

Nov. 19, 1946.

F. C. MOCK
CHARGE FORMING DEVICE
Filed Dec. 29, 1941

2,411,287

2 Sheets-Sheet 1

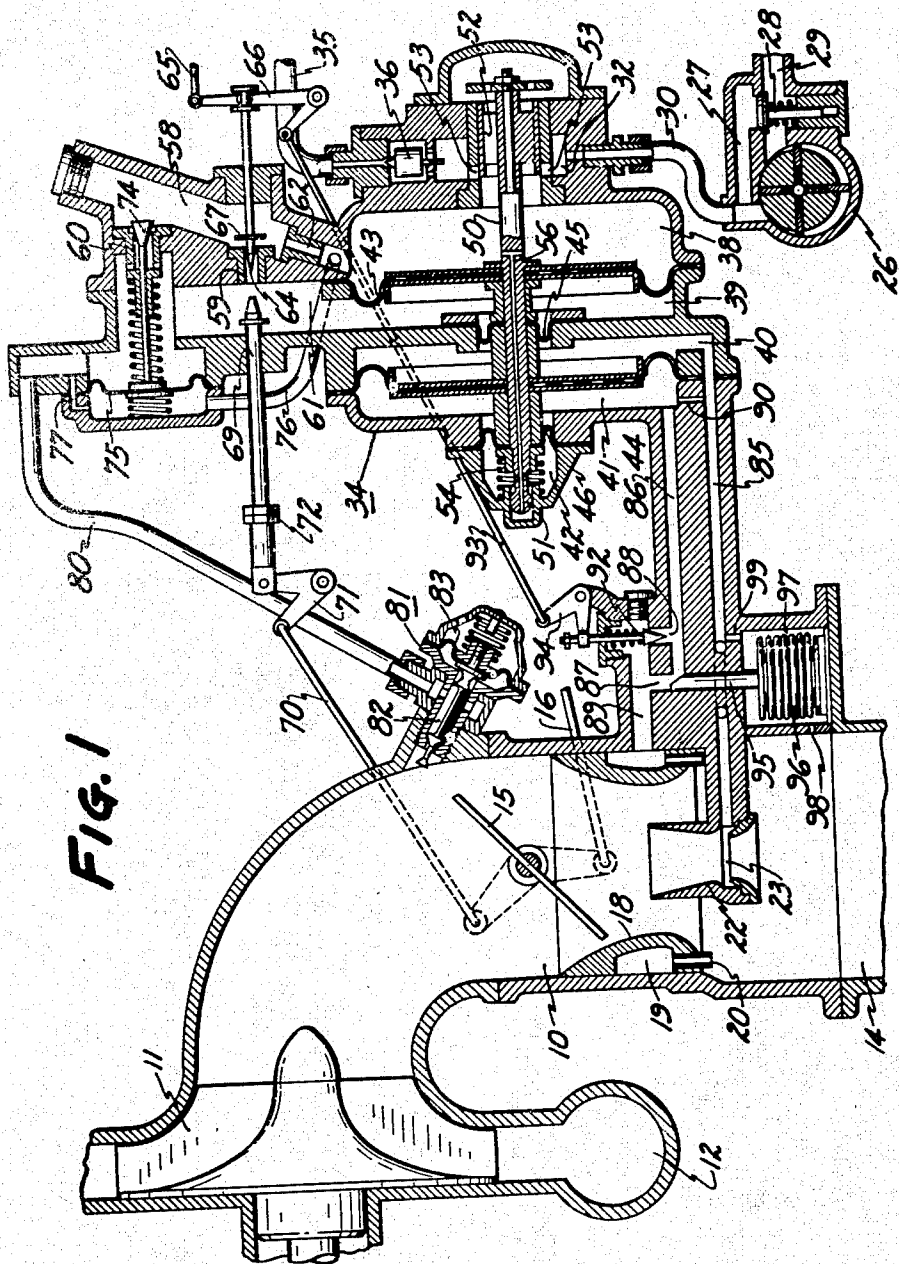


FIG. 1

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2 Sheets-Sheet 2

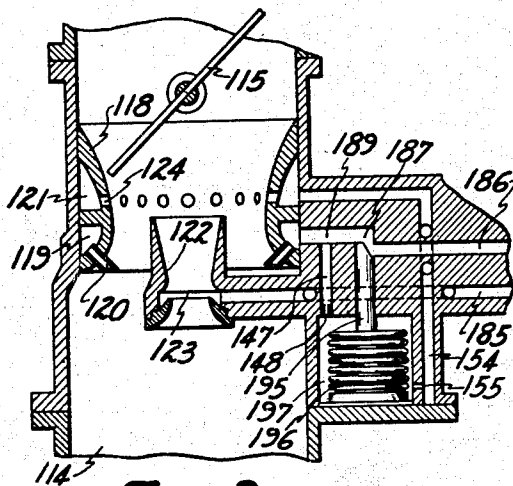


FIG. 3

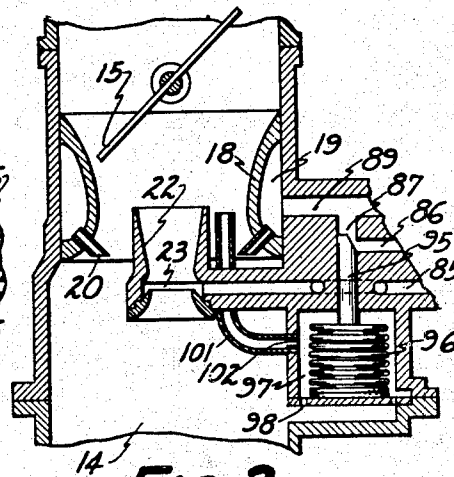


FIG. 2

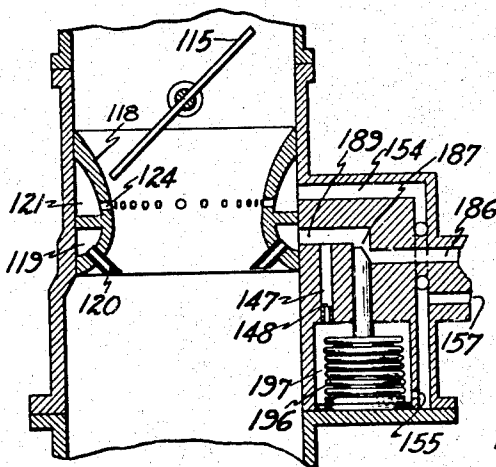


FIG. 4

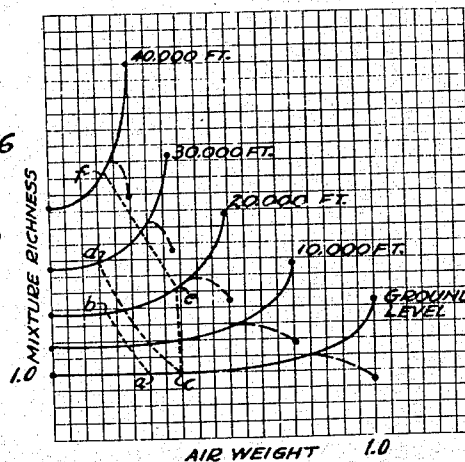


FIG. 5

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CHARGE FORMING DEVICE

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Application December 29, 1941, Serial No. 424,715

11 Claims. (Cl. 261—39)

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This invention relates to charge forming devices for internal combustion engines, principally of the aircraft type, and more particularly to mixture controls therefor for modifying or controlling the richness of the mixture supplied to the engine in response to variations in the velocity or density of the air flowing through the device. The instant mixture control is particularly adapted for use with a charge forming device of the pressure feed type disclosed in my co-pending U. S. application Serial No. 202,206, filed April 15, 1938, now Patent No. 2,390,658 dated Dec. 11, 1945, is an improvement over the mixture control disclosed therein.

The recent trend in aircraft engine design is toward higher supercharging capacity so that the full or rated horsepower of the engine may be developed up to as great an altitude as possible, a boost control or other limiting device being used to prevent overcharging the engine at lower altitudes. Since substantially the same weight of air is required by the engine at rated horsepower regardless of altitude, it is apparent that the air velocity through the venturi or other air metering device of the engine carburetor is proportionately increased as the air density decreases so as to supply the required weight of air. Thus, if rated horsepower is maintained up to an altitude of 20,000 ft., at which the air density is roughly one-half that at ground level, the air velocity in the venturi will be double the maximum air velocity experienced on the ground. Similarly, if the rated altitude is 30,000 ft., the velocity will be nearly three times that at ground level. Thus, the recent and substantial increases in rated altitude necessitate that the carburetor operate satisfactorily through a very much higher range of Venturi air velocities than heretofore.

