

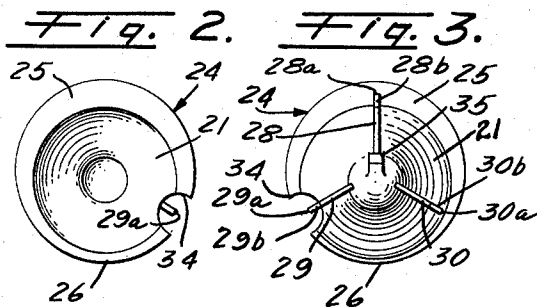
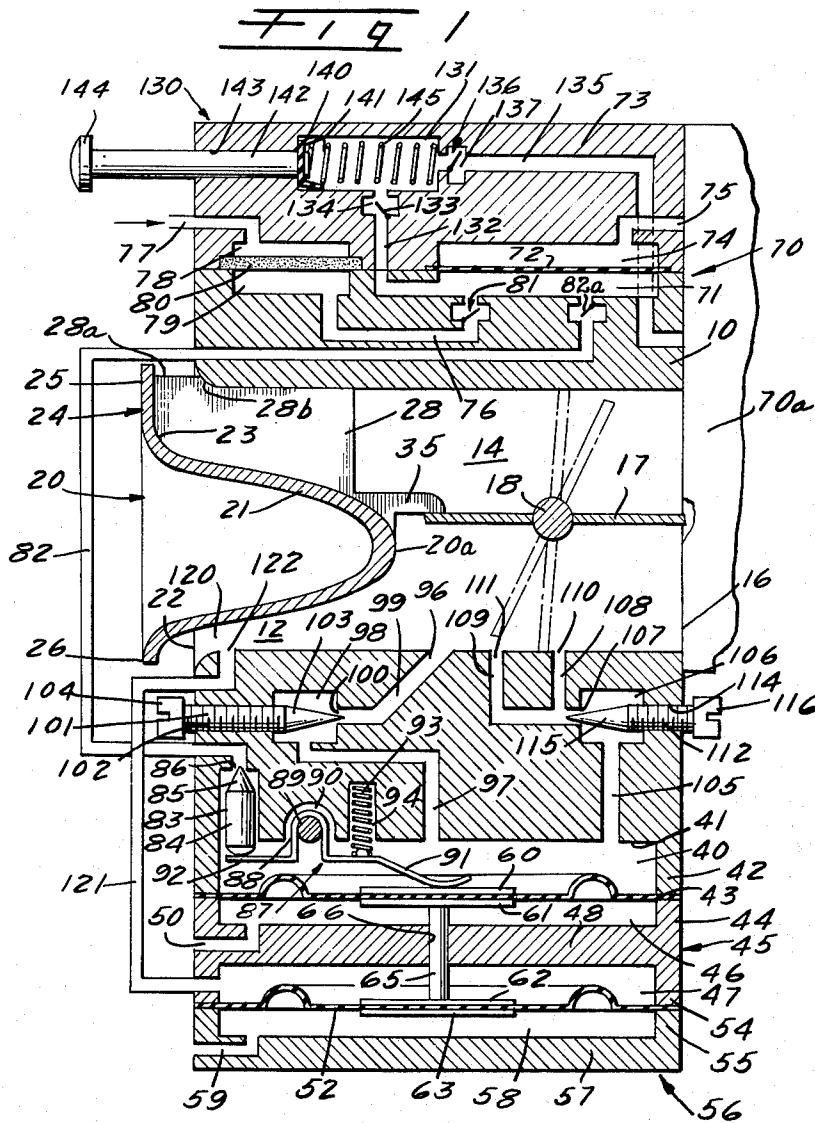
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CHARGE FORMING DEVICE

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CHARGE FORMING DEVICE

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This invention relates to fuel feeding systems for internal combustion engines and more particularly to devices or systems in which liquid fuel is supplied thereto under super-atmospheric pressure.

While the invention has particular utility in connection with two-cycle internal combustion engines, and is disclosed herein in such connection, it is to be understood that its utility is not confined thereto.

