

Sept. 2, 1969

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3,464,803

VARIABLE VENTURI CARBURETOR

Filed March 30, 1966

2 Sheets-Sheet 1

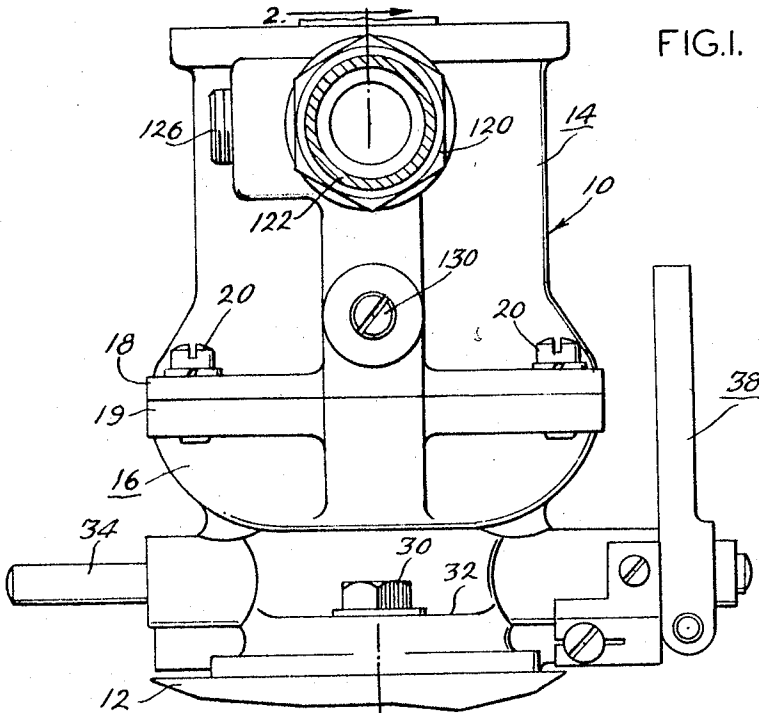


FIG. 1.

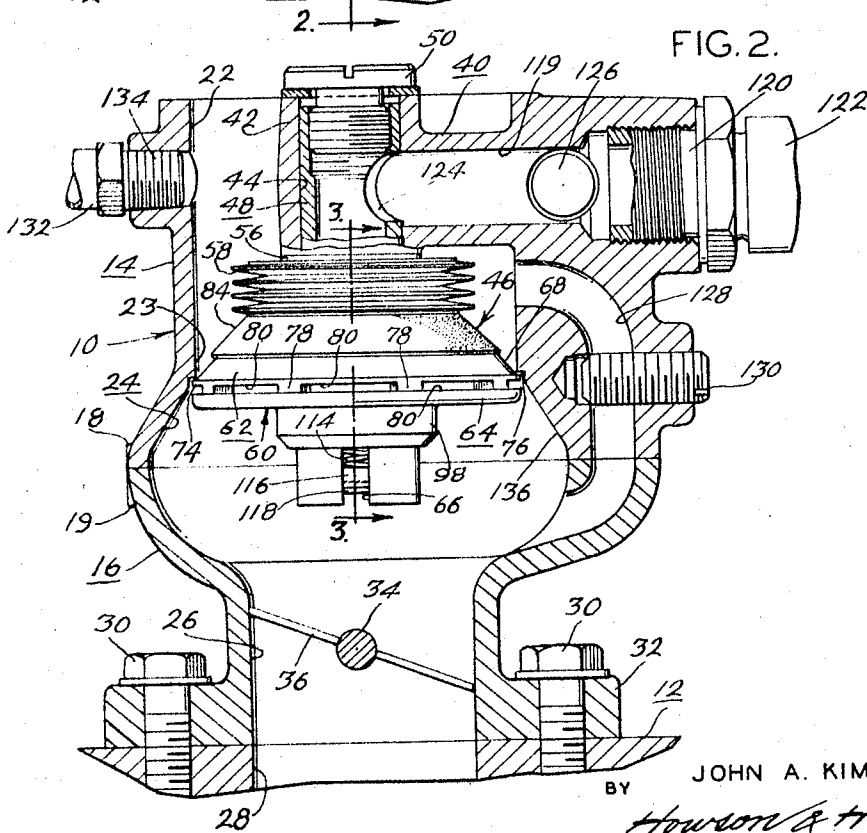


FIG. 2.

