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2,361,228

CHARGE FORMING DEVICE

Filed Dec. 15, 1941

2 Sheets-Sheet 1

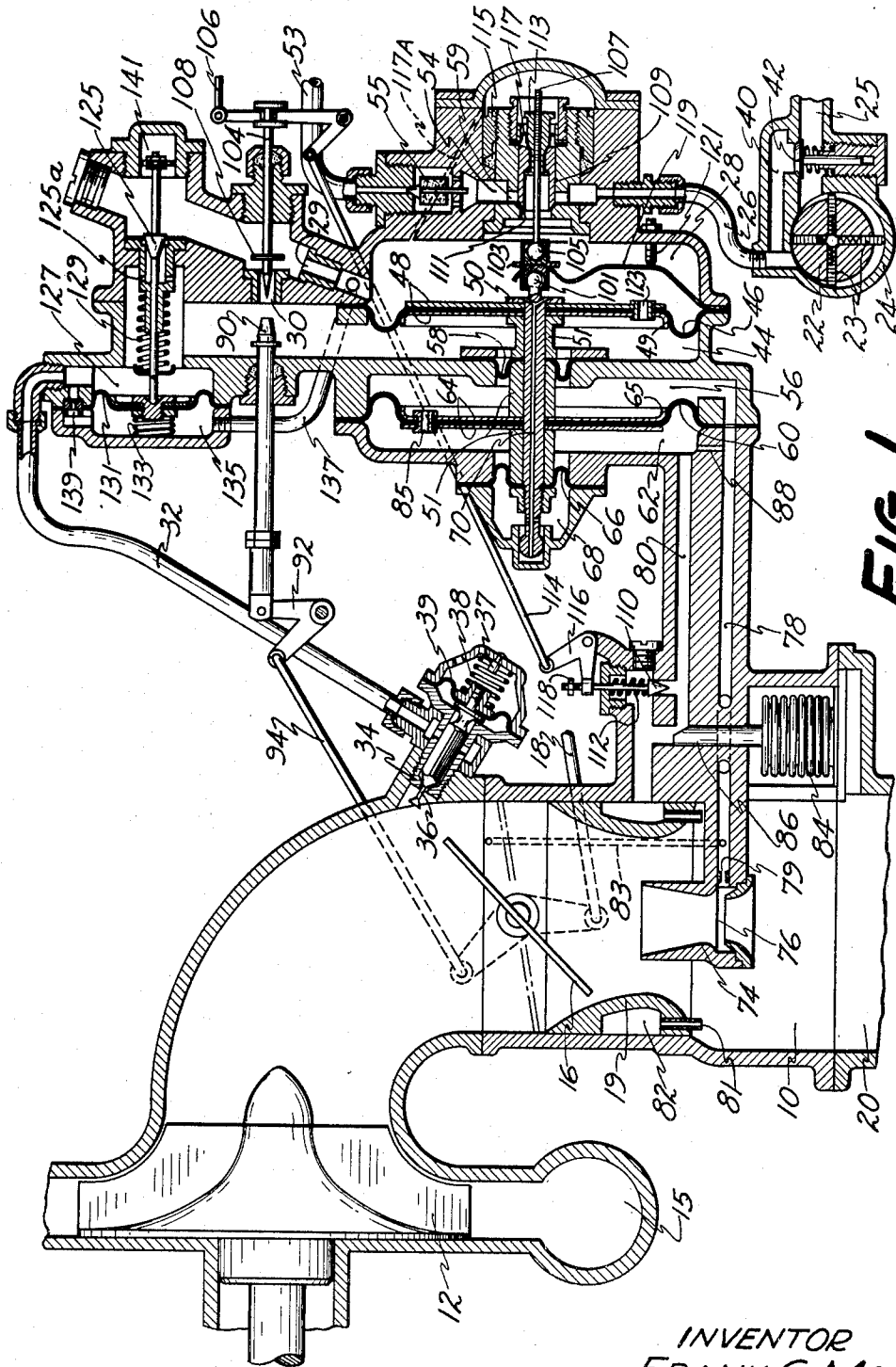


FIG. 1

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2 Sheets-Sheet 2

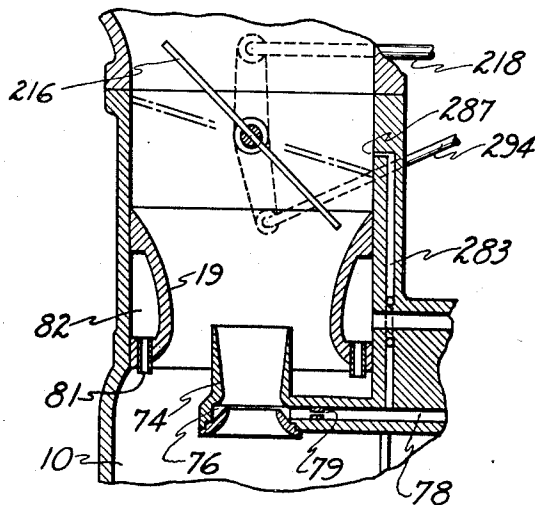


FIG. 2

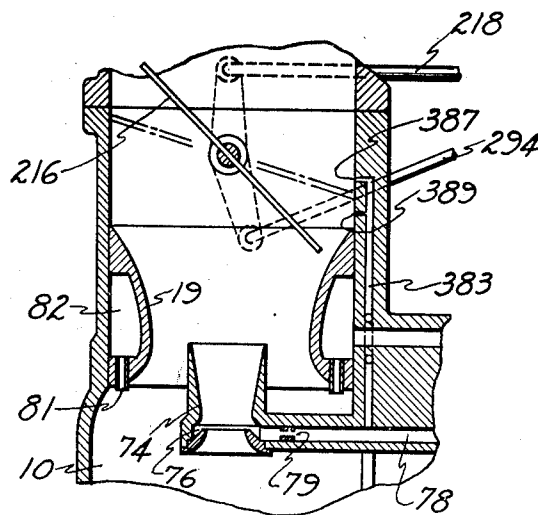


FIG. 3

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CHARGE FORMING DEVICE

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15 Claims. (Cl. 261—5)

This invention relates to charge forming devices for internal combustion engines and more particularly to idling systems or arrangements for charge forming devices of the pressure type in which the fuel is maintained under positive pressure while being metered. This application is a continuation-in-part of my copending application, Serial No. 202,206, filed April 15, 1938.

One of the principal objects of the present invention is to supply the liquid fuel under positive pressure, the fuel supply being regulated to maintain a proper fuel to air ratio both at idle and through the open-throttle range. This arrangement causes the fuel to be atomized under pressure to produce a better mixture and keeps the fuel under superatmospheric pressure at all times thereby eliminating boiling of the fuel and insuring accurate metering.

Another object of the invention is to prevent the formation of ice in the fuel mixture passage. This is accomplished by injecting the fuel into a warm or hot part of the manifold system or the like posterior to the throttle.

Another object of the invention is to provide an idling system having no tendency to form ice, which would interfere with idling operation. This is accomplished by utilizing ports adjacent the throttle which transmit suction but do not discharge fuel.

Another object of the invention is to provide an idling system in a pressure type carburetor which is simple and inexpensive, but capable of producing any desired richness characteristic through the idling and low-speed range.