There are various problems and difficulties involved in the provision of a carburetor or fuel supply system for two-cycle internal combustion engines which will provide the proper fuel mixture under various operating conditions of the engine, and it is an object of the present invention to provide a fuel system or carburetor or charge forming device that will solve these problems and overcome said difficulties.

It is another object of the invention to provide a charge forming device of this character wherein the fuel-air ratio remains constant.

It is still another object of the invention to provide a device of this character wherein there is instantaneous response of the system to changes in air flow to thereby maintain the fuel-air ratio constant.

It is a further object of the invention to provide a device of this character utilizing mass air flow, thereby providing a sound metering system.

It is another object of the invention to provide a device of this character wherein there is a smooth transition from idling to normal operation.

It is still another object of the invention to provide a device of this character wherein flat spots are eliminated.

It is a further object of the invention to provide a charge forming device or carburetor of this character wherein spit-back from the air horn is eliminated.

It is a still further object of the invention to provide a device of this character wherein there is a boost to the discharge of fuel with opening movement of the throttle valve from the idle position.

It is another object of the invention to provide a system or device of this character having a signal system controlling discharge of fuel, said signal system being responsive to pressures in predetermined locations in the induction passage.

It is a still further object of the invention to provide a device or system of this character having a primer which will not only provide a fuel required for starting but also fills the fuel passages of the device so that there will be no possible interruption of the supply of fuel after the engine has started.

It is another object of the invention to provide a device or system of this character having a novel venturi.

It is still another object of the invention to provide a device or system of this character having improved signal characteristics.

It is a further object of the invention to provide a device or system of this character having improved air-flow characteristics and wherein more air will flow there-through.

It is a still further object of the invention to provide a device of this character that is extremely compact.

It is still another object of the invention to provide a simplified device of this character which may be built at reasonable cost and which is capable of accurately

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regulating the fuel supply to maintain the proper fuel-to-air ratio through wide ranges of engine load and speed.

The characteristics and advantages of the invention are further sufficiently referred to in connection with the following detailed description of the accompanying drawing, which represents one embodiment. After considering this example, 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.

Referring to the drawing, which is for illustrative purposes only:

FIG. 1 is a schematic sectional view showing a carburetor or fuel supply system, or charge forming device, embodying the present invention;

FIG. 2 is a reduced front view of the venturi insert; and FIG. 3 is a rear view of said insert.

Referring more particularly to the drawing, the device comprises a body 10 having an induction passage therethrough which includes an air-inlet portion or section 12 and an air-fuel mixing section or chamber 14 having a mixture outlet 16 adapted to be connected to the mixture inlet of the engine in the usual well known manner.

Control of the fluid flow through the induction passage is effected by a throttle valve 17 of the usual butterfly type mounted on a throttle shaft 18 which extends across the induction passage and has end portions journaled in the walls of the body 10. Throttle shaft 18 is provided with a throttle layer, not shown, connected to suitable actuating mechanism of any well known type.

At the air-inlet end of the induction passage there is means defining, with the adjacent portions of the induction passage wall, a venturi, said means comprising an insert indicated generally at 20. This insert comprises a hollow elongated body portion 21 having a curved inward taper terminating in a rounded end 20a, the body 21 presenting a streamlined exterior with the smaller end 20a within the induction passage and the larger end spaced outwardly of the air-inlet opening 22 of the air-inlet section 12. The outer end of the body 21 curves outwardly at 23 and merges with a flange, indicated generally at 24, extending radially outwardly. Flange 24 is generally circular but is offset from the axis of the body 21 and hence is eccentric relative to said body. Consequently flange 24 is wider at one side, as indicated at 25, than it is at the diametrically opposite side 26.

Means for positioning the insert 20 within the induction passage is provided and comprises a plurality of vanes, there being three vanes provided and indicated by respective reference numerals 28, 29 and 30. These vanes run lengthwise of the insert and, hence, lengthwise of the induction passage and are annularly spaced apart substantially 120°, as best shown in FIG. 3. However, any suitable arrangement of vanes may be used.

