March 28, 1939. C. A. KILLMEYER ET AL 2,152,057

NOZZLE

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Fig. 1.

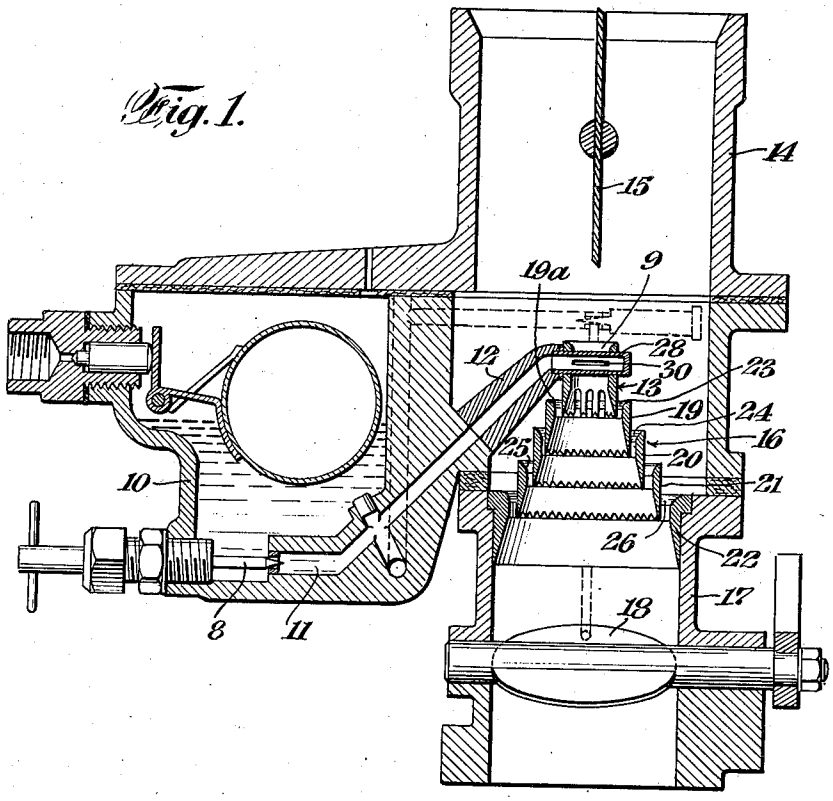
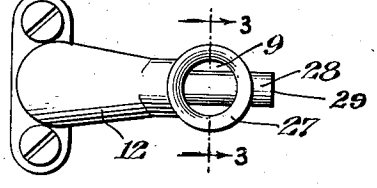


Fig. 2.



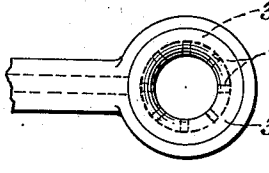


Fig. 4.

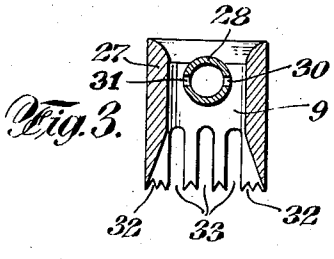


Fig. 3.

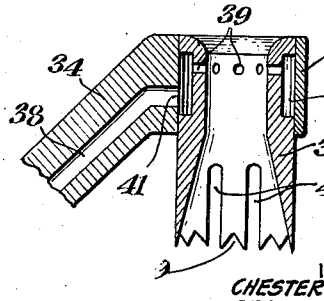


Fig. 5.

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NOZZLE

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9 Claims. (Cl. 261—76)

This invention relates to fuel nozzles adapted for use in conjunction with internal combustion engines, gasifying devices and other types of combustion apparatus.

In most carburetion devices the highest vacuum is generally at the fuel nozzle outlet; and it is a common occurrence that when the engine is started, the fuel, after leaving the nozzle, enters a low-pressure, low-velocity zone with the result that portions of unatomized liquid fuel will drop down to the intake manifold or the floor of the mixing tube to form a puddle there. This condition is especially prevalent at the low velocities during full power and low speed operation—so that particularly under these conditions the maximum power is not obtained from the fuel. It is hence one of the objects of our invention to eliminate the aforesaid low-pressure zone within a nozzle, and cause the fuel to be atomized at points of high velocity, in this manner obviating the drooling and puddling of liquid fuel within the engine. And in this aspect of our invention, it is another object to effectuate an efficient atomization of the fuel at all throttle positions and rates of flow so as to obtain a high efficiency and procure the maximum power obtainable from the fuel over a wide range of velocities of the air and fuel mixture.

Briefly, the above objectives are accomplished by creating what is in effect two zones in the fuel nozzle, one for effecting delivery of the required fuel from the nozzle jet, and the other for re-atomization at a region of high velocity located at the beginning of the mixing chamber into which the air-fuel stream is introduced and caused to expand.

