of fuel or metering head in said conduit 52 being hereinafter referred to as pressure B. Also, as the fuel pressure in chamber 54 is at all times substantially the same as that in the passage 53 posterior to the jet 56, said pressure in chamber 54 and passage 53 will be hereinafter referred to as pressure C or metered fuel pressure.

Chamber 54 has an outlet connected by a conduit 58 with a fuel nozzle member 60 discharging into the induction passage posterior to the throttle valve. Air is bled into the nozzle member 60 through cross passages 61 in a tip portion 62 of an air tube 63 having an air passage 63a therein receiving air from a tube 64 by way of a passage 65; the tube 64 being located in the air entrance 12 of the induction passage and adapted to receive the impact of air entering said induction passage. Tip portion 62 extends part way into the fuel passage of the nozzle and fuel emulsion is discharged from an annular groove 66 between the shoulder at the base of said tip portion 62 and the adjacent end of nozzle 60. The outlet for the chamber 54 is provided with a fitting 67 having a bore within which a flat sided or fluted valve 68 is slidably guided, said valve having a conical tip 69 cooperating with a valve seat 70 of a port 71 in said fitting for controlling the discharge of fuel from chamber 54. The end of the valve 68 opposite the conical tip is attached to a diaphragm 72. As shown, the attached valve end is riveted over at 73 and a washer-like spring retainer cup 74 is attached to the diaphragm on the side opposite chamber 54. The spring retainer 74 provides means for retaining the adjacent end of a spring 76 disposed in a chamber 78 within a housing 80. The spring is adapted to react between the retainer 74 and a second retainer 82 carried by a screw 84 and

urges the valve 68 in the closing direction, said valve normally being closed when the engine is inoperative. The effective force of the spring is adjustable by reason of the screw 84 which is threadably received in an opening in the casing 80 provided therefor. An atmospheric vent 86 is provided for the chamber 78.

The valve port 32 is controlled by a valve 90 having a stem 92 secured to a diaphragm 94 which forms one wall of the inlet chamber 34. The diaphragm 94 also forms a wall of a chamber 96 formed in a housing 98. A spring 100 is disposed in the chamber 96, reacting between a spring retainer 102 secured to the diaphragm and a spring retainer 104 disposed on a screw 106 threadably received in an opening in a boss 108 of the housing 98. A lock nut 110 may be provided on the screw 106 for retaining same in adjusted positions. Chamber 96 is also vented to atmosphere by means of a vent 112.

Means for varying the effective size of orifice 56 comprises a valve 114 controlled by a suction responsive device indicated generally at 116. The valve 114 is connected to or formed integral with a valve stem 118 slidable in a guide 120, said stem 118 being connected at its outer end to a plate 122 forming one wall of a sealed expansible bellows 124 located in a chamber 125 formed by a casing 126 which is supported on the body 128 of the device by screws, not shown, or any other suitable well known means. The casing is subjected to engine charging pressure by means of a conduit 130 which communicates with said casing adjacent the lower portion thereof, so as to draw off any fuel which may seep past the stem 118, and communicates with the induction passage posterior to the throttle valve 18, as shown. However, if a supercharger is used, conduit 130 is connected to the engine manifold posterior to the supercharger. The valve 114 is therefore controlled in accordance with engine charging pressure which reflects throttle position and engine speed and load. A light compression spring 132 may be provided within the bellows, an arrangement that is particularly desirable, if the bellows is partially or completely evacuated, to extend the bellows to a normal balancing position and it may be desirable for said spring and bellows to be so calibrated and arranged that the valve 114 will be normally closed when the pressure in the casing 126 is at its highest operating value.

Operation

During normal operation fuel is supplied under pressure to the inlet 46 of the centrifugal pump 47 by means such as the fuel pump 20 although other means may also be employed to supply fuel to said inlet 46. Fuel received by pump 47 is discharged under an increased pressure into passage 52 from which it flows through metering orifice 56 to conduit 53 and chamber 54, past valve 68 which is opened by the pressure of fuel in chamber 54 acting on diaphragm 72, into conduit 58, and thence to the fuel delivery nozzle 60 or other fuel discharge means.

Normally the spring 100 is adjusted to maintain a predetermined fuel pressure, pressure A, in chamber 34 and conduit 36.

Due to the inherent characteristics of the centrifugal pump 47, the pressure B at the outlet of pump 47 will be greater than the pump inlet pressure A 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.