The diameter of flange 24 is somewhat greater than the diameter of the inlet 22 of the induction passage and the outer end portions 28a, 29a and 30a of the vanes extend outwardly of the plane of the inner wall of the induction passage. A major portion of each vane extends within the induction passage and the respective vanes have outwardly rounded shoulders 28b, 29b and 30b which abut against the correspondingly rounded outer end of the air-inlet section to thereby space the flange 24 outwardly of the adjacent wall of the body 10 to provide inlet air flow passage means. Since the insert 20 is eccentrically disposed within the induction passage, the offsetting of the axis of said insert relative to the axis of the induction passage being downwardly, the inlet air passage means at the bottom of the induction passage is substantially smaller than the portion of said passageway

means at the upper side of the induction passage, the purpose of this arrangement being described more particularly hereinafter.

Any suitable means may be used to secure the insert in the induction passage. However, the means used comprises a screw, not shown, disposed in a tapped opening in the adjacent part of the body 10, said screw extending through a peripheral notch 34 in the flange 24 of the insert and a portion of the body thereof, as best shown in FIGS. 2 and 3. The head of the screw overlies a portion of the flange 24 at the edge of the notch 34 and thereby holds the insert in position in the induction passage.

At the inner end of the insert there is a throttle valve stop 35 which extends from the inner end of the insert toward the throttle valve and projects into the path of movement of an edge portion of said valve, as best shown in FIG. 1. The various parts of the insert are shown as being integral although these parts could be separate elements which are secured together by any suitable means.

The body 10 includes a shallow recess 40 defined by a top wall 41 and an annular wall 42 normal to the top wall 41. A flexible diaphragm 43 substantially parallel to the wall 41 closes the open end of the recess 40 to thereby define a pressure fuel chamber, said diaphragm being marginally clamped between the annular wall 42 and the upper end or edge, as shown in FIG. 1, of an annular wall 44 of an intermediate plate, indicated generally at 45, which has an upper recess 46 and a lower recess 47 separated by a partition wall 48. Flexible diaphragm 43 serves as a movable wall separating the pressure fuel chamber 40 from the chamber 46, the latter being vented to atmosphere by means of a vent passage 50 so that said chamber 46 may be termed an atmospheric chamber, since atmospheric pressure prevails therein.

Recess 47 has its open lower end closed by a flexible diaphragm 52 which is marginally clamped between the lower free end or edge of an annular flange 54 of the intermediate plate 45 and the upturned annular flange 55 of an outer plate or cap, indicated generally at 56, having a bottom wall 57 from which said annular flange 54 extends. The intermediate plate 45 and the cap 56 are secured to the body 10 by any suitable means, such as, for example, screws, not shown.

Chamber 47 is a signal sensing chamber, while the chamber 58 defined by the cap 56 and diaphragm 52 is an atmospheric chamber which is vented to atmosphere by means of a vent passage 59 so that atmospheric pressure prevails in the chamber 58.

Diaphragm 43 may be termed the wet diaphragm since it comprises one wall of the fuel chamber 40 and is exposed on its upper side, as shown in FIG. 1, to the fuel in chamber 40. Diaphragm 52 is termed the dry diaphragm or sensing diaphragm.

Diaphragm reinforcing plates 60 and 61 are disposed on the top and bottom sides of the diaphragm 43 and are secured in position by any suitable well known manner. It is to be noted that the plates 60 and 61 are of substantially smaller diameter than the diaphragm 43 and are axially arranged on the diaphragm 43 and secured together with a central portion of said diaphragm between said plates.

Diaphragm 52 is provided with similar plates 62 and 63 and there is an operable connection between said diaphragms, said connection comprising a pin 65 slidably disposed in the partition wall 48 of the intermediate plate 45. The top and bottom ends respectively of the pin 65 are in engagement with the plates 61 and 62, so that upward movement of the diaphragm 52 will effect a corresponding movement of the diaphragm 43 and downward movement of said diaphragm 43 will effect a corresponding movement of the diaphragm 52.