Another object is to provide a fuel feeding device or system which will operate properly in any position so that when it is installed on aircraft the engine will be properly supplied with fuel both at idle and open-throttle operation regardless of the position of flight. This is highly important during maneuvers of different kinds, at which time an adequate fuel supply is indispensable. This is particularly desirable at idle so that when the engine is throttled back during a critical portion of the maneuver, the engine will not tend to stall.

The invention has for still another object to provide an accurately metered fuel supply whereby the fuel and air ratio can be maintained within very close limits.

Other objects of the invention will be clearly apparent from the following detailed description of the accompanying drawings, which represent certain preferred embodiments. After considering these examples, skilled persons will under-

stand 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.

Figure 1 is a diagrammatic sectional view of a charge forming device embodying the invention; Figure 2 is a partial view in section of the air passage of the device of Figure 1, in which a modified idling arrangement is provided; and

Figure 3 is a view similar to Figure 2 of a further modification of the invention.

Referring first to Figure 1, a main air intake conduit 10 leads to a rotary blower or supercharger 12 of an internal combustion engine which may be of any desirable type. The conduit 10 is controlled by a throttle 16 which is operated by a rod 18 extending from the pilot's cockpit. The pilot thus controls directly the air charge of the engine while the fuel charge is automatically controlled by the apparatus hereinafter described in detail. Anterior to the throttle is a venturi 19 of any suitable contour. In some cases a second supercharger may be employed to supply air at higher than atmospheric pressure to the entrance 20 of passage 10, and in such cases the supercharger 12 serves both to step up the pressure and as a fuel mixer and distributor. In other cases the entrance 20 is merely flared and opens in the direction of travel of the craft, so that the inertia of the entering air will build up a pressure above atmospheric at the entrance, which is in such cases usually referred to as a scoop.