Considerable difficulty has been experienced in obtaining proper fuel-air proportioning with such increased air velocities, particularly because the differential pressure created by the venturi increases much more rapidly than desired in the high velocity range. It has generally been assumed that the Venturi differential pressure, for a constant entering air density, varies substantially as the square of the velocity of flow, and since fuel flow through an orifice varies in accordance with the same law, substantially constant fuel-air proportioning is obtained. It has further been assumed that a change in air density, as with change in altitude, increases the richness of the mixture a fixed percentage throughout the range of weight

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or velocity of air flow. These assumptions are substantially correct through the relatively low range of air velocities previously experienced in carburetors and as a consequence an altitude mixture control which modified the richness a given percentage in accordance with the altitude would inherently correct the richness at all air flows at that altitude.

It has been found, however, particularly in carburetors in which the fuel is not injected into the venturi, that the Venturi depression does not vary as the square of the velocity in the high velocity ranges now experienced, but rather departs suddenly and drastically therefrom as the velocity approaches some high or critical value, and as a consequence the mixture richness is greatly increased. This effect is at least partially compensated for in carburetors in which fuel is delivered into the venturi as the fuel vaporizes and tends to partially satisfy or overcome the excessive suction; however, no such compensation is obtained when the fuel is not delivered into the venturi. An altitude mixture control of conventional constant percentage type, although able to properly compensate the mixture through the low range of velocities, provides insufficient compensation in the high velocity range.

It is accordingly an object of the present invention to provide a carburetor having an improved altitude mixture control of the automatic type.

It is a further object of the invention to provide a carburetor altitude mixture control capable of automatically correcting the richness of the mixture through wide ranges of air density and Venturi air velocity.

It is a further object of the invention to provide a carburetor altitude mixture control in which the pressure responsive element is subjected to a pressure varying as a function of the Venturi air velocity and air density.

It is a further object of the invention to provide a carburetor altitude mixture control in which the sensitive element is responsive to variations in the entering air temperature and pressure, and Venturi air velocity.

Other objects and advantages will be readily apparent to one skilled in the art from the following description taken in connection with the accompanying drawings in which:

Figure 1 is a diagrammatic sectional view of a carburetor of the pressure feed type embodying the invention;

Figure 2 is a partial view in section of a modified form of the invention;

Figure 3 is a similar view of a further modification of the invention;

Figure 4 is a partial view in section of another modification of the invention; and

Figure 5 is a graph of the inherent and uncorrected metering characteristics of single and multiple Venturi carburetors at various altitudes, the range of air flow having been extended beyond that normally experienced in a carburetor.

With reference to Figure 1, in which much of the structure is as shown in my said copending application Serial No. 202,206 an air passage 10 leads to a blower or supercharger 11 of either a single or multi-stage type having a discharge ring 12 in communication with the cylinders of an internal combustion engine. The passage 10 has an air entrance section 14 which normally opens in the direction of travel of the craft and is referred to as a scoop. A throttle 15 controls the passage and is operated by a rod 16 extending from the pilot's compartment. The pilot thus directly controls the air charge of the engine while the fuel charge is automatically controlled by apparatus hereinafter described. Anterior to the throttle is a large venturi 18 having an annular chamber 19 which is in communication with the air entrance through a plurality of circumferentially spaced impact tubes 20. A small venturi 22, positioned within the venturi 18 in the customary manner, includes an annular chamber 23 opening substantially into the Venturi throat.

A fuel pump, indicated generally at 26, is of the sliding vane type having a by-pass passage 27 controlled by a spring-loaded valve 28. The pump receives fuel through a pipe 29 and delivers it through pipe 30 to an annular chamber 32 of a main fuel regulator indicated at 34. A vapor venting pipe 35 leads back to the fuel supply tank from the uppermost portion of chamber 32 and is controlled by a float type valve 36.

The fuel regulator 34 comprises five chambers 38, 39, 40, 41 and 42 separated from each other by two large plate-backed actuating diaphragms 43 and 44, and by two small sealing diaphragms 45 and 46. The diaphragms are each preformed with an annular groove adjacent the outer periphery to permit axial displacement thereof without change in effective area. The diaphragms are secured to a central control rod 50 having a spherical guide portion 51 at one end and a slide valve 52 connected thereto at its other end. The valve 52 controls a set of ports 53 between the annular chamber 32 and the unmetered fuel chamber 38 whereby axial movement of the diaphragm-valve assembly varies the effective area of ports 53 and the quantity of fuel flowing therethrough. An idle spring 54 urges the control rod 50 and valve 52 in a direction to maintain a slight opening of the ports 53.