Fuel is supplied to the fuel chamber 40 by means of a pump, indicated generally at 70, said pump being of

any suitable character but being shown as a pulse pump of well known type. The pump has a fuel chamber 71 formed in the body 10 and closed at its outer side by a flexible pump diaphragm 72 which is marginally clamped between portions of the body about the chamber 71 and a cover 73. The latter has a pulse chamber 74 formed in the under side thereof opposite the fuel chamber 71, said pulse chamber being closed at its under or open side by the diaphragm 72 so that said diaphragm is responsive to pulsations in the chambers 74. In order to provide pulsations in chamber 74 there is a conduit or passageway 75 which is connected to the crankcase 70a of a two-cycle engine.

Fuel chamber 71 is connected to a suitable source of fuel by means of inlet passageway means 76 and 77, the latter terminating at its downstream end in a filter chamber 78 formed in the cover 73. The passageway 76 has one end connected with the fuel chamber 71 and the opposite end connected with a filter chamber 79 in the body 10 in alignment with the filter chamber 78, there being a filter 80 disposed in a recess provided therefor in the cover 73, said filter 80 being disposed between the filter chambers 78 and 79 for filtering the fuel passing from the inlet passage 77 to the inlet passage 76. A check valve 81 is disposed in the passageway 76 and permits fuel to enter the fuel chamber 71 but prevents reverse flow of fuel through said passage 76.

Fuel is discharged from the pump 70 by way of a conduit 82 which has a connection with a valve chamber 83 in which is operably disposed a movable valve member 84 having a conical tip 85 controlling the inlet port 86 of the valve chamber 83. Conduit 82 has a check valve 82a therein permitting flow to said valve chamber but preventing reverse flow through said conduit 82.

Means for controlling the fuel valve 84 is provided and includes a lever 87 having a U-shaped part 88 intermediate its ends, said part 88 being disposed on a pivot 89 in a recess 90 in the upper wall of the fuel chamber 40. Lever 87 includes a part 91 engaging the top plate 60 of the wet or fuel diaphragm 43. The opposite end portion 92 of the lever 87 engages a lower end of the fuel valve 84 and there is a spring 93 disposed in a recess 94 in the top wall of the chamber 40 which yieldingly urges the lever 87 in a clockwise direction and, hence, urges the valve 84 in the closing direction.

There is a main fuel discharge orifice or port 96 located between the venturi formed by the insert 20 and the throttle valve 17, said orifice being connected to the fuel chamber 40 by means of a fuel passage 97, a needle valve chamber 98 and a fuel passage 99, said needle valve chamber 98 being disposed between the passages 97 and 99.

An adjustable orifice 100 is provided between the passages 97 and 99 at the entrance to the passage 99, the sides of orifice 100 being controlled by a needle valve 101 threadably disposed in a tapped bore 102 provided therefore in the body 10, said valve 101 having a conical tip 103 which extends into the orifice 100. The opposite end of the valve 101 extends outwardly of the body 10 and is provided with an enlarged head 104 having a slot therein for reception of a tool whereby the valve 101 may be rotated to variably position the tip 103 and thereby determine the size of the orifice 100.

The carburetor also includes a secondary fuel system which includes a passage 105 from the fuel chamber 40 to a needle valve chamber 106. The latter is provided with an orifice 107 communicating with a pair of passages 108 and 109, passage 108 terminating in an idle port 110 disposed downstream of the adjacent or lower edge of the throttle valve 17 when the latter is in the closed position. Passage 109 terminates at its downstream end in a midrange port 111 disposed between the said adjacent or lower edge of the throttle valve 17 when the latter is closed and the main fuel port 96. Idle port 110 is close to the trailing edge of the throttle valve 17 when the latter is in the closed position, the midrange port 111 be-

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ing spaced somewhat further from the said edge of the throttle valve when in the closed position than the port 110.