In our invention described in Patent No. 2,102,800 granted December 21, 1937, for Method of and apparatus for gasifying a liquid fuel, an extremely high vacuum is obtainable by means of an arrangement of multiple venturis, the depressions in the first or foremost venturi being extremely high. For example, in employing a series of four venturis a vacuum of 18 to 20 Hg is very readily obtainable in the foremost venturi with 3 inches of Hg at the intake manifold. With such extremely high depressions, it is practically impossible to properly meter the fuel into the multiple Venturi mixing conduit. It is hence another of our objectives to provide a fuel nozzle and spraying method particularly adapted for use in combination either with the multiple Venturi system disclosed in the aforesaid patent, or with other high vacuum systems. In one form of nozzle constituting part of this invention, the terminal outlet of the nozzle jet is serrated and slotted and is operatively associated with the first or foremost venturi of said patented structure in such a manner as to enable the depression in the choke band thereof to be reduced to a predetermined value. In other words, the said slots of the nozzle are so positioned within the throat of the said foremost venturi as to produce what in effect is a leakage at the restricted region or choke band thereof, and hence a breaking down of the depression to an operable value, such as, for example, 5 inches of Hg. And in this aspect of our invention, another object is to enable any predetermined depression to be obtained at the point of ingress into the mixing chamber irrespective of the velocity of the atomizing medium.

It is also within the contemplation of our invention to enable a uniform fuel spray discharge to be obtained from the nozzle into the mixing chamber.

Other objects, features and advantages will appear from the drawing and the description hereinafter given.

Referring to the drawing,

Figure 1 is a vertical cross-section of a downdraft carburetor embodying one form of our invention.

Figure 2 is a plan view of the nozzle of Figure 1.

Figure 3 is a section of Figure 2 taken along line 3—3.

Figure 4 is a fragmentary plan view of another form of nozzle constituting this invention, and

Figure 5 is a section of Figure 4 taken along line 5—5.

In the drawing, the float bowl 10, of conventional structure, contains the fuel passage 11 controlled by the needle valve 8, said passage communicating with the fuel duct 12 forming a part of the nozzle structure 13 which will hereinafter be more fully described. The apparatus contains the pipe 14 for air or other atomizing medium, and within this pipe is positioned a suitably controlled valve 15, the said air pipe being in communication with a mixing tube or flow conduit 16 which leads into the outlet tube 17 provided with a suitably controlled valve 18, and communicates with the intake manifold of an internal combustion engine or other fuel-consuming device not shown in the drawing. The carburetor structure hereinabove referred to, with the exception of the fuel nozzle 13 and

flow conduit 16, will not be fully described inasmuch as it is of more or less conventional design and is fully understood by anyone conversant with the art.

The said mixing tube or flow conduit 16 consists of a plurality of successively expanding overlapping venturis 19, 20, 21 and 22, certain of these having serrated terminals positioned within the throats of succeeding venturis. The sprayed fuel from nozzle 13 is introduced within said flow conduit 16, and atomizing or combustion air is introduced in stages through opening 9, and the gaps 23, 24, 25 and 26 between the venturis, all in a manner clearly described in the said Patent No. 2,102,800.

The form of fuel nozzle 13 shown in Figures 1, 2 and 3 consists of a tubular member 27 which is preferably although not necessarily of Venturi construction as shown. Extending transversely through the tube 27 and connected to the fuel duct 12 is the pipe 28, closed at terminal 29 as shown, said tube containing at the inlet section thereof two lateral and preferably diametrically disposed jet openings or orifices 30 and 31, said pipe being in spaced relation to the walls of tube 27. As shown in the drawing which, as aforesaid, illustrates a Venturi type of tube, the position of the apertures 30 and 31 is preferably within the most restricted portion or throat of the Venturi tube.

The outlet section or skirt of tube 27 contains the serrated terminal edge 32 and the elongated slots 33 circumferentially disposed about the said skirt of the tube. The slotted portion of the tube 27, it will be noted, is positioned within the choke band or restricted throat of the foremost venturi 19.

In the operation of this device, the fuel from the float bowl 10 flows through the passageway 11 and the fuel duct 12 into the pipe 28, and is forcibly pulled through the orifices 30 and 31 by the down-draft suction created within the throat of Venturi tube 27, the depression in the extremely small throat of said tube being very high, particularly because of the operating effect of the flow conduit 16. Due to the position of orifices 30 and 31, the fuel will initially be ejected transversely with respect to the flow conduit, and will then impinge against the internal wall of the said tube 27; and inasmuch as the said orifices are elongated and are, as indicated in the drawings, substantially of a length equal to the diameter of the tube 27, practically the entire internal wall of the tube 27 will receive the ejected fuel from the orifices, the fuel thereafter flowing down the skirt of the nozzle tube until it reaches the serrated terminal edge 32 positioned, as above stated, within the throat of venturi 19. Inasmuch as the depression within the throat of said venturi 19 is extremely high, for reasons above set forth, the film of fuel flowing down the sides of the skirt of tube 27 will be torn off the multiple pointed or serrated terminal edge 32 to form a finely pulverized homogeneous mixture.

It is thus apparent that the form of nozzle above described is particularly adaptable for use with the multiple Venturi arrangement herein illustrated wherein extremely high depressions and velocities are produced. It is, of course, understood that where high velocities are also obtainable in forms of flow conduits or mixing tubes other than the said multiple Venturi arrangement, the nozzle constituting this invention is equally adaptable to such other designs.