An instrumentality such as the blower 12 is not essential to the invention, but is here shown as representing approved practice in aircraft engines, and serves to or assists in atomizing and properly distributing fuel introduced into the air line in the manner presently referred to. The blower discharges into a generally annular chamber 15 from which pipes lead to the intake ports of the various cylinders, as usual in this type of engine.

It is to be understood that the entire air passage between the throttle and the engine intake ports represents broadly an intake manifold, and the term is to be so construed in this specification. Any known or suitable fuel pump, capable of delivering fuel under positive pressure, is provided, that shown being of the sliding vane type and comprising a rotor 22 slidably carrying a set of vanes 23 and rotatably mounted in a casing 24.

The casing has a fuel inlet 25, an outlet 26, and a return by-pass 40 controlled by a pressure re-

sponsive valve 42, so as to maintain a substantially constant outlet fuel pressure, in the known manner. The pump thus delivers fuel to passage 26 and thence into annular chamber 54, through ports 59 past a tapered poppet or lift type of valve 109 which seats at 111, into pressure chamber 28, through fixed metering orifice 22, an adjustable metering orifice 30, into chamber 127 and through passage 32 to a discharge jet 34 positioned in the conduit 10 posterior to the throttle.

The discharge jet 34 is provided with a valve 36 opening away from the manifold and connected to a flexible diaphragm 39. Fuel pressure entering through the pipe 32 acts on one face of the diaphragm 39 tending to open the valve 36, and is opposed by a spring 38. Since manifold vacuum is effective on valve stem 36 merely to the extent of its application on an area equivalent to that of the valve orifice whereas the fuel pressure is effective to the extent of its application on the relatively large area of the diaphragm 39, the fuel discharge pressure is practically unaffected even by large changes in manifold vacuum. The relatively large diaphragm area also enables the valve to change from a relatively closed position to a wide open one (to give low and high rates of fuel discharge) with but a slight change in discharge pressure. This relatively constant pressure feature aids in obtaining accurate metering under variable operating conditions. A fixed stop 37 is preferably provided to limit opening of valve 36 to prevent damage in case of back fire or the like.

A second pressure chamber 44 is positioned adjacent chamber 28 and is separated therefrom by a flexible diaphragm 46 which is preferably of the type having no elastic reaction to stress, comprising a fabric sheet secured at its outer edges and having its central portion secured between a pair of disks 48. The disks 48 are in turn secured to a rod 50 which terminates at its extreme right end in a ball 101 slidable within a socket 103 which also receives a ball 105 carried by the extreme left end of a valve stem 107 of inlet valve 109. A universal connection is thus provided between the valve and the rod 50 of the diaphragm assembly hereinafter described. The parts are thus free to float to align themselves, thereby decreasing side pressure on the rod or valve which might cause binding.

Valve 109 is carried by a plug 113 threaded on the valve stem 107. The valve assembly is held in place by means of an outer nut 115 which may be removed to take the assembly apart without disturbing the adjustment of the poppet valve on the valve stem relative to the diaphragms. A diaphragm 117 serves to seal the outer end of the valve member to prevent fuel from escaping. A passage 117A communicates the fuel chamber 28 with the space to the right of the diaphragm 117. The diaphragm 117 is equal in effective area to the effective area of the valve seat 111 and is thereby effective to balance the unbalance which would otherwise result from the differential in pressure across the valve 109.

A leaf spring 118 engages the socket 103 to urge the valve assembly toward the open position to provide an enrichment at idling speeds as will be described hereinafter. The force of the spring urging the valve toward open position may be varied by means of an adjusting screw 121. The spring is preferably of such design that it acts on rod 50 and valve 109 only when the said valve is in a nearly closed position. The

flange of collar 103 moves away from and is substantially free of any effect of the spring at any substantial valve opening. The spring 118 is carried by a gasket which engages the outer edge of the diaphragm 46 and when the shell surrounding the valve mechanism 109 is removed the spring 118 remains in position, whereby it is possible to check the adjustment of the valve and valve assembly.

The chamber 54 is preferably connected to the top of the fuel tank, not shown, by a pipe 53 controlled by a float valve 55 to vent back to the tank any air or vapor entrained by the pump.