The size of orifice 107 is adjustable by means of a needle valve 112 disposed in a tapped bore 114 provided therefor in the body 10. Valve 112 is provided with a conical tip 115 which is adjustable inwardly and outwardly of the orifice 107 to vary the size thereof, the outer end of valve 112 being provided with an enlarged head 116 disposed outside of the body 10, said head 116 being slotted to provide means for engagement by a suitable tool for actuating said valve and to thereby vary the size of the orifice 107.

Signal sensing chamber 47 has a sensing connection with the throat 120 of the venturi defined by the insert body portion 21 and the adjacent wall of the induction passage, said connection comprising a conduit 121 having one end connected with said sensing chamber 47 and the opposite end connected with a port 122 at the throat 120 of said venturi.

When the throttle valve 17 is in the idle position, as shown in FIG. 1, fuel for idling is discharged from the idling port 110 which is at the engine side of the throttle valve, such discharge of fuel for engine idling is effected while the liquid regulator, including the wet diaphragm 43, is under a sub-atmospheric condition. At this time, as the idling fuel is being discharged from the port 110, air is bled to the idling fuel passage 103 from the mid-range port 111 which is at the atmospheric side of the throttle valve when the latter is in the idling position. The strength of air-to-fuel ratio of the idling fuel mixture is determined by the adjustment of the needle valve 112. When the throttle valve is in the idling position the dry regulator, which includes the diaphragm 52, is not functioning.

As the throttle valve 17 is initially moved from the idling position to expose the port 111 to suction from the engine, there is a very low air flow condition so that there is no signal at the port 122, fuel being discharged from the port 110 and 111 to take care of the idling of the engine and the midrange transition as the throttle valve is moved further in the opening direction.

Upon such further opening movement of the throttle valve the engine speed increases accordingly so that there is an increase in air flow through the induction passage. This increase in air flow is sensed by the port 122 and the signal thus sensed is transmitted to the signal sensing or pressure chamber 47 to thereby effect upward movement of the dry diaphragm 52. Upward movement of the diaphragm 52 is simultaneously transmitted through the pin 65 to the wet diaphragm 43. The liquid regulator, including the diaphragm 43, then changes from a subatmospheric to a positive pressure liquid regulator.

As the result of the signal from the port 122 and the upward movement of the diaphragms, fuel begins to be discharged from the main fuel nozzle or port 96 and the fuel-air ratio begins to assume the straight line function required for good performance and the engine will respond quickly to demand for power.

As the throttle valve is opened to the wide open position fuel is discharged from the main nozzle or port 96, the midrange port 111 and the idling port 110 at a positive pressure or atmospheric pressure so that the carburetor is then operating as a full pressure system.

It will be apparent from the foregoing that the present system or device utilizes mass flow metering, that is the air-fuel ratio by weight is proportional to the square root of the ratio of air pressure drop at the venturi throat, that is venturi pressure to fuel pressure drop at the nozzle orifice.

It should be noted that the pressure drop across a high efficiency venturi is negligible when used at its designated air-flow value, and the incompressible fluid-flow equation can be used for both the air and fuel flows, thus providing a sound metering system.

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Further, due to the instantaneous response of the system to changes in air flow the fuel-air ratio remains constant, whereas in a conventional carburetor when the throttle is opened for acceleration, there is a lag in fuel delivery due primarily to inertia of the fuel which in many cases makes it necessary to equip the carburetor with an acceleration pump. In the present case an acceleration pump is not required.

As the throttle is moved in the closing direction the reverse order of functioning occurs.

A fuel enrichment device or primer, indicated generally at 130, is provided and comprises a cylinder 131 formed in the cover 73 which is connected to the fuel chamber 71 of the pump by means of a conduit 132, the end of said conduit connected with the cylinder 131 is connected thereto intermediate the ends thereof at a substantially central point. There is a check valve 133 in the connection 132, said check valve being disposed in an enlarged valve chamber 134 and permits flow of fuel into the cylinder 131 through conduit 132 but prevents reverse flow through said conduit.