A passage 56 in the control rod 50 forms a pressure transmitting connection between the chamber 42 and the unmetered fuel chamber 38. The chamber 38 is also connected to the metered fuel chamber 39 by means of a fuel duct 58, a pair of orifices 59 and 60 in parallel relationship and a fuel duct 61. If desired, a calibrated orifice 62 may be used in duct 58 anterior to the orifices 59 and 60. A tapered valve 64 controls the effective area of the orifice 59 and may be variably positioned by the operator through a link 65 and pivoted lever 66. A disc 67 is secured to the valve 64 and closes the orifice 59 upon ex-

treme inward movement of the valve 64. A second tapered valve 68 is operated by the throttle through link 70 and bell crank 71, and is adapted to variably restrict the passage 59 as the throttle approaches closed position. The double lock-nut arrangement 72 permits adjustment of the valve 68 relative to the throttle. As shown the valves 64 and 68 cooperate with the opposite ends of a single orifice 59; however, it will be apparent that each could cooperate with separate orifices in series relationship. The economizer orifice 60 is controlled by a spring closed valve 74 secured to a diaphragm 75, one side of which is subjected to the pressure in the unmetered fuel chamber 38 through pipe 76, and the other side is subjected to the pressure in the metered fuel chamber 38. A small calibrated vent 77 is provided for eliminating air and vapor to permit complete fuel filling of the device.

The metered fuel chamber 39 is connected to the induction passage through duct 61, a pipe 80, and a discharge nozzle 81 having a spring closed valve 82. A diaphragm 83 is secured to the valve 82 and is urged in a direction to open the valve by the pressure of the fuel supplied to the nozzle.

The chamber 40 is connected to the annular chamber 23 of the primary venturi 21 through an air passage 85 and is therefore subjected to the pressure existing at the throat of the primary venturi. The chamber 41 is connected to the annular chamber 19 by an air passage 86, ports 87 and 88 and passage 89, and is therefore subjected to the pressure in the air scoop. A calibrated port 90 interconnects the Venturi passage 85 and the air chamber 41. Port 88 is controlled by a spring closed valve 92 which may be opened, in case of an emergency to by-pass the port 87, by extreme movement of link 65 by means of the bell-crank 66, a link 93 and a bell-crank 94 having an overrunning connection with the valve 91.

The port 87 is controlled by a tapered automatic mixture control valve 95 connected to the free end of a sealed capsule 96 mounted in a chamber 97. The device of Figure 1 as so far described conforms with the device shown in my above-mentioned copending application Serial No. 202,206; however, in the said application the chamber 97 is in free communication with the air inlet whereas in accordance with the instant invention the chamber communicates with the air inlet 14 through a calibrated port 98 and with the Venturi air passage 85 through a calibrated port 99. The port 99 is normally larger than the port 98 so that the pressure in chamber 97, although intermediate between the venturi and air scoop pressures, will tend to more nearly approach that at the venturi than that in the air scoop. However, the relative size of the ports 98 and 99 may be varied to obtain any desired relation between the pressure in chamber 97 and the pressures in the venturi and scoop; however, the port 98 may be omitted if desired and the chamber 97 subjected to the full suction of the venturi. The continuous flow of air from the scoop, through port 98, across the surface of bellows 96 and out port 99 tends to make the bellows quickly responsive to variations in the temperature of the air entering the induction passage.

During operation of the engine, the air flow through the induction passage creates a differential in the pressures in the annular chamber 23 of the venturi 22 and the annular chamber 19 which, at least through the low range of