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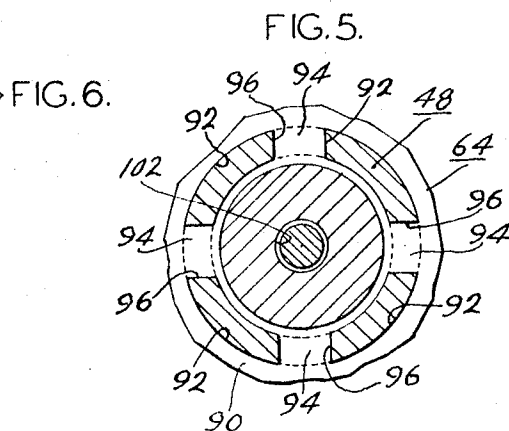
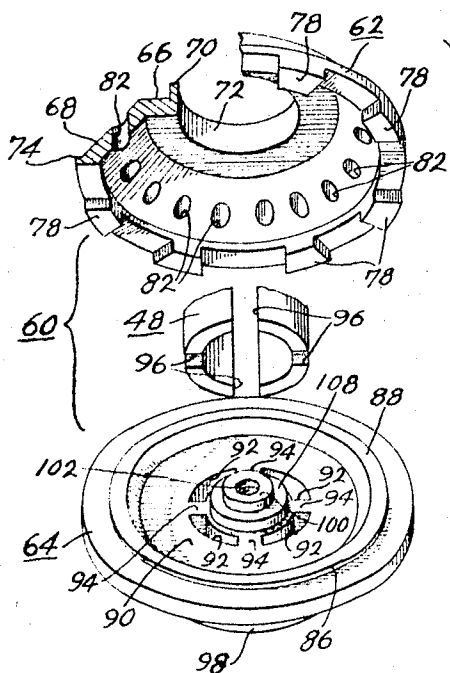
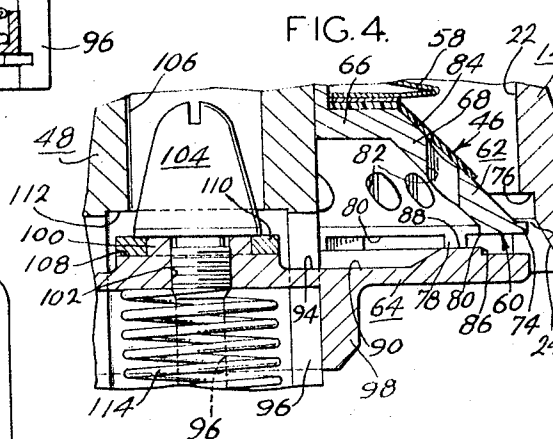
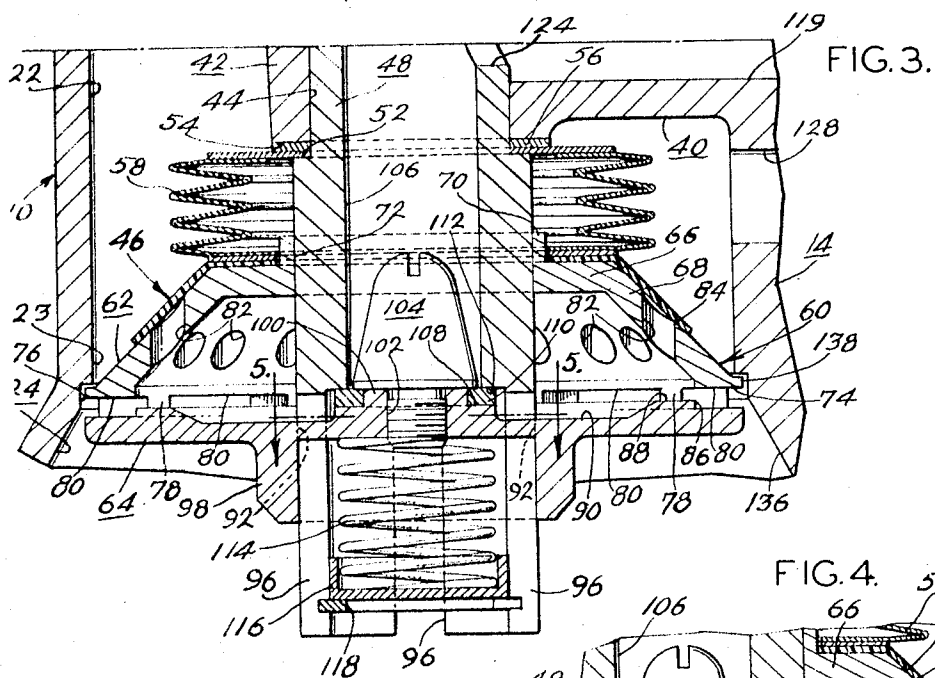
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2 Sheets-Sheet 2