Adjacent the chamber 44 is a chamber 56, separated therefrom by a small diaphragm 58, which merely serves the purpose of a leakless stuffing box. A second large diaphragm 60 separates chamber 56 from another chamber 62, and rod 50 is connected to the disks 64 of this diaphragm in the same manner as to those of diaphragm 46. A second "stuffing box" diaphragm 66 is secured to the end of rod 50 and separates the chamber 62 from a chamber 68 positioned adjacent thereto.

The sealing diaphragms 58 and 66 are preferably made of duprene, synthetic rubber or other suitable material and are formed with annular grooves as clearly shown to give a rolling action against the confining walls. It will be observed that the effective area of the diaphragm is unchanged regardless of the position to which it is moved. Fluctuations of pressures which might interfere with the proper operation of the parts to which the diaphragm is attached are thereby avoided. To facilitate assembly of the parts, the diaphragms may be formed with thickened attaching flanges while the working sections remain thin.

In order to balance out the unavoidable pressure effects of diaphragms 58 and 66, chambers 28 and 68 are interconnected by a pressure equalizing passage 70 formed in the rod 50.

The rod 50 carries enlarged cylindrical hub members 51 adjacent the diaphragms 58 and 66 of substantially the same diameter as the flat central portions of the diaphragms on the low pressure sides thereof. The diaphragms are formed with deep annular grooves as shown, the sides of which lie respectively against the members 51 and outer circular confining walls. Due to this construction and the differential in fluid pressure which exists on the two sides of the diaphragms, the grooves in the diaphragms maintain a substantially constant effective radius as the rod 50 moves, so that the effective areas thereof remain constant regardless of movement of the rod 50. The same construction is preferably followed in connection with the diaphragms 46 and 60 by providing circular flanges 49 and 65 on the plates 48 and 64 respectively. This is an important feature since it enables the diaphragms always to exert the same force in response to equal pressures regardless of the deflection of the diaphragms. It will be observed that the end of the rod 50 is rounded to minimize friction and to permit it to seek a non-binding position.

A small venturi 74 is positioned in the intake conduit 10 concentrically with the venturi 18 and is formed with an annular opening 76 substantially at its throat which is connected through a passage 78 with chamber 56. A small by-pass 83 interconnects the passage 78 with the induction passage posterior to the throttle 16. A cali-

brated restriction 78 may be provided in the passage 78 between the passage 83 and the Venturi annulus 78. A similar passage 80 leads from chamber 62 to an annular chamber 82 formed in the venturi 18 and communicating with the inlet end of the conduit 10 through a series of tubes 81 so as to be subjected to the pressure of the incoming air. The tubes 81 project out a substantial distance so that any rain or the like washing up the walls of the air conduit 10 will flow around them and will not enter the chamber 82.

The basic principles of operation of the invention thus far described are here introduced in order to aid in clarifying the functions of parts of the invention hereinafter described. Chamber 62 is subjected to air scoop pressure, chamber 56 to Venturi suction, modified by the pressure in the induction passage posterior to the throttle at idling speeds, chamber 44 to what is generally referred to as "metered-fuel" pressure and chambers 28 and 68 to "unmetered-fuel" pressure. When the engine is in operation, it draws air through the air conduit 10, and a differential pressure is thus created between the air scoop and the venturi, the amount of which is a function of the rate of air flow. This differential in pressures acting in chambers 56 and 62 creates a net force tending to move rod 50 to the right in a direction to open valve 109. If this force were unopposed the rod 50 and valve 109 would move to the extreme right. As valve 109 opens, however, fuel which is supplied under pressure to valve chamber 54, will flow into the unmetered-fuel chamber 28, through the metering orifices, into the metered-fuel chamber 44, and thence to the discharge jet 34 as previously described. A differential in pressure between chambers 28 and 44 is therefore created which is equivalent to the pressure drop across orifice 29 and passage 30 and is a function of the rate of fuel flow therethrough. Since the pressure in chamber 44 is maintained within relatively narrow limits by the action of jet 34, opening of valve 109 will increase the pressure in chamber 28 (due to decreased throttling loss across said valve) thereby increasing the differential pressure across the metering orifices and increasing the rate of fuel flow. The differential in pressure between chamber 44 and chambers 28 and 68 will exert a force on rod 50 tending to move it to the left or in a direction to close valve 109, thus opposing the force on rod 50 created by the depression at venturi 14.