velocities in the induction passage, varies substantially as the square of the rate of air flow therethrough. These pressures, transmitted through passages 85 and 86 to chambers 40 and 41, acting on opposite sides of diaphragm 44 create a force tending to move the control rod 50 to the right to open valve 52. If this force was not counteracted, it would completely open the valve 52; however, as the valve opens fuel supplied to pipe 30 by the pump 26 flows into the unmetred fuel chamber 38, through orifices 62 and 59, into the channel 61 communicating with the metered fuel chamber 39, through pipe 80 to the discharge nozzle 81, and discharges into the induction passage. The flow of fuel through the orifices 62 and 59 results in a differential in the pressures in chambers 38 and 39 which varies substantially as the square of the rate of fuel flow therethrough. These pressures acting on diaphragm 43 urge the rod 50 and valve 52 to the left tending to close the ports 53. The control rod 50 and valve 52 therefore float under the action of the air force on diaphragm 44 and the fuel force on diaphragm 43, and thereby regulate the quantity of fuel in accordance with the quantity of air. Thus, if the quantity of air increases, the air force on diaphragm 44 will increase and will open the valve 52 to increase the fuel flow sufficiently to increase the fuel differential pressure and the fuel force on diaphragm 43 to balance the increased air force. Constant fuel air proportioning will thus be obtained as long as the fuel and air forces on the diaphragms vary in accordance with the quantity of air and fuel flow to the engine, unless the balance on the control rod is upset by some extraneous force such as idle spring 54. At idle, the force of spring 54 is an appreciable factor in urging the rod 50 to the right, and consequently an increased fuel force is required to balance both the air force and the spring force thereby creating a rich mixture at idle as desired. At higher air flows the force of the idle spring is very small in comparison with the relatively large air force and consequently has but a negligible effect on the richness of the mixture. It has been found desirable to design spring 54 to produce a richer mixture at idle than desired and to use the throttle controlled valve 69 to restrict the fuel orifice 59 at closed throttle to obtain the desired richness of mixture.

It will be apparent that the regulator 34 maintains the differential fuel pressure across diaphragm 43 at a value depending upon the air flow, and that a change in the effective area of the fuel metering orifice will correspondingly change the richness of the mixture. Thus, operation of the link 65 will vary the position of the tapered valve 64 and will therefore vary the richness of the mixture. A manual mixture control is thus provided. Extreme movement to the left of link 65 causes the disc 67 to fully close orifice 59 to shut off the fuel flow so as to stop the engine.

As the power output from the engine increases the fuel consumption and consequently the fuel differential pressure across diaphragm 43 and therefore across diaphragm 75 correspondingly increase. When the fuel differential pressure reaches some predetermined value the diaphragm 75 opens the economizer valve 74 and thereby increases the richness of the mixture for high power operation, as is desired. The orifice 62 is normally greater than the effective area of the orifice 59 but smaller than the sum of the areas of orifices 59 and 60. As a consequence

when the economizer valve 74 is open the orifice 62 is the primary metering restriction, at which time movement of the valve 64 will have substantially no effect on the richness of the mixture. The arrangement of the orifices 62, 59, and 60 is the same as is shown in my above mentioned copending application.

As is generally known, the Venturi-to-air-scoop differential pressure created by a given weight of air flow per minute will increase with decrease in air density and if applied across the diaphragm 44 will produce an increase in the fuel flow and consequently a richer mixture. It has further been discovered that as the air velocity through the venturi increases beyond a relatively high value, the Venturi differential pressure increases at a rate considerably greater than the square of the air velocity, thus producing an enrichment of the mixture at high air velocities.

The foregoing inherent metering characteristics are clearly shown in the graph of Figure 5 in which the mixture richness has been plotted against the weight of air flow for various altitudes. The characteristics of a single Venturi carburetor are shown in full lines and those of a multiple Venturi carburetor in broken lines. The richness scale in Figure 5 utilizes unity (1.0) to designate the desired richness for operation at ground level, and the weight of air scale utilizes unity (1.0) to designate the maximum weight of air which can be drawn through the Venturi system with an entering air density corresponding to ground level, at which time the air velocity in the main venturi reaches its maximum or critical value. The circled termination point of each of the curves corresponds to critical flow at that particular altitude. It will be noted that the metering characteristics of single or multiple Venturi carburetors are substantially the same through the major portion of the air flow range but sharply diverge as the maximum flow is approached. This results from the fact that the velocity in the small venturi is greater than that in the main venturi and as a consequence reaches a condition of critical flow before the main venturi. At this time the depression in the small venturi, which determines the fuel flow, reaches a maximum; and subsequent increase in flow through the large venturi to its critical flow rate increases the total air flow without increasing the fuel flow. The mixture richness through this range is therefore decreased as indicated by the broken lines which diverge from the solid lines.