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VARIABLE VENTURI CARBURETOR

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Filed Mar. 30, 1966, Ser. No. 538,808

Int. Cl. F02m 9/14

U.S. Cl. 48—180

11 Claims

ABSTRACT OF THE DISCLOSURE

A variable venturi carburetor with a gaseous fuel distribution means which allows for the uniform distribution of a fuel into an annular region of high velocity laminar air flow, located around the periphery of the venturi just below the venturi throat, with means to prevent backfire damage to the carburetor.

The present invention relates to an improved variable venturi carburetor of the type adapted for supplying a gaseous fuel and air mixture to an internal combustion engine.

A number of mixing devices have been previously developed for mixing air and a pressurized gaseous fuel, such as liquefied petroleum gas. These devices are commonly characterized by a fuel valve coupled to and controlled by a main valve element in the venturi, the position of which is dependent on the pressure differential across the venturi. In the typical device, the fuel is introduced into the air flow in a region well downstream of the venturi where the air velocity is relatively slow. Mixing of the gaseous fuel is understandably less thorough in such a slow air flow than in a high velocity flow such as in the venturi region. However, introduction of the fuel gas at or near the venturi is likely to cause an undesirable turbulent flow condition at the venturi which would impair the carburetor efficiency. A turbulent venturi flow furthermore results in an unstable condition of the venturi valve, characterized by an oscillating or fluttering action of the valve and a consequently non-uniform flow of fuel-air mixture to the engine.

The present invention provides an optimum mixing of the gaseous fuel into the air stream by uniformly distributing the fuel into an annular region of high velocity laminar air flow just below the venturi throat. The novel cooperating shapes of the flow chamber and venturi valve insure a laminar air flow through the venturi throat over the full range of operating conditions and maintain the primary pressure drop and hence the maximum air velocity at the venturi throat. The chamber and venturi valve structures and the novel manner in which the fuel is distributed just below the venturi throat provide a thorough mixing of the fuel and air while holding the pressure drop through the carburetor to a minimum.

It is accordingly a primary object of the present invention to provide a variable venturi carburetor for accurately metering and thoroughly mixing a gaseous fuel into an air flow over a wide range of operating conditions.

A further object of the invention is to provide a carburetor as described adapted to effect a uniform distribution of the gaseous fuel into an annular high velocity laminar air flow just below the venturi throat.

Another object of the invention is to provide a carburetor as described having a novel flow chamber and venturi valve adapted to maintain a continuous laminar air flow through the venturi throat regardless of variations in the flow rate through the venturi.

An additional object is to provide a carburetor of the type described having means in the venturi valve to prevent backfire damage to the carburetor.

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A still further object is to provide a carburetor of the type described of a simplified design which may be inexpensively manufactured.

Additional objects and advantages of the invention will be more readily apparent from the following detailed description of an embodiment thereof when considered with the accompanying drawings wherein:

FIG. 1 is a side elevational view of a carburetor embodying the present invention;

FIG. 2 is a sectional view taken along line 2—2 of FIG. 1 showing the carburetor with the venturi valve in the closed position;

FIG. 3 is an enlarged view taken along line 3—3 of FIG. 2 showing details of the venturi valve and the fuel gas valve;

FIG. 4 is a partial view similar to FIG. 3 showing the venturi valve and fuel valve in an open position;

FIG. 5 is a sectional view taken along line 5—5 of FIG. 3 showing the slots in the lower end of the valve tube; and

FIG. 6 is an exploded perspective view showing details of the upper and lower venturi valve elements and including between the elements a fragmentary view of the slotted valve tube lower end.

