The principal object of the invention is to produce a fuel vapor and air mixing device for internal combustion engines whereby the air and liquid fuel particles comprising the fuel mixture are brought into desired intimate contact after issuing from a carburetor whereby better combustible mixture is obtained for consumption in the cylinders of the engine.

Another object is to control the flow of the mixture in such a manner that undesirable vortices and eddy current are eliminated, thereby improving the quality, maintaining the improved quality of the vapor mixture in varying quantities as desired.

Other objects are to improve fuel economy; to reduce the accumulation of unconsorbed deposits from partial combustion; and to generally improve vaporization of the liquid fuel to create a totally combustible mixture.

This invention contemplates the incorporation of a simple, efficient and easily installed Venturi tube of special design in the low pressure zone of and in the intake manifold located between the carburetor throttle valve and the intake valves of an internal combustion engine.

A further object of the invention is to provide a specially constructed throttle valve operative in connection with the aforesaid Venturi tube, to further improve mixture stability and to automatically maintain a substantially constant velocity of the mixture in its passage through the exit zone of said Venturi tube; and to provide means whereby the desired exit velocity of the mixture is maintained substantially throughout the entire working and speed range of the engine; and to eliminate condensation of the mixture on and around the throttle valve and in the walls of the intake manifold.

Figure 1 is a vertical sectional view through a portion of a carburetor and intake pipe, with one form of the invention applied.

Figure 2 is an enlarged sectional view of a portion thereof, with modified intake passage.

Figure 3 is a horizontal section there through, Figure 4 is an enlarged view showing the valve and a fragment of the Venturi tube in side elevation.

Figure 5 is a vertical section view of a modification.

Figure 6 is a view similar to Figure 3 of the modification.

Figure 7 is a vertical sectional view of the Venturi tube with critical dimensions applied.

Figure 8 is a vertical sectional view of a fragment of the Venturi tube with throat sections bent to closed positions.

Figure 9 is a vertical sectional view of a modification.

Figure 10 is a horizontal view through its Venturi tube.

Figure 11 is a diagrammatical view illustrating principles of Figures 2 and 9, and Figure 12 is a horizontal cross section of the valve stem of Figure 9.

In the drawings, reference numeral 1 designates a portion of an internal combustion engine, 2 an intake port thereof, and 3 a standard type of carburetor, including among other usual parts, a main discharge nozzle 4, main metering restriction 5, valve seat and orifice 6, valve 7, accelerating pump 8, step up passage 9, idling discharge holes 10 and air bleed opening 11, substantially as set forth in Patent 1,909,389.

The carburetor communicates with the intake port 1' by means of an intake pipe 12 attached to said intake pipe by bolts 14 passing through flanges 15 of the latter and threading into flanges 16 of the former. Between these flanges are clamped a pair of gaskets 17 and between the latter is clamped a thin metal gasket 18 to the bore of which is permanently affixed the base of a Venturi tube 19. The conical approach 21 of the venturi forms an angle of substantially 60° with its base, and the rounded approach 22 to the exit portion 23 is formed on a radius of substantially 6 of the throat diameter. The length of the exit portion 23 is not less than three fourths of the mean throat diameter. These relative dimensions go to make up the novel venturi for preventing the building up of a flow restricting vortex in the inlet cone by preventing an excessive amount of spinning of the gas vapor at high velocity, thus increasing the flow capacity of the tube. An active vortex would retard velocity and upset a constant discharge coefficient.

While the walls of the Venturi exit portion 23 are normally parallel, provision is made for bending the walls thereof inwardly or outwardly, this being permitted by V-shaped slots 24 providing intermediate throat sections 25. Bending the exit portion sections 23 inwardly, thereby closing the slots 24, tends to decrease the exit area, and bending the exit sections outwardly opens the slots 24 and decreases the vortex and increases the exit area.