It must be borne in mind that these curves extend into regions of velocity far in excess of those previously or at present experienced, or even contemplated, in carburetors for internal combustion engines, but have been here shown merely to indicate the full characteristic of such devices. Up until but a few years ago, few airplanes were able to reach altitudes above 20,000 ft. and utilized maximum air flow values roughly indicated by the dotted line *a-b*, the maximum weight of air supplied to the engine decreasing with increase in altitude. Through this limited range of altitude and air flow, as determined by the line *a-b* and the ground level and 20,000 ft. curves, a carburetor tends to produce a substantially constant richness of mixture at each altitude. In order to obtain a mixture richness at altitude equal to that at ground level, the altitude mixture control may apply a percentage correction dependent upon the altitude.

With the intrend of superchargers and improved charging of the engines the maximum air-flow at each altitude was somewhat increased as indicated by the line c—d; however, substantially constant richness is obtained at each altitude even through this somewhat enlarged range, and an altitude control functioning solely in response to variations in entering air density satisfactorily compensates the richness of the mixture at various altitudes regardless of the rate of air flow.

With proposed highly supercharged and boost-controlled engines the maximum airflow at each altitude is substantially as defined by the line c—e—f. Through the greatly increased velocity ranges now experienced, particularly at altitude, the richness no longer tends to remain constant at each altitude, but rather increases sharply with the increased velocity. An altitude mixture control which at a given altitude applies the necessary percentage correction at low air flows, provides insufficient compensation at the high air flows.

To accomplish the desired mixture correction for variations in altitude and velocity I provide, referring again to Figure 1, the valve 95 for variably restricting the port 87. When the valve 95 is withdrawn from the port, as at low power ground level operation, the calibrated port 90, being of small size in comparison with the port 87, has substantially no effect on the pressures in chambers 40 and 41. However, movement of the valve 95 into a restricting position in port 87 restricts the flow of air from the annular chamber 19 to the chamber 41 and consequently the Venturi suction in passage 85 is effective to partially reduce the pressure in chamber 41 and thereby decreases the differential pressure across diaphragm 44. The richness of the mixture is correspondingly decreased. The valve 95 is variably positioned within the port 87 by the expandible bellows 96 subjected to a pressure varying in accordance with the absolute pressure in a venturi positioned anterior to the throttle and preferably forming a portion of the fuel metering instrumentality. In the modification of Figure 1 the bellows is subjected to variations in the absolute pressure in the venturi 23 by means of the port 99 intercommunicating the bellows chamber 97 and the Venturi passage 85. The port 98 from chamber 97 into the air inlet provides a continuous flow of air across the bellows 96 whereby it will quickly respond to changes in density resulting from variations in entering air temperature. The bleed 98 also serves to partially destroy the suction within chamber 97 whereby any desired correlation may be obtained in the relative responsiveness of the bellows to variations in the air velocity as reflected in the absolute Venturi pressure and to entering air density as reflected both in the pressure at port 98 as well as the pressure in the venturi. Correlation of the contour of valve 95 and the pressure in chamber 97 to produce constant fuel air proportioning at one altitude will produce substantially the same proportioning at all altitudes.

In the event that the bellows controlled valve 95 jams or sticks while in a restricting position, the emergency valve 92 may be opened by extreme movement to the right of link 65, thereby providing an air by-pass around the valve 95 to prevent undue leanness which would otherwise occur upon reduction in altitude or air velocity after the valve 95 jammed.

The embodiment of Figure 2 is somewhat simi-

lar to that of Figure 1 and differs therefrom principally in that the bellows chamber 97 communicates with the throat of the large venturi 18 by means of an open-ended tube 101 extending into the venturi in the direction of air flow. A calibrated restriction 102 is provided in the tube 101. As before, the chamber 97 communicates with the air inlet through one or more ports 98. The remaining structure disclosed in Figure 2 is similar to that of Figure 1 and has been given corresponding reference numerals.

In Figure 3, corresponding parts having been given corresponding reference numerals with the addition of 100, a large venturi, 118, positioned anterior to the throttle 115, is provided with two annular chambers 119 and 121, the former communicating with the inlet through impact tubes 120, and the latter communicating with substantially the throat of the venturi through a plurality of ports 124. Annular chamber 123 in the small venturi 122 communicates with the chamber 40 of the regulator through the passage 185 and the annular chamber 119 communicates with the chamber 41 of the regulator through passages 186 and 189 and port 187 controlled by the bellows actuated valve 195. The chamber 197 enclosing the bellows 196 is connected to the annular chamber 119 by a passage 147 having a calibrated restriction 148, and is connected to the chamber 121 by a passage 154 and a calibrated port 155. The bellows of Figure 3 is thus subjected to a pressure dependent upon the absolute pressure at the large venturi and the entering impact pressure.