Referring to the drawings and particularly FIGS. 1 and 2, a variable venturi carburetor generally designated to embodying the present invention is shown mounted on the intake manifold 12 of an internal combustion engine (not shown). The carburetor comprises upper and lower housing members 14 and 16 which are joined along their respective flanged edges 18 and 19 by screws 20. The upper housing member includes an upwardly opening vertical cylindrical air intake channel 22 which connected at its lower end 23 with a coaxial bowl-shaped mixing chamber 24, the lower portion of which is formed by the lower housing member.

The mixing chamber communicates downwardly with the coaxial cylindrical throttle chamber 26 which connects with the intake passage 28 of the engine intake manifold 12. As shown in FIG. 2, the carburetor is mounted on the intake manifold by means of screws 30 passing through a flanged base 32 of the lower housing member. A throttle shaft 34 passing transversely through the throttle chamber 26 rotatably supports the throttle butterfly plate 36, the position of which is controlled in a conventional manner by the lever assembly 38 connected to the engine throttle linkage (not shown).

Extending transversely into the air intake channel 22 from the side wall thereof is the hollow valve support member 40 which terminates in a valve support head 42 having a vertical bore 44 coaxial with the air intake channel 22. A valve assembly 46 depends from the valve support member 40, extending axially along the air intake channel and into the mixing chamber. The valve assembly 46 includes a valve tube 48, the upper end of which is secured within the bore 44 of the support head 42 by the retaining screw 50 which is screwed into an interiorly threaded portion of the valve tube. Tightening of the screw 50 draws annular shoulder 52 of the valve tube upwardly toward the annular seat 54 on the lower end of the support head 42 as shown in FIG. 3. A gasket 56 and the upper end of a bellow assembly 58 are clamped between the shoulder 52 and annular seat 54 upon tightening of the screw 50 to secure the valve tube rigidly to the support head.

A hollow venturi valve 60 slidable on the valve tube below the shoulder 52 is formed of upper and lower venturi valve elements 62 and 64 which are most clearly illustrated in the exploded view of FIG. 6. The upper valve element 62 has a hollow frusto-conical configuration including an annular land portion 66 extending radially from the valve tube and having a depending down-

wardly inclined skirt portion 68. The land portion 66 includes an annular neck 70 having a bore 72 adapted for sliding engagement with the valve tube 48. The conical surface of the skirt portion 68 terminates in a radially projecting lip 74 which cooperates with the slot 76 at the lower end 23 of the air intake channel to substantially close the channel in the position of the valve shown in FIG. 3. Depending in circumferentially spaced relation from the lower edge of the skirt portion 68 beneath the lip 74 are a plurality of spacing elements 78 which define, in cooperation with the lower valve element 64, a plurality of fuel distribution ports 80 around the periphery of the venturi valve.

The skirt portion 68 includes a plurality of spaced backfire relief ports 82 over which is provided a backfire relief flap 84 of rubber or other suitable elastic material, the flap being secured by cement to the land portion 66 of the upper valve element. The flap extends downwardly along the skirt portion 68 a distance sufficient to cover the backfire relief ports 82 and is held against the skirt portion to seal the ports 82 during normal operation of the carburetor by the air flow through the air channel. The lower end of the above mentioned bellows assembly 58 is fastened over the backfire relief flap on the land portion 66 and serves to seal the slidable valve on the valve tube as well as provide a damping of the valve as discussed hereinafter.

The lower valve element 64 is a generally disc shaped member having a peripheral groove 86 formed by the annular shoulder 88 in which the spacing elements 78 of the upper valve element are seated to form the fuel distribution ports 80. The inner side of the shoulder 88 slopes downwardly to a floor 90 through which pass the axially centered arcuate slots 92 as shown most clearly in FIG. 6. The slots 92 are separated by radial webs 94 which are adapted for slidable engagement in the slots 96 of the lower end of the valve tube 48. An annular guide flange 98 aligned with the slots 92 depends from the lower face of the lower valve element for sliding co-action with the valve tube.