Fuel from cylinder 131 is discharged through an outlet passage 135 which leads to a primer nozzle, not shown, discharging into the crankcase 70a of the engine to which the carburetor is attached. Fuel is adapted to flow from the cylinder 131 into the crankcase but is prevented from return flow by a check valve 136 disposed in a valve chamber 137 forming a part of the fuel discharge or outlet passage of the primer.

At the end of the cylinder opposite the discharge end there is normally disposed a piston 140 of any suitable material and construction, said piston being shown as formed of plastic and being cup-shaped with the open end facing the discharge end of cylinder 131. It is to be noted that the material of the piston is somewhat flexible and that the free edge 141 slidably engages the wall of the cylinder 131. Means for actuating piston 140 comprises a stem 142 slidably disposed in a bore 143 provided therefor in the cover 73. Stem 141 extends outwardly of said cover and is provided with an enlarged head 144 which comprises a pressure member engageable by the thumb, or the like, of the operator to force the piston 140 toward the discharge end to thereby effect a discharge of priming fuel into the crankcase. The piston is urged in the opposite direction by a spring 145 which reacts between the discharge end of cylinder 131 and the piston 140.

While the primary function of the primer 130 is to discharge fuel into the crankcase of the engine to thereby enrich the fuel mixture delivered to the engine cylinder or cylinders, it is to be noted that when the piston is moved to the normal position by spring 145 fuel is drawn from the fuel chamber 71 of the pump and also through the passage 77, filter chamber 79 and passage 76, so that these passages and chamber are filled with fuel and there is an immediate supply of fuel to the carburetor nozzle or orifices to supply the engine with a proper fuel mixture.

The invention and its attendant advantages will be understood from the foregoing description and it will be apparent that various changes may be made in the form, construction and arrangement of the parts of the invention without departing from the spirit and scope thereof or sacrificing its material advantages, the embodiment hereinbefore described being merely for purposes of illustration.

I claim:

1. In charge forming apparatus:

(A) means defining an induction passage having an air inlet section and a mixture outlet section;

(B) an insert removably disposed in the air inlet of said induction passage to define, with the adjacent portion of the induction passage, a venturi, said insert including

(a) a hollow elongated body portion,

(b) said body having a curved inward taper,

- (c) and being offset downwardly relative to the axis of the induction passage so that the most restricted part of the throat of said venturi is at the bottom of the induction passage,
 - (d) said body presenting a streamlined exterior with the smaller end within the induction passage and the larger end spaced outwardly of the air inlet opening of the air inlet section,
 - (e) the outer end of said body curving outwardly,
 - (f) a flange on the outer end of said body and arranged axially of said induction passage,
 - (aa) said flange extending radially outwardly and normal to the axis of the body,
 - (bb) but offset from the body axis so as to be eccentric relative to the body with the wider part of the flange at the top and the smaller part at the bottom,
 - (cc) the diameter of said flange being somewhat greater than the diameter of the air inlet of the induction passage;
 - (g) means for positioning the insert within the induction passage, comprising
 - (aa) a plurality of radially arranged and spaced vanes on the body,
 - (bb) said vanes extending longitudinally of the body and hence lengthwise in the induction passage and spaced substantially 120° apart,
 - (cc) the outer ends of said vanes being joined to said flange,
 - (dd) the major portion of each vane extending within the induction passage,
 - (ee) said vanes having shoulders engageable with the edge portion of the air inlet to limit inward movement of said insert,
 - (ff) a throttle stop extending inwardly from the inner end of the body of the insert;
 - (h) means releasably securing said insert in said induction passage;
 - (C) a butterfly throttle valve operably mounted in the induction passage downstream of the insert,
 - (a) said throttle stop extending into the path of the trailing edge of said throttle valve;
 - (D) fuel supply means, including
 - (a) a first movable wall, defining a fuel chamber
 - (aa) having a fuel inlet;
 - (E) signal sensing means, including a second movable wall,
 - (a) defining a signal pressure sensing chamber connected with the most restricted part of the venturi throat;
 - (F) means operably interconnecting said movable walls;
 - (G) and means controlled by the first movable wall for controlling the inflow of fuel into said fuel chamber, said induction passage having
 - (a) a main fuel port,
 - (b) a midrange fuel port,
 - (c) and an idle fuel port,
 - (d) said ports being connected with said fuel chamber,
 - (e) said main fuel port being adapted to discharge fuel into the induction passage between said venturi throat and the throttle valve,
 - (f) said midrange port being between said main port and the throttle valve,
 - (g) and said idle fuel port being adapted to discharge idling fuel into the induction passage downstream of and closely adjacent to said throttle valve.
2. In charge forming apparatus:
- (A) means defining an induction passage having an air inlet section and a mixture outlet section;
 - (B) an insert removably disposed in the air inlet of said induction passage to define, with the adjacent