The slots 24 provide openings to permit the gradual expansion of the mixture stream and also provide means to sever the liquid particles to...
make more homogenous the mixture, diffusing
the fuel particles in the vapor mixture more readily. The slots also form individual eddy currents that are helpful in keeping the stream at the discharge side, by flattening out the ever-present vortex which is never entirely eliminated, and which vortex is at a right angle to said eddy currents.

Drill holes 25 in the venturi of the juncture of the exit sections 23' and the rounded throat or approach portion tend to prevent fracture of the sections during bending thereof, and also assure openings even when the slots 24 are entirely closed, thereby preventing an excessive amount of fuel liquid being pocketed in the well 26.

The Venturi tube described may be employed alone, as illustrated through Figure 5, in which case the usual throttle valve 28 is employed, and the feed of the carbureter, the reference character "2" is adjusted by changing the main metering discharge nozzle 3 to a smaller output and otherwise reducing the liquid fuel supply according to the particular type of carbureter. Thus economy in fuel consumption is obtained through the use of the particular Venturi choke tube 20 and through readjustment of the carbureter.

Further mixture economy with greater power, may be obtained by elimination of the conventional throttle valve 36 in cooperation with the venturi 20, and extension of the step up passage by means of a tube 8' from the previous low pressure side to the new position of low pressure formed by use of throttling valve 36, together with recalcitrance of the carbureter and formation of the stroke of the accelerating pump 7 and size of the valve seat orifice 4.

In eliminating the conventional throttle valve, a lever 31 is substituted therefor and a link 32 extends through the Venturi tube 20 through a drill hole 33. The link rod 32 is free to slide within the drill hole but is confined from detachment from the valve 30 by a head 34. The drill holes 33 extend parallel with the valve axis and are formed at the inner ends of V-shaped slots 35 on the conical skirt of the valve, thereby providing bendable valve sections 30' which may be bent inwards or outwards to close or open the slots 35 as in the case of the Venturi tube. Opposite side edges of each valve section 30' are similarly beveled as at 35' to produce mixture spinings.

The hub 35 of the valve is centrally bored, the bore expanding Venturi-like at its bottom and upper ends 37, 38 respectively, lugs 39 being disposed at intervals in the Venturi-Face 38 to engage the bottom face of the adjusting nut 40 to prevent closing of the Venturi passage between the surface 38 and the nut 40. A coil spring 41 encircles the nut 40 and the hub of the valve, and is held by its upper end 41 passing through the nut and engaging a flute of the stem 42 upon which the nut is threaded. The lower end of the spring bears against the valve 30 in the crotch between its conical skirt and its hub.

The nut 40 is adjustable threaded upon the upper end of a fluted stem 42' which is cruciform in cross section and which is formed on its lower end with radial spider arms 42, having their outer edges clinched into slots 45 provided for this modification in the base of the venturi 20. The spider arms 42 also have shoulders 44 conforming to and engaged with the conical approach 21 of the venturi to assist in maintaining the guide stem 42' centralized. The step-up passage extension tube 8 is bent to pass longitudinally up one of the guide stem flutes from the high pressure to the low pressure side of the venturi.

Now the floating valve 30 is held closed upon the Venturi tube 20 by the spring 41, but suction when the engine is running lifts the valve against the pressure of the spring to a height limited by the position of the throttle link stop head 34. When closed, an idling mixture flows through the flutes of stem 42' and through the bore of the valve 30, the flutes preventing spinning of the idling mixture, and the spider arms 42 likewise preventing spinning of the main vapor charge, thereby eliminating a vortex. When the valve is open, sufficient vapor passes through the flutes and valve bore to compensate for the area displaced by the valve mechanism.

The slots in the Venturi tube 20 function the same whether the valve is employed or not, and the slots in the valve may be opened or closed to a greater or less extent by bending the sections 30', thereby varying the slots. The valve itself, being conical, spreads the fuel vapor quickly after it leaves the Venturi tube 20, and maintains a constant velocity and a continued spreading of the mixture over the complete working range of the engine, regardless of throttle position, thus providing a uniform flow path and distribution of the fuel vapor through the slots 35 issue from the upper side of the valve in a spinning condition, due to the beveled edges 35' of the slots. These slots 35 maintain spinning of the vapor as it issues therefrom even when almost completely closed.