The floor 90 of the lower valve element 64 is elevated within the arcuate slots 92 to form a fuel valve platform 100, into the axial threaded bore 102 of which is screwed the fuel valve 104 as shown in FIG. 4. The valve 104 has an upwardly tapering shape and at its widest point at its base is slightly smaller in diameter than the bore 106 of the valve tube into which it extends. An annular groove 108 in the platform 100 beneath the periphery of the valve 104 supports a resilient valve gasket 110 which, in the closed position of the venturi valve shown in FIG. 3, is adapted to coact in sealing contact with an annular valve seat 112 of the valve tube formed by a shoulder in the valve tube. A compression spring 114, seated on spring retainer 116 secured in the lower end of the valve tube by retaining ring 118, urges the venturi valve upwardly to maintain the sealed condition of the fuel valve when the venturi valve is in the closed position.

With reference to FIG. 2, the hollow valve support member 40 includes a horizontal fuel passage 119 which is connected by means of a suitable threaded connector 120 with a fuel conduit 122 leading to a suitable source of pressurized gaseous fuel. The passage 119 of the valve support member communicates with the bore of the valve tube 48 through an aperture 124 in the valve tube. A fuel adjusting screw 126 is provided in the passage 119 to control the fuel flow into the carburetor.

An idle bypass conduit 128 is provided in the upper and lower housing members connecting the air intake channel 22 at a point above the venturi valve with the lower region of the mixing chamber 24. An idle adjusting screw 130 in the upper housing member passes through the conduit 128 permitting adjustment of the air bypassed therethrough during idling operation of the carburetor.

A balance line 132 is threadedly connected to the upper housing member at 134 in communication with the air intake channel and connected to a fuel pressure regulator unit (not shown) to provide a conventional atmospheric pressure balancing of the regulator.

During operation of the carburetor, the engine produces a below atmospheric pressure in the mixing chamber 24, thereby causing a pressure differential to act on the venturi valve which moves the valve along the valve tube against the force of the spring 114. As shown in FIG. 4, a downward displacement of the venturi valve lowers the lip 74 of the upper valve element from the slot 76 of the air intake channel and disposes the lip in a spaced disposition from the conically flared wall 136 of the mixing chamber 24. The annular opening 138 between the lip and the mixing chamber wall comprises the variable area venturi throat of the carburetor through which air is drawn from the air intake channel by the pressure differential. As the engine throttle linkage is selectively actuated to vary the engine output, the butterfly plate 36 is rotated to vary the pressure in the mixing chamber, which may range from the low engine intake manifold pressure at full throttle to a pressure close to atmospheric pressure during idling. The venturi valve is correspondingly repositioned for each throttle setting in accordance with the pressure differential across the venturi throat thereby advantageously maintaining a high velocity air flow through the venturi throat regardless of the engine operating conditions. The position of the variable venturi valve at any time is thus a direct function of the air demand of the engine. The frusto-conical shape of the upper venturi valve element in conjunction with the cylindrical shape of the air intake channel and the conically flared wall of the mixing chamber serves to maintain a laminar flow condition of the air passing into and through the venturi throat thus preventing an undue oscillation or "fluttering" of the venturi valve and minimizing the pressure drop across the carburetor. The bellows assembly 58 provides a damping of the valve should oscillations develop during transient flow conditions.

The pressurized gaseous fuel passes into the valve assembly 46 through the passage 119 and valve tube bore 106, the fuel adjusting screw 126 being initially adjusted in accordance with the heating value of the fuel employed. When the venturi valve is axially displaced, such as shown in FIG. 4, the fuel valve is displaced relative to the valve seat 112 permitting the pressurized fuel to pass into the interior of the hollow venturi valve from which it passes through the fuel distribution ports 80 into the laminar air flow in the venturi region just below the venturi throat. Because of the substantial peripheral area of the fuel distribution ports, the gaseous fuel is distributed evenly into the thin high velocity air flow with very little stratification.