portion of the induction passage, a venturi, said insert including

- (a) a hollow elongated inwardly tapering body portion,
 - (b) said body being offset downwardly relative to the axis of the induction passage so that the throat of said venturi is smaller at the bottom of the induction passage,
 - (c) said body having its smaller end within the induction passage and the larger end spaced outwardly of the air inlet opening of the air inlet section,
 - (d) a flange on the outer end of said body,
 - (e) arranged axially relative to said induction passage,
 - (aa) said flange being offset from the body axis so as to be eccentric relative to said body,
 - (bb) the diameter of said flange being somewhat greater than the diameter of the air inlet of the induction passage;
 - (f) means for positioning the insert within the induction passage comprising
 - (aa) a plurality of vanes on the body spaced substantially 120° apart,
 - (bb) said vanes extending lengthwise in the induction passage,
 - (cc) the outer ends of said vanes being joined to said flange,
 - (dd) means limiting inward movement of said insert,
 - (g) means releasably securing said insert in said induction passage;
 - (C) a throttle valve operably mounted in the induction passage downstream of the venturi;
 - (D) means, including a first movable wall, defining a fuel chamber having a fuel inlet;
 - (E) means, including a second movable wall, defining a signal pressure sensing chamber connected with the smallest part of the venturi throat;
 - (F) means operably interconnecting said movable walls;
 - (G) and means controlled by the first movable wall for controlling the inflow of fuel into said fuel chamber,
 - (H) said induction passage having
 - (a) a main fuel port,
 - (b) a midrange fuel port,
 - (c) and an idle fuel port,
 - (d) said ports being connected with said fuel chamber,
 - (e) said main fuel port being adapted to discharge fuel into the induction passage between said venturi and the throttle valve,
 - (f) said midrange port being between said main port and the throttle valve,
 - (g) and said idle fuel port being adapted to discharge idling fuel into the induction passage downstream of and closely adjacent to said throttle valve.
3. In charge forming apparatus:
- (A) means defining an induction passage having an air inlet section and a mixture outlet section;
 - (B) an insert removably disposed in the air inlet of said induction passage to define, with the adjacent portion of the induction passage, a venturi, said insert including
 - (a) a hollow elongated inwardly tapering body portion,
 - (b) said body being offset relative to the axis of the induction passage so that the throat of said venturi is smaller at one part of the induction passage,
 - (c) said body having its smaller end within the induction passage and the larger end spaced

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- outwardly of the air inlet opening of the air inlet section,
 (d) a flange on the outer end of said body,
 (e) arranged axially relative to said induction passage,
 (aa) said flange being offset from the body axis so as to be eccentric relative to said body,
 (bb) the diameter of said flange being somewhat greater than the diameter of the air inlet of the induction passage;
 (f) means for positioning the insert within the induction passage comprising
 (aa) a plurality of vanes on the body spaced annularly apart,
 (bb) said vanes extending lengthwise in the induction passage,
 (cc) the outer ends of said vanes being joined to said flange
 (dd) means limiting inward movement of said insert,
 (g) means releasably securing said insert in said induction passage;
 (C) a throttle valve operably mounted in the induction passage;

- (D) said induction passage having
 (a) a main fuel port,
 (b) a midrange fuel port,
 (c) and an idle fuel port;
 (E) and means for supplying fuel to said fuel ports.

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