Figure 4 discloses the induction passage of a single Venturi carburetor in which the venturi is similar in structure to the large venturi of Figure 3 and is formed with annular chambers 119 and 121 respectively subjected to the entering air impact pressure and the Venturi throat pressure. The pressure in chamber 119 is transmitted to the regulator chamber 41 through passages 186 and 189 and port 187, and the pressure in chamber 121 is transmitted to the chamber 40 of the regulator through passages 154 and 157. The chamber 197 enclosing the bellows 196 communicates with the chamber 119 through passage 147 and restriction 148 and with the chamber 121 through port 155 and passage 154.

Although several forms of the invention have been disclosed, the various parts of the separate modifications may readily be combined to form further modifications, for example, the chamber 197 of Figure 4 may, if desired, be connected to the air inlet as in Figures 1 and 2 rather than to the impact pressure chamber 119. Similarly, the modifications of Figures 1 and 2 may utilize a connection from the bellows chamber 97 to the impact chamber 19 rather than the connection 98 to the air inlet. Many other changes may be made in the arrangement of the various parts without departing from the spirit of the invention and I contemplate the use of all such arrangements falling within the scope of the appended claims. Portions of the structure disclosed but not claimed herein are being claimed in my co-pending applications Serial No. 202,206, filed April 15, 1938, and Serial No. 362,572, filed October 24, 1940.

I claim:

1. In a fuel feeding system for an engine, an air passage, a throttle in the air passage, Venturi means in the air passage anterior to the throttle, a main fuel regulator responsive to variations in the pressure in the Venturi means for variably

controlling the fuel flow to the engine in response to variations in the air flow through said Venturi means, and an automatic mixture control comprising a chamber having a wall movable in response to variations in absolute pressure in said chamber, a control element actuated by said movable wall and operative to control the rate of fuel delivered to the engine by the regulator to thereby control the richness of the mixture, and a passageway connecting the chamber to a low pressure zone in the Venturi means whereby the movable wall is subjected to a pressure which decreases with increase in air velocity through the Venturi means and also with an increase in altitude, said passageway having an effective cross-sectional area which remains constant with variations in the position of said control element.

2. In a fuel feeding system for an engine having a throttle controlled air passage, Venturi means in said passage anterior to the throttle for creating a pair of air pressures the difference of which varies with variations in the air flow through the passage, a fuel conduit for supplying fuel to the engine, means in said conduit for creating a pair of fuel pressures the difference of which varies with variations in fuel flow through the conduit, a fuel valve in the conduit, diaphragms operatively connected to the valve and responsive to said pairs of air and fuel pressures, and an altitude mixture control comprising an air chamber, a sealed capsule in the air chamber having a wall movable in response to variations in the absolute pressure and temperature of the air in said air chamber, a control element actuated by said wall and operative to vary at least one of the air pressures on said diaphragms, and a passageway of fixed cross-sectional area during periods of engine operation connecting the air chamber to a zone of reduced pressure in the Venturi means.

3. The invention defined in claim 2 comprising in addition a second passageway connecting the air chamber to a zone of relatively higher pressure in the air passage anterior to the throttle.

4. In a fuel feeding system for an engine, an air conduit for supplying air to the engine, a throttle in the conduit, a venturi in the conduit anterior to the throttle, a passage including a restricted portion connecting the venturi adjacent the throat thereof to a point in said conduit anterior to the throttle and spaced from said throat, a valve in said passage, an air chamber in fixed and continuously open pressure communication with the venturi during all periods of engine operation, a sealed capsule in said chamber having a wall connected to said valve and movable in response to variations in the absolute pressure in said chamber, a fuel supply duct, a fuel control valve in said duct, and means responsive to variations in pressure in said passage for actuating the fuel control valve.