A summation of forces acting on the rod 50, neglecting the spring 119 which has substantially no effect except at very small flows corresponding to idling range, will show that the rod 50 will adjust itself to a point of equilibrium such that the differential across the fuel metering orifices is equal to the differential pressure between air scoop and venturi. If now, the pressure of fuel delivered by pump 22 is increased, as by faulty pump action, the pressure in chamber 28 will increase which will cause valve 109 to move toward closed position thereby restoring the fuel metering differential pressure to its original value. If the engine speed is decreased, by a change in the propeller pitch or from any other cause, the rate of air flow through venturi 14 decreases, decreasing the differential pressure acting on diaphragm 60, causing valve 109 to move toward closed position and thus decreasing the fuel flow to compensate for the decreased rate of air flow which initiated the adjustment.

The rate of fuel flow is directly controlled therefore by the rate of air flow, and a constant mixture ratio can be attained.

At low air flows, corresponding to idle operation, the spring 119 acts on rod 50, thus adding an increment of force to the normal Venturi action tending to open the valve 109 and thereby requiring an increased pressure differential across diaphragm 60 to balance the forces on rod 50. This results in increased fuel flow and a richer mixture for idle operation.

When the throttle 16 is in the idling position, the suction existing posterior to the throttle is transmitted through passage 83 and tends to increase the suction in passage 78 and chamber 56. The increased force operating on rod 50 tends to open valve 109 and a richer mixture is consequently produced at idle. It will be apparent that restriction 79 may be omitted if desired; however, its use increases the sensitivity of the passage 83. It will be observed that the port 83 opens into the induction passage adjacent the trailing edge of the throttle, so as to change from posterior to anterior to the throttle as the throttle opens. The enrichment created by port 83 may thus be eliminated at any desired throttle position.

Spring 119 and by-pass 83 have similar effects at idle, namely to increase the richness of the mixture. The port 83, however, is effective to enrich the mixture at low air flows corresponding to idling operation but not at low air flows with the throttle open, as at heavy load and low engine speed, whereas spring 119 enriches the mixture at low air flow regardless of whether the throttle is open or closed. The idle spring 119 and port 83 may be used together or either may be used without the other as desired. Use of the port 83 either alone or in combination with spring 119 makes possible a leaner mixture at low speed wide open throttle than is used at part throttle, a feature which is very desirable for many engines.

The passage 80 is controlled by a capsule or aneroid 84, shown in Figure 1 as a sealed, corrugated bellows which carries a valve member 86 which tends to open passage 80 at high barometric pressures (as at ground or sea level) and to close the same at low pressures (as at high altitudes). A calibrated passage 88 connects the lower portion of chamber 62 to the passage 78. Passage 88 is sufficiently small in comparison with passages 78 and 80 that when valve 86 is open, air flow through passage 88 is not effective in materially altering the pressures existing in chambers 62 and 56. As altitude is gained, valve 86 moves toward closed position under action of the bellows 84, flow of air from chamber 62 into passage 80 is thereby restricted and the air flow from passage 80 through passage 88 becomes more effective in reducing the pressure existing in chamber 62, thus decreasing the differential pressure acting on diaphragm 60 and tending to close valve 109 and lean out the mixture as desired with increase in altitude. Passage 88 also serves as a drain for any moisture collecting in chamber 62.

To guard against the building up of a differential of fluid pressures between chambers 56 and 62 which might prevent the rod 50 from actuating the valve 109 when it is desired to start the engine, a small bleed orifice 85 may be employed to interconnect the chambers 56 and 62. It will be understood of course that the orifice 85 operates with the passage 88 to equalize pres-

tures between the chambers 56 and 62; however, these two passages may be made sufficiently small that they will accomplish their desired functions without interfering with the operation of the device.

The bellows 84 is preferably only partially evacuated so that it will be responsive to changes in temperature as well as pressure, the amount of temperature response being controlled by the degree of evacuation. As the temperature of the air entering the air scoop 20 increases, bellows 84 will elongate slightly, moving valve 86 to a position to restrict the passage 80, reducing the pressure in chamber 62, and thereby reducing the pressure differential across the diaphragm 60. Consequently the fuel flow will be slightly reduced to provide a leaner mixture as the inlet air temperature rises.

In some cases it is desirable to design spring 119 and by-pass 83 to give an excessively rich idling mixture and then use valve 90, which is throttle connected through bell crank 92 and link 94 and arranged to move into passage 30 at closed throttle, to restrict the flow of fuel through passage 30 so as to obtain the desired idle richness. The valve 90 can be given any desired configuration to provide the desired rate of fuel flow at closed as well as substantially closed throttle. Valve 90 is drawn clear of passage 30 as the throttle valve 16 is opened so that during normal operation the valve 90 occupies substantially the position shown and does not affect the fuel flow. The use of valve 90 represents a preferred embodiment but may be omitted if desired, in which case the idle spring 119 and/or port 83 are designed to produce the necessary enrichment for idling operation.