During operation, with the valve 114 in a partially open position, fuel at pressure B will flow through the calibrated restriction 56 into passage 53 and chamber 54.

Preferably, but not necessarily, the spring 76 is adjusted to permit the valve 68 to be opened by a fuel pressure C in chamber 54 somewhat less than pressure A, for a purpose to be hereinafter described. Normally, except for considerations hereinafter explained, the metered fuel pressure C of the fuel in chamber 54, will be maintained equal to pressure A. In the event pressure C should tend to exceed pressure A the valve 68 will tend to open to allow the escape of additional fuel to the nozzle and consequent lowering of pressure C, and the reverse action will occur if C tends to be less than A. It should be noted that the above mentioned tendencies of pressure C to vary from the normal will be temporary and will be generally momentary. Also normally pressure C will be maintained substantially the same or greater than pressure A.

As is generally known, the quantity of fuel which will flow through a given size metering orifice such as metering jet 56 will vary in proportion to the square root of the differential in pressures B and C on opposite sides of the orifice, and since this differential varies as the square of the engine speed, it will be apparent that the quantity of fuel flowing through orifice 56 for a given setting of valve 114 will vary directly as the engine speed.

In view of the fact that the weight of air flow to an engine at a given manifold pressure varies substantially in direct proportion to the engine speed, except for variations caused by variables such as exhaust back pressure and intake air and exhaust gas temperatures, which may be compensated for as described in U. S. Patent No. 2,456,604 issued to Wirth and Barfod on December 14, 1948, the device here described will supply fuel to the engine in accordance with the air flow thereto.

If at a given engine speed the manifold or engine charging pressure is increased, the weight of air supplied to the engine will likewise increase, and the quantity of fuel supplied to the engine should be correspondingly increased. This increase in fuel flow is accomplished in the present device by the operation of the valve 114. Any increase in charging pressure is transmitted through passage 130 to the chamber 125 and will cause bellows 124 to partially collapse whereupon valve 114 will move in a direction to increase the effective area of the calibrated restriction 56.

Upon increase in the effective area of orifice 56, pressure B will be reduced and pressure C increased. As a consequence the valve 68 will open to permit discharge of fuel to the engine at a greater rate such that the pressure C will be accordingly reduced to again equal pressure A, but fuel then is delivered through orifices 56 and 71 at a greater rate to compensate for the increase in air flow which instigated the change in the area of orifice 56.

A number of advantages are obtained by the present invention among which are the maintenance of pressure throughout the system thereby eliminating the formation of vapor therein and the provision of a device which at all times has ample metering head and pressures to properly control the operation of the various parts.

By properly contouring valve 114, the effective area of orifice 56 may be so controlled as to

obtain any desired fuel to air relationship with variations in engine charging pressure. For example, at conditions of high power output, corresponding to low intake manifold pressure it is generally desirable to increase the richness of the mixture. This may be readily accomplished by the proper shaping of the contour of valve 114. If said valve is arranged to maintain the effective area of the metering orifice directly proportional to the manifold pressure, a constant mixture ratio will be obtained. However, if the needle contour is such as to increase the orifice area more rapidly when the charge density drops below a predetermined value, the richness of the mixture will be correspondingly increased, thereby providing a power enrichment as is generally desired.

If desired, other arrangements may be provided for obtaining various desired fuel to air relationships in accordance with engine variables.

Provision may be made for enriching the idling fuel mixture as is desired. One means for effecting idle enrichment is to adjust valve 68 so that it is opened by a pressure C somewhat less than pressure A. Then at low engine charging pressures, corresponding to idle operation, the arrangement is of material effect in producing a relatively large increase in fuel flow, thereby providing the desired rich mixture at idle. However at high engine charging pressures the arrangement has a negligible effect and has substantially no effect on the richness of the fuel mixture which is maintained at the normal fuel to air ratio.

It is thus apparent that the basic structure will provide a substantially constant mixture richness, but by introducing an extraneous factor to effect variations in the position of valve 68 as by varying the area of the metering orifice 56, any fuel metering characteristic may be obtained. Means other than pump 47 might also be used to create a pressure in passage 52 which varies as the square of engine speed, or other changes might be made without departing from the principles of the invention and I contemplate the use of any such arrangements properly falling within the scope of the subjoined claims.