While the invention has been described and illustrated in connection with an up-draft carbureter, it will be understood that the same conditions exist relatively with a downdraft carbureter.

In the modified form shown in Figure 9, instead of a straight parallel walled intake passage, against which the fuel vapor is deflected by the valve, one having an outward bulge 12' is employed, the bulge being surrounded by a heating jacket 13 for the conical skirt of the valve 30, which passes through the slots 35 in the valve 30, thereby providing bendable valve sections 30' which may be bent inwards or outwards to close or open the slots 35 as in the case of the Venturi tube. Opposite side edges of each valve section 30' are similarly beveled as at 35' to produce mixture spinings.

The hub 35 of the valve is centrally bored, the bore expanding Venturi-like at its bottom and upper ends 37, 38 respectively, lugs 39 being disposed at intervals in the Venturi-Face 38 to engage the bottom face of the adjusting nut 40 to prevent closing of the Venturi passage between the surface 38 and the nut 40. A coil spring 41 encircles the nut 40 and the hub of the valve, and is held by its upper end 41 passing through the nut and engaging a flute of the stem 42 upon which the nut is threaded. The lower end of the spring bears against the valve 30 in the crotch between its conical skirt and its hub.

The nut 40 is adjustable threaded upon the upper end of a fluted stem 42' which is cruciform in cross section and which is formed on its lower end with radial spider arms 42, having their outer edges clinched into slots 45 provided for this modification in the base of the venturi 20. The spider arms 42 also have shoulders 44 conforming to and engaged with the conical approach 21 of the venturi to assist in maintaining the guide stem 42' centralized. The step-up passage extension tube 8 is bent to pass longitudinally up one of the guide stem flutes from the high pressure to the low pressure side of the venturi.
"step-up" passage is provided to supply additional liquid fuel under certain conditions such as emergency high demand. Under certain other conditions with certain carburetors, this additional fuel may be forced through the "step-up" passage by the operator; and in connection with certain other carburetors, the additional fuel is automatically passed through this passage in response to the predetermined demand. The outlet of the "step-up" passage is in the valve seat of the valve 30.

While the advantages of a properly proportioned Venturi tube are present in all forms of the invention, an added advantage is present in the form of the intake passages or portrayed in the diagram, the object of a properly proportioned bulged intake passage and discharge throat is to maintain a desired constant velocity at all engine speeds. By making the throat discharge passage with a cross-sectional area of X, the valve or apical portion of a cross-sectional area of X/2, and with a cross-sectional area of X/2 between the valve stem and Venturi throat, a cross-sectional area of X/2 must be maintained for the annulus between the valve and the bulged intake passage wall for top engine speed when the valve is fully open.

When the spreader valve is approximately half closed, because of lower engine speed, a velocity substantially equal to the velocity at higher speeds should be maintained and this is accomplished by curving the passage wall inwardly at that point to give cross-sectional area of X/4 between the half-open valve and the passage wall, the cross-sectional area of the annulus between the bulged wall and the tapered side of the valve being reduced also to X/4. The cross-sectional area of the Venturi throat has a constant of X/2.

What is claimed:

1. In a mixing device of the character described, a pipe line leading from a source of vapor supply to the intake of an internal combustion engine, a Venturi tube in said pipe line, a fluted sleeve passing axially within the Venturi tube, and a valve adapted for cooperation with the exit portion of said Venturi tube and having a bore through which the stem passes, a nut threaded upon the stem, and a spring having one end bearing against the valve and its other end passing through the nut into engagement with the flutes of the stem.