The port 30 may further be controlled by a plunger 104 controlled manually from the pilot's seat through a linkage 106 to provide either a rich or lean mixture. When the end of the plunger 104 is projecting into the port 30, as shown, the flow of fuel is restricted and a lean mixture results. To obtain a richer mixture the pilot may operate linkage 106 to withdraw the plunger 104 completely from the port 30 to leave it unrestricted. Preferably the plunger 104 carries a disc 108 adapted to close the port 30 completely so that the pilot can cut off the fuel supply at will in case of emergency or when the engine is to be stopped.

A further manual control is provided by a valve 110 in the passage 80 urged onto its seat by a spring 112 and connected to the linkage 106 by a link 114. The link 114 is pivoted to one end of a bell crank lever 116, the other end of which is slidable on the stem of the valve 110 and is adapted to engage a nut 118 on the end thereof. This arrangement provides a lost motion connection so that the plunger 104 can be operated as described above without affecting the valve 110. However, if the linkage 106 is pulled back to its extreme limit the valve 110 will be opened to admit air at intake pressure to the chamber 62 thereby opening the valve 109 further and increasing the richness of the mixture regardless of position of valve 86.

The control means thus far described provide a mixture of suitable richness for varying speeds, loads, and throttle openings, and provide a degree of compensation for changes in altitude. However, during periods of operation at high power output it is desirable to richen the mixture and for this purpose a fuel-metering-head economizer is employed. In this device a calibrated

by-pass 125a around metering orifice 30 connects the unmetered fuel in chamber 28 with the metered fuel in chamber 127 above the chamber 44. A valve 125 controls the by-pass and is urged toward the closed position by a spring 129. The valve may be urged toward the open position by a diaphragm assembly 131. A spring 133 in the diaphragm chamber 135 urges the diaphragm in the direction to open the valve 125 against the spring 129. The spring 133 may be adjusted to seat the valve 125 at any predetermined value. The rate of valve opening is of course a function of the differential forces exerted by the springs 129 and 133 and the differential in the fuel pressures on opposite sides of the diaphragm 131.

The diaphragm 131 is subjected on the right side to the metered fuel pressure in the chamber 127 and on the left side to the pressure of the unmetered fuel in the diaphragm chamber 135, a conduit 137 being employed in the form shown to transmit the unmetered fuel from the chamber 28 to the diaphragm chamber 135. A small vent 139 serves to permit the escape of any air from the chamber 135, which might be trapped in the unmetered fuel.

A dashpot 141 may be provided on the end of the economizer valve 125 if it is desired to damp out sudden oscillations or movements of the valve.

As the power output of the engine increases, by opening the throttle or otherwise, the fuel delivered to the engine increases and consequently the fuel metering differential pressure increases. The fuel metering differential pressure, that is the differential in the pressures in chambers 28 and 44, acting on the economizer diaphragm 131 tends to open the economizer valve 125. When the fuel differential pressure equals or exceeds a predetermined value the force of spring 129 will be overcome and the valve 125 will open, thereby enriching the mixture as is desired.

It is to be noted that with this type of economizer control only one diaphragm is utilized in contrast to other arrangements in which balanced sealing diaphragms are required in addition to the main actuating diaphragm.

A relatively small orifice 123 extends through the diaphragm 46 to permit both diaphragm chambers 28 and 44 to fill with fuel simultaneously.

Some operators desire to be able to regulate richness of the mixture during emergency operation when the valve 125 is open, while others prefer that the richness of the mixture at this time shall be automatically regulated independently of the control of the pilot. Either of these conditions can be obtained as desired by inclusion or exclusion of the orifice 29 or by properly proportioning the size of this orifice. For example, if the area of passage 125a is greater than that of orifice 29, orifice 29 functions as the sole restriction to fuel flow when valve 125 is open as at full power, and operation of plunger 104 has then no effect on the fuel flow. On the other hand, if the restriction formed by the orifice 29 is omitted or the orifice is made larger than the combined areas of passages 125a and 30, fuel flow is metered by these two passages and the pilot, through operation of plunger 104, may control the mixture both during normal and emergency operation.