Due to the tapered shape of the valve 104, the fuel passing through the valve tube around the valve is accurately metered in accordance with the air flow around the venturi valve so that the fuel delivered will be proportionate to the air flow regardless of the demands of the engine. When the engine is stopped, the pressure in the mixing chamber returns to atmospheric pressure and the venturi valve is moved by the spring 114 into the closed position shown in FIG. 3 wherein the resilient gasket 110 is moved into sealing contact with the valve seat 112 to shut off the flow of pressurized fuel. It will be noted that in this sealed condition of the fuel valve, the lip 74 of the venturi valve does not seat against the slot 76 of the upper housing member but remains slightly spaced therefrom to insure a tight seating of the fuel valve.

During operation of the carburetor, the fuel passing through the fuel distribution ports 80 into the laminar air flow just below the venturi throat is, as described above, uniformly distributed into the air flow and is subsequently

mixed with the air in the turbulence resulting from the expansion of the air and fuel in the mixing chamber 24. The expansion of the air in this region and the necessary funnelling of the mixture into the restricted throttle chamber produces a desirable turbulence which, while effecting a thorough mixing of the air/fuel mixture, does not add an appreciable pressure drop to the system. The smoothly curved lower region of the mixing chamber leading into the throttle chamber permits flow through this region with a minimum drag.

The bellows assembly 58 as described above serves to prevent valve flutter and also shields the valve tube slide surface from contamination. In addition, the bellows serves during acceleration and deceleration of the engine to delay the venturi valve response a sufficient amount to provide a desirable enrichment of the charge during acceleration and a reduction during deceleration. During acceleration, the dragging action of the filling bellows slows the response of the venturi valve, resulting in a substantially lower mixing chamber pressure than would result from the same throttle setting under steady operation. The lower mixing chamber pressure causes a correspondingly greater pressure drop across the fuel valve which produces a fuel enrichment until the venturi valve reaches its balanced position.

Conversely, during deceleration, the lag of the venturi valve produces a higher than normal mixing chamber pressure while the bellows is emptying, resulting in a lower pressure drop across the fuel valve and a decreased fuel delivery. A separate acceleration device and fuel economizer circuit are thus unnecessary in view of the described bellows action.

The bellows in expanding fills with gaseous fuel which passes thereinto between the slide surfaces of the valve tube and the upper valve element. To maintain a constant bellows damping action under a variety of temperature conditions, it is essential that the valve assembly elements be formed of a temperature stable material. A preferred material for this purpose is a self-lubricating plastic having suitable strength and stability characteristics.

A further advantage of the present carburetor structure is its self-choking capability. The lip 74, on moving downwardly in the slot 76 during cranking of the engine, does not enlarge the venturi throat until the lip is opposite the conically flared wall 136 of the mixing chamber as shown in FIG. 4. The fuel valve opening, however, is substantially enlarged by a small axial displacement of the valve 104 and a substantially enriched mixture accordingly results automatically during the cranking period. Since the fuel pressure is above ambient at the fuel valve, an immediate flow of fuel gas passes into the venturi upon cranking of the engine, resulting in prompt engine starting.

In the event of engine backfire, the carburetor is protected from damage by the backfire relief ports 82 in the upper valve member 62. A backfire pressure wave closes the venturi valve, passes into the hollow valve through the fuel distribution ports, and passes out through the relief ports 82 into the air intake channel, the resilient flap 84 being raised momentarily upwardly from the skirt portion 68. Following the backfire, the flap returns to its former position against the skirt portion and the carburetor operation continues in the normal manner.

From the above it can be understood that the present invention provides, in a relatively simple structure, a versatile, compact and efficient gaseous fuel carburetor. In view of the efficiency of the variable venturi, a single carburetor size can be employed with a wide range of engine sizes without sacrificing engine performance.

Manifestly, changes in details of construction can be effected by those skilled in the art without departing from the spirit and scope of the invention as defined in and limited solely by the appended claims.