5. In a fuel feeding system for an internal combustion engine, an air conduit for supplying air to the engine, a throttle in said conduit, a venturi in said conduit anterior to the throttle, a first passage including a restricted portion and connecting the throat of said venturi to a point in said conduit spaced from said throat, a valve in said passage, a pressure responsive member for operating said valve to vary the air flow through said passage, a second passage interconnecting two spaced points in the air conduit anterior to the throttle at which the pressures differ by an amount varying with the velocity of air flow through the conduit, said pressure re-

sponsive member being located in said second passage so as to be exposed to the air flowing therethrough, and means responsive to the pressures at spaced points in said first passage for controlling the flow of fuel to the engine.

6. In a fuel supply system for an internal combustion engine having an air conduit, a throttle in said conduit, Venturi means including at least one venturi in the conduit anterior to the throttle, a fuel regulator having two air chambers, a first passageway connecting the venturi to one of the air chambers, a second passageway connecting the other of the air chambers to the air conduit at a point anterior to the throttle and spaced from the throat of said venturi, and means responsive to variations in the differential of the pressures in said chambers for controlling the fuel flow to the engine: the combination therewith of an automatic mixture control for varying the quantity of fuel supplied to the engine by the regulator comprising a variable pressure chamber having a movable wall responsive to the absolute pressure in said variable pressure chamber, a valve connected to said wall to be actuated thereby and operative to vary the pressure in one of said two air chambers, and a passageway connecting said variable pressure chamber to the Venturi means whereby the pressure in said variable pressure chamber is decreased with increase in air velocity through the air conduit and also with increase in altitude, said last named passageway remaining open during all periods of engine operation.

7. In a charge forming device for an engine, an air passage having an inlet portion, a throttle in said passage, means in the air passage anterior to the throttle for creating a pressure varying with variations in the rate of air flow through the air passage, a fuel regulator responsive to variations in said pressure for variably controlling the fuel flow to the engine, and an automatic mixture control comprising an air chamber, a sealed capsule in said chamber having a wall movable in response to variations in the absolute pressure in said chamber, a control element actuated by said movable wall and operative to control the rate of fuel delivered to the engine by the regulator to thereby control the ratio of fuel and air supplied the engine, and a passageway leading from the chamber and opening into the air passage anterior to the throttle at a point at which the pressure is less than the pressure in said inlet portion by an amount which increases with increase in the velocity of air flow through the air passage, the cross-sectional area of said passageway remaining fixed with variations in the position of said control element.

8. In a charge forming device for an engine, an air passage having an inlet portion, a throttle in the passage, Venturi means including at least one venturi in the passage anterior to the throttle, a fuel regulator responsive to variations in the pressure in said venturi for variably controlling the fuel flow to the engine in response to variations in the air flow through the air passage, and a mixture control comprising a chamber having a wall movable in response to variations in the absolute pressure in said chamber, a control element actuated by said movable wall and operative to control the rate of fuel supplied to the engine to thereby control the richness of the fuel-air mixture, and a pair of passageways of fixed effective cross-sectional area during periods of engine operation connecting the chamber to the Venturi means and to the said inlet portion, whereby the

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movable wall is subjected to a pressure which decreases with increase in air velocity through the air passage and also with increase in altitude.

9. In a charge forming device for an engine, an air passage, a throttle in the passage, a main venturi in the passage anterior to the throttle, booster Venturi means discharging into the main venturi, a main fuel regulator responsive to variations in pressure in the booster Venturi means for variably controlling the fuel flow to the engine, and an automatic mixture control comprising a chamber, a pressure transmitting connection from the chamber to the main venturi, a sealed capsule in said chamber having a wall movable in response to variations in the absolute pressure in said chamber, and a control element connected to said wall and operative upon movement thereof to variably control the rate of fuel delivered to the engine to thereby control the richness of the mixture.

10. In a fuel feeding system, an air passage hav-

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ing an inlet, a throttle in the passage, a main venturi in the passage anterior to the throttle, a small venturi discharging into said large venturi, fuel regulating means responsive to the pressure in the air inlet and to the pressure in the small venturi for controlling the supply of fuel to the engine, and an automatic mixture control comprising a chamber having a wall movable in response to the absolute pressure in said chamber, a control element actuated by said movable wall and operative to control the rate of fuel delivered to the engine to thereby control the richness of the mixture, and a passageway connecting the chamber to the small venturi, said passageway being of fixed cross-sectional area regardless of the position of said control element.

11. The invention defined in claim 10 comprising in addition a passageway connecting the chamber to a point in the air passage anterior to the throttle and spaced from the small venturi.

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