Figures 2 and 3 disclose modified forms of the suction idling arrangement of Figure 1. Corresponding parts have been given the same reference numerals but where the structure or ar-

rangement differs from that of Figure 1 corresponding reference numerals with the addition of 200 in Figure 2 and 300 in Figure 3 have been used.

In Figure 2 the throttle 216, arranged to open in the opposite direction from that of Figure 1, is actuated by the pilot through the link 218. If an idle needle 90 (Figure 1) is used, it may be actuated by the throttle through link 294 to restrict the orifice 30 upon closing movement of the throttle, as before. A passage 283 leads from the Venturi suction conduit 78 and has an outlet 287 in the induction passage posterior to and adjacent the leading edge of the throttle, and consequently is subjected to the suction posterior to the throttle regardless of throttle position. As a consequence the richness of the mixture does not decrease as rapidly as the throttle is opened as with the arrangement of Figure 1.

The modification of Figure 3 is similar to that of Figure 2 but differs therefrom in that a suction conduit 383 intercommunicating the Venturi passage 78 and the induction passage is provided with two outlets 387 and 389 adjacent the leading edge of the throttle and on opposite sides thereof when in a closed position.

With a single port, as disclosed in Figure 2, the mixture richness will tend to decrease quite rapidly as the throttle opens from idle because of the decreasing vacuum at the port and also because the increment increase in suction in passage 78 created thereby will produce a diminishing percentage enrichment as the air flow and resulting suction at venturi 74 increase. With the arrangement of Figure 3 the port 389 is gradually brought into the high suction range as the throttle opens, thus preventing too rapid decrease in mixture richness as the throttle opens. By controlling the relative sizes of ports 387 and 389 and the position of the latter relative to the throttle when in closed position, any desired richness characteristic through the idle and near idle range may be obtained. If desired, the port 387 may be provided with an adjustable valve so that the richness at idle may be readily varied. Obviously, more than two ports could be used if desired or a narrow slot might also be used.

It will also be understood that many changes might be made in form and arrangement of parts and it is not intended that the scope of the invention shall be limited to the forms shown and described nor otherwise than by the terms of the appended claims.

I claim:

1. In a fuel supplying system for an internal combustion engine, an induction passage, a throttle therein, a venturi in the passage anterior to the throttle, a fuel conduit for supplying fuel to the engine, a metering element in the conduit, fuel valve means for controlling the flow of fuel to the engine, a casing, diaphragms within the casing forming four chambers therewith, said diaphragms being operatively connected to said valve means for operating the same, pressure transmitting means intercommunicating two of the chambers with the fuel conduit anterior and posterior to the metering element and arranged so that an increase in the differential of said pressures tends to decrease the fuel flow to the engine, a pressure transmitting connection from the venturi to another of the chambers and arranged so that a decrease in pressure at the venturi tends to increase the fuel flow to the engine, means for decreasing the pressure in said other chamber during idling including port means

in the induction passage posterior to the throttle, and a passageway interconnecting the port means and the said other chamber.

2. The invention defined in claim 1 wherein the port means is adjacent the trailing edge of the throttle.

3. In a fuel supplying system for an internal combustion engine including an air passage, a throttle therein, air differential pressure creating means in the air passage anterior to the throttle, a fuel conduit, fuel valve means controlling the flow of fuel to the engine, a casing, pressure responsive diaphragm means in the casing forming movable walls of a plurality of chambers and being operably connected to the valve means, area restricting means in the fuel conduit for creating a differential in the fuel pressures at spaced points in the conduit, means for subjecting two chambers to the fuel pressures in the fuel conduit at the said spaced points in such manner that an increase in the differential in the fuel pressures acting on the diaphragm means tends to decrease the fuel flow to the engine, and means for subjecting two chambers to air pressures derived from the air differential pressure creating means in such manner that an increase in the differential in the air pressures acting on the diaphragm means tends to increase the fuel flow to the engine: the combination therewith of means for increasing the flow of fuel to the engine during idling operation comprising means for increasing the differential between said air pressures during idling including a passage leading from the chamber subjected to the lower of the air pressures and having an opening into the induction passage posterior to the throttle when in the idling position.

4. The invention defined in claim 3 comprising in addition a throttle controlled valve for varying the effective area of the area restricting means.

5. The invention defined in claim 3 comprising in addition a spring for yieldingly urging the valve means in a direction tending to increase the fuel flow to the engine.