I claim:

1. In a variable venturi carburetor for mixing air and a gaseous fuel comprising housing means defining an air

intake channel opening into a mixing chamber, the juncture of said channel and said chamber comprising the venturi throat of the carburetor, a valve assembly disposed within said housing means, said valve assembly including a venturi valve axially movable within said venturi throat, means resiliently mounting said valve adapted to position said valve in said venturi throat in accordance with the pressure differential across said valve, fuel inlet conduit means for conducting a gaseous fuel into said valve assembly, and fuel valve means adapted for metering fuel into said assembly in accordance with the position of said venturi valve, the improvement comprising fuel distribution means for uniformly distributing the fuel into the high velocity laminar air flow just below the venturi throat at any position of the valve, said distributor means comprising a mixing chamber having a conically flaring wall cooperating with said venturi valve to define a venturi passage, and fuel conduits communicating with said fuel inlet conduit means and opening uniformly around the periphery of said valve just below and immediately adjacent said venturi passage whereby fuel is introduced into the air flow of maximum velocity at any operative position of the valve.

2. The invention as claimed in claim 1 including damping means connected with said venturi valve adapted to prevent oscillation of said valve and providing a delayed response of said valve to changes in the pressure differential across said venturi throat to provide a fuel enrichment during an increase in the pressure differential and a decrease in fuel delivery during a decrease in the pressure differential.

3. The invention as claimed in claim 1 including backfire relief means in said valve assembly, said backfire relief means comprising relief ports in said venturi valve and means associated with said relief ports permitting fluid flow from said mixing chamber into said air intake channel but preventing fluid flow through said ports in the opposite direction.

4. A variable venturi carburetor for mixing air and a gaseous fuel comprising housing means defining a cylindrical air intake channel opening into a coaxial bowl-shaped mixing chamber, the juncture of said channel and said chamber comprising the venturi throat of said carburetor, a valve assembly disposed within said housing means, said valve assembly including a hollow venturi valve axially movable within said venturi throat to provide a variable venturi air passage, means resiliently mounting said venturi valve adapted to position said valve in said venturi throat in accordance with the pressure differential across said valve, fuel inlet conduit means for conducting a gaseous fuel under pressure into said hollow venturi valve, a fuel valve coupled with said venturi valve for metering fuel into said venturi valve through said fuel inlet conduit means in accordance with the axial position of said venturi valve, a conically flaring wall of said mixing chamber cooperating with the periphery of said venturi valve to define the variable venturi air passage, and a plurality of fuel distribution ports uniformly disposed around the periphery of said venturi valve just below and adjacent to said venturi passage adapted to uniformly distribute fuel from said hollow valve into the high velocity laminar air flow immediately below the venturi passage at any operative position of the valve.

5. The invention as claimed in claim 4 including damping means connected with said venturi valve adapted to prevent undue oscillation of said valve and providing a delayed response of said valve to changes in the pressure differential across said venturi throat to provide a fuel enrichment during an increase in the pressure differential and a decrease in fuel delivery during a decrease in the pressure differential.

6. The invention as claimed in claim 5 wherein said damping means comprises a bellows assembly connected to said venturi valve.

7. The invention as claimed in claim 4 including backfire relief means in said valve assembly, said backfire

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relief means comprising relief ports in said venturi valve and means associated with said relief ports permitting fluid flow from said mixing chamber into said air intake channel but preventing fluid flow through said ports in the opposite direction.

8. The invention as claimed in claim 7 wherein said means associated with said relief ports comprises a resilient flap hingedly secured over said port.

9. The invention as claimed in claim 4 wherein in the non-operating condition of said carburetor said fuel valve is closed in sealing relation to insure against pressurized fuel leakage, the venturi valve being substantially closed but slightly spaced from the housing means at the venturi throat.

10. The invention as claimed in claim 4 including means providing an automatic choking of said carburetor, said means including means for substantially opening said fuel valve upon an initial displacement of said venturi valve prior to a substantial opening of said annular venturi throat air flow path.

11. The invention as claimed in claim 4 wherein said venturi valve has a frusto-conical configuration with the larger diameter thereof extending into said mixing cham-

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ber, the variable annular air flow of the venturi throat being formed between said larger diameter of said venturi valve and the conically flared wall of said mixing chamber immediately below said air intake channel, the shape of said venturi valve and mixing chamber insuring a laminar air flow through the venturi throat and in the fuel distribution region just below the venturi throat.

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