2. In a mixing device of the character described having a pipe line leading from a source of vapor supply to the intake of an internal combustion engine, the combination of a Venturi tube member located in the pipe line, said Venturi tube having a conical mouth portion, a rounded throat portion, and a substantially cylindrical slotted discharge portion; a conical throttle valve mounted to move axially of the Venturi tube and when in closed position having its tip end located within the Venturi tube and its sides adjacent its base seated upon the end of the discharge portion of the Venturi tube, means working through said Venturi tube for operating the valve, and a tube from the source of vapor supply communicating through said valve with the low pressure side of the Venturi tube.

4. In a mixing device of the character described having a pipe line leading from a source of vapor supply to the intake of an internal combustion engine, the combination of a Venturi tube located in the pipe line, said Venturi tube having a conical mouth portion, a rounded throat portion, and a slotted substantially cylindrical discharge portion; a conical throttle valve mounted to move axially of the Venturi tube into and out of closing engagement with the end of the discharge portion of said Venturi tube, the tip end of the valve being located within the Venturi tube and the sides of the valve adjacent its base seating upon said discharge end of the Venturi tube when the valve is closed, the valve having an axial bore, a fluted valve guide arranged within said bore axially of the Venturi tube, and a tube leading from the source of vapor supply and located in one of the flutes of the valve guide and in the bore of the valve to discharge vapor into the Venturi tube.

5. In a mixing device of the character described having a pipe line leading from a source of vapor supply to the intake of an internal combustion engine, the combination of a Venturi tube member located in the pipe line, said Venturi tube having a conical mouth portion, a rounded throat portion, and a substantially cylindrical discharge portion; a conical valve member having its tip end located within the discharge portion of the Venturi tube and its sides adjacent its base engaged with the end of the discharge portion of the Venturi tube when said valve is in its closed position, and guide means to confine the movement of said valve in a direction axially of said Venturi tube in its opening and closing movements, said discharge portion being provided with vortex disturbing slots extending in the general longitudinal direction of the axis of the Venturi tube.

6. In a mixing device of the character described having a pipe line leading from a source of vapor supply to the intake of an internal combustion engine, the combination of a Venturi tube member located in the pipe line, said Venturi tube having a conical mouth portion, a rounded throat portion, and a substantially cylindrical discharge portion; a conical valve member having its tip end located within the discharge portion of the Venturi tube and its sides adjacent its base engaged with the end of the discharge portion of the Venturi tube when said valve is in its closed position, and guide means to confine the movement of said valve in a direction axially of said Venturi tube in its opening and closing movements, said discharge portion being provided with vortex disturbing slots extending in the general longitudinal direction of the axis of the Venturi tube.

7. A mixing device of the character described, including in combination a unidirectional portion of a pipe line leading from a source of vapor sup-
ply to the intake of an internal combustion engine, a Venturi tube located within the pipe line, said Venturi tube having a converging entrance portion leading to a throat and having a substantially cylindrical discharge portion beyond the throat portion, said discharge portion being spaced from said pipe line and provided with longitudinal vortex disturbing slots through which minor portions of the vapor in passing through said slots is directed substantially conically, said slots providing substantially cylindrically arcuate segments comprising said discharge portion, whereby the major portion of said vapor is substantially confined in an unswirled column and flowing in a direction coextensive with said discharge portion substantially throughout said pipe line portion.

8. A mixing device of the character described including in combination a unidirectional portion of a pipe line leading from a source of vapor supply to an intake of a combustion engine, said portion including an enlarged concentric annular portion, said annular portion providing a concave annular passage, a Venturi tube in said portion and disposed coaxially and concentrically therein, said Venturi tube having a conical mouth portion, an arcuate throat portion, and a substantially cylindrical discharge portion terminating substantially upstream of said enlarged annular portion and spaced from said pipe line, a conical throttle valve having its tip end located within the discharge passage of the Venturi tube, said valve having its sides adjacent its base engageable with the end of the discharge portion of the Venturi tube when said valve is in its closed position, and guide means to direct the movement of said valve axially of said Venturi tube whereby the vapor passing said valve is deflected into said concave passageway during all open positions of said valve.

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