6. The invention defined in claim 3 comprising in addition a spring urging the valve means in a direction tending to increase the fuel flow to the engine during idling, and a throttle controlled valve for decreasing the effective area of the area restricting means as the throttle is moved toward closed position.

7. In a charge forming device, an induction passage having an air entrance, a throttle valve in the passage, a venturi in the passage anterior to the throttle, a fuel conduit, fuel valve means controlling the flow of fuel through the conduit, area restricting means in the fuel conduit creating a pair of fuel pressures the differential of which varies with variation in fuel flow through the conduit, diaphragm means connected to the fuel valve means for controlling the latter to thereby regulate the fuel flow, the said diaphragm means forming movable walls of four chambers, means for subjecting two of the chambers to the said pair of fuel pressures, a passageway connecting another of the chambers to a source of air at substantially air entrance pressure, and passageway means connecting the fourth chamber to the venturi and to the induction passage posterior to the throttle.

8. The invention defined in claim 7 comprising in addition a throttle controlled member for varying the effective area of the area restricting means.

9. The invention defined in claim 7 comprising in addition a spring for urging the fuel valve means in a direction tending to increase the fuel flow to the engine.

10. The invention defined in claim 7 comprising in addition a spring urging the fuel valve means in a direction tending to increase the fuel flow to the engine during idling, and a throttle controlled valve for decreasing the effective area of the area restricting means as the throttle is moved toward closed position.

11. In a fuel feeding system, an air passage, a throttle therein, means in the air passage anterior to the throttle for creating an air differential pressure variable in accordance with variations in air flow, a fuel conduit leading from a source of fuel and discharging in the induction passage posterior to the throttle, means in the fuel conduit for creating a fuel differential pressure variable in accordance with variations in fuel flow, a fuel valve controlling the flow through the conduit, diaphragms responsive to variations in said air and fuel differential pressures operably connected to the fuel valve and so arranged that an increase in the air differential pressure tends to increase the fuel flow and an increase in the fuel differential pressure tends to decrease the fuel flow; whereby substantially constant fuel to air proportioning is obtained, and means for increasing the air differential pressure to which the diaphragms are subjected during idling to thereby increase the ratio of fuel to air during idling comprising a port opening into the air passage posterior to the throttle, and a pressure transmitting passageway leading from the port to the pressure responsive diaphragms and so constructed and arranged that an increase in suction at said port tends to move said fuel valve in a direction to increase the fuel flow.

12. The invention defined in claim 11 comprising in addition a throttle controlled element for modifying the fuel flow increasing effectiveness of the last recited means.

13. In a fuel supply system for an internal combustion engine, an air-induction passage provided with a throttle for controlling the flow of air to the engine, means in said passage anterior to the throttle creating a differential air pressure varying in relation to the rate of air flow, a conduit for supplying liquid fuel under superatmospheric pressure to said passage to be mixed with

air flowing to the engine, means in said conduit creating a fuel differential pressure varying in relation to fuel flow to the engine, a fuel valve movable to vary the flow of fuel through the conduit, a casing, flexible diaphragm means operatively connected to said valve, said diaphragm means in the casing being in opposed pressure communication with said air differential pressure creating means and said fuel differential pressure creating means, respectively, to produce fuel flow in proportion to air flow, and a pressure-transmitting passage forming a communication between said diaphragm means and the air-induction passage posterior the throttle to supplement the air differential pressure applied to said diaphragm means when the throttle is in near idling or idling position to thereby increase the richness of the mixture during idling.

14. In a charge forming device for an internal combustion engine, an induction passage having an air inlet, a throttle in the passage, a venturi in the passage anterior to the throttle, a fuel regulating device having a depression air chamber and a pressure air chamber, valve means for controlling the flow of fuel to the engine, means responsive to the air pressure in said chambers controlling said valve means, an air passage leading from the venturi adjacent the throat thereof to the depression air chamber, an air passage connecting the air inlet to the pressure air chamber, and a passage connecting the depression air chamber to the induction passage posterior to the throttle.

15. In a charge forming device for an internal combustion engine, an induction passage having an air inlet, a throttle in the passage, a venturi in the passage anterior to the throttle, valve means for controlling the flow of fuel to the engine, a depression air chamber, a pressure air chamber, means responsive to the pressures in said chambers for actuating the valve means, an air passage from the air inlet to the pressure air chamber, a calibrated passage interconnecting the pressure and depression air chambers, an air passage from the depression air chamber to the venturi adjacent the throat thereof, and a calibrated connection between the last-named passage and the induction passage posterior to the throttle.

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