I claim:

1. A fuel feeding device for an internal combustion engine, comprising a conduit for supplying fuel to the engine; fuel metering means in said conduit; rotatable means, for supplying fuel to said metering means at a pressure varying in accordance with engine speed; means for supplying fuel to the inlet of said rotatable means at a substantially constant pressure; fuel control means, including a valve for said conduit posterior to the metering means, so constructed and arranged that the metered fuel pressure normally is maintained substantially at the same pressure as the inlet fuel pressure; and means for increasing the effective area of the metering means upon a rise in charging pressure.

2. A fuel feeding device for an internal combustion engine, comprising a conduit for supplying fuel to the engine; a metering jet in said conduit; a regulating valve posterior to the metering jet for controlling the flow of metered fuel; a pressure creating means for supplying fuel to the metering jet at a pressure varying in response to variations in engine speed; means for varying the effective area of the metering jet; and means for controlling the jet varying means in accordance with engine charging pressure.

3. A fuel feeding device for an internal combustion engine, comprising a conduit for supplying fuel to the engine; a metering restriction in said conduit; a valve in said conduit posterior to said restriction; a diaphragm connected with said valve; pressure creating means having an inlet, and an outlet supplying fuel to said conduit anterior to the metering restriction at a pressure varying in an amount substantially proportional to the square of engine speed; means for subjecting the diaphragm to fluid pressure posterior to the restriction for urging the diaphragm in the valve opening direction; and means for varying the effective area of the metering restriction.

4. In a fuel supply system for an internal combustion engine having an intake manifold controlled by a throttle: a conduit for supplying fuel to the manifold; a metering jet in said conduit; a valve in the conduit posterior to the jet; a fluid pump having an inlet, and an outlet supplying fuel to the conduit anterior to the jet at a pressure varying in an amount substantially proportional to the square of engine speed; a source of fuel, at a substantially constant pressure, connected to the inlet; means for subjecting the valve to the metered fuel pressure for urging the valve in the opening direction; yielding means urging the valve in the closing direction, said means being so calibrated as to normally maintain the metered fuel at a pressure substantially the same as the pressure of fuel supplied to the inlet; and means responsive to manifold pressure posterior to the throttle for varying the effective area of the metering jet.

5. In a fuel supply system for an internal combustion engine: a conduit; means for supplying fuel to said conduit at a substantially constant pressure; a metering restriction in said conduit; pressure creating means having an inlet receiving fuel from the first mentioned means and an outlet supplying fuel to the metering means at a pressure varying in an amount substantially proportional to the square of engine speed; and means subjected to metered fuel pressure, tending to maintain metered fuel at substantially the same pressure as the first mentioned pressure.

6. The invention defined by claim 5 wherein there is means for temporarily varying the metered fuel pressure.

7. The invention defined by claim 5 wherein there is means for momentarily modifying the metered fuel pressure.

8. The invention defined by claim 5 wherein there is means, responsive to an engine variable, for varying the effective area of the metering restriction.

9. The invention defined by claim 5 wherein there is means responsive to engine charging pressure for varying the effective area of the metering restriction.

10. In a fuel supply system for an internal combustion engine: a conduit for conveying fuel to the engine; means for supplying fuel to the conduit at a substantially constant pressure; a normally open valve in said conduit; a diaphragm connected to the valve and subjected to fuel pressure posterior thereto, said fuel pressure urging the valve in the closing direction; yielding means urging the valve in the opening direction; pressure creating means posterior to the valve and adapted to effect a flow of fuel therethrough, the quantity of which will vary directly as the engine speed; a metering restriction posterior to the pressure creating means; a

normally closed valve posterior to the metering restriction; a diaphragm connected to the valve and subjected to metered fuel pressure for urging the valve in the opening direction; and yielding means urging the valve in the closing direction.

11. The invention defined by claim 10 wherein the yielding means are so calibrated that the metered fuel pressure and the pressure of fuel supplied to the pressure creating means tend to be maintained normally at substantially the same value.

12. The invention defined by claim 10 wherein the yielding means are so calibrated and arranged that the metered fuel pressure is normally maintained at substantially the same value as the pressure of fuel supplied to the pressure creating means, and the idling mixture is enriched at engine idling speeds.

13. The invention defined by claim 10 wherein

there is means for varying the effective area of the metering restriction and said means is controlled by engine charging pressure.

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