It will be observed that, in the operation of this device, after the fuel is ejected from the orifices 30 and 31 at the extremely high velocity zone within tube 27, it is again reatomized at the high depression zone at the ingress to the flow conduit 16, and immediately expanded thereafter into the fuel stream. In this way a low depression zone, after the initial spraying of the fuel, is avoided, all the fuel reatomized by expanding into the flow conduit being maintained in an atomized or vaporized state, thereby eliminating drooling and the formation of puddles of liquid fuel.

When the depression within venturi 19 is very high, it is found to be difficult to meter the fuel from jet 13 into the flow conduit 16. However, by positioning the tube 27 within the throat of venturi 19 so that the slots 33 intersect the upper terminal edge 19a of venturi 19, there will be what in effect amounts to a leakage of air through said slots into the nozzle and the flow conduit. This obviously causes a reduction in the depression, to enable a proper metering to be effectuated. By varying the position of the slotted skirt within the throat of venturi 19, different depressions can be obtained so that a predetermined positioning can obtain a predetermined depression for optimum operation.

In the modified form of fuel nozzle illustrated in Figures 4 and 5, and coming within the scope of this invention, the fuel conduit 34, leading from the fuel well, contains at its upper terminal portion a ring-like member 35 rigidly secured, such as by a press fit or other suitable means, to the upper section of the nozzle tube 36 shown in its preferred form to be of Venturi construction. The said upper section of the said tube contains an annular recessed portion or chamber 37 which is in communication with the passageway 38 within the conduit 34. Circumferentially disposed about the upper portion of nozzle tube 36 are a plurality of spaced orifices 39, these being in communication with the annular chamber 37 but positioned in spaced relation to and above the outlet port 41 of passageway 38. The skirt of tube 36 contains serrations 39 and elongated slots 40 similar in general construction to that hereinabove described in connection with the structure of Figures 1, 2 and 3.

In the operation of this modified form of nozzle, the fuel from conduit 34 enters the chamber 37 at inlet port 41, and thereafter it rises to be introduced into the tube 36 through the orifices 39. Inasmuch as the direction of the fuel discharge through the orifices is transverse to the axis of tube 36, the fuel will be sprayed upon the inner wall of said tube, and drawn down to the serrated terminal of the skirt of the tube, to be torn off into finely divided particles in the manner hereinabove described.

With the construction above described, there will be a uniform discharge of the fuel from all of the orifices 39, particularly in view of the fact that there is afforded an opportunity for the fuel to rise after entering chamber 39 through port 41 and before being ejected through the said orifices, thereby insuring a simultaneous and even discharge through the orifices. This obviously would not be the case if said orifices and the port 41 were at the same level, for in such a case the orifices closest to the port would receive and discharge the fuel earlier than those located farther away.

It is, of course, understood that the form of nozzle shown in Figures 4 and 5 is adapted for

adjustable insertion within the mixing tube or flow conduit 16, in a manner similar to the nozzle of Figures 1, 2 and 3.

It is, of course, understood that the various embodiments above described and shown in the drawing are illustrative of our invention and not employed by way of limitation, inasmuch as numerous changes and modifications may be made within the scope of the appended claims without departing from the spirit of this invention.

What we claim is:

1. In an apparatus for converting a liquid fuel into a gaseous fluid, the combination of a fuel spray nozzle and a mixing tube for receiving and conducting therein an atomized fuel stream from said nozzle, the nozzle having at its outlet section a fuel discharge terminal edge and a plurality of circumferentially disposed slots presenting edges directed substantially longitudinally of the nozzle and extending to the said terminal edge thereof, the discharge section of the nozzle extending into the inlet of the mixing tube, the plane of the inlet edge of the tube intersecting said slots whereby only a portion of each of the slots extends into the tube.

2. In an apparatus for converting a liquid fuel into a gaseous fluid, the combination of a fuel spray nozzle and a mixing tube for receiving and conducting therein an atomized fuel stream from said nozzle, said tube having at the inlet portion thereof a restricted section at which the outlet section of the nozzle is positioned for optimum operation, said outlet section containing in the lateral wall thereof a plurality of spaced circumferentially disposed elongated slots extending to the terminal edge of the nozzle, whereby the said optimum operation is obtained by positioning the said slotted outlet section in predetermined relation to the inlet edge of the tube and in intersecting relation with said restricted section thereof.

3. In an apparatus for converting a liquid fuel into a gaseous fluid, the combination of a fuel nozzle and a mixing tube of progressively expanding proportions for receiving and conducting therein an atomized fuel stream from said nozzle, said tube being of Venturi construction at its inlet portion, the outlet section of the nozzle being positioned at the throat of the venturi for optimum operation, the discharge terminal edge of the nozzle being serrated, said outlet section of the nozzle containing in the lateral wall thereof a plurality of spaced circumferentially disposed elongated slots extending to said serrated terminal edge of the nozzle, whereby the said optimum operation is obtained by positioning the said outlet section of the nozzle with the slots thereof in predetermined intersecting relation with respect to the inlet edge of the mixing tube.

4. In an apparatus for converting a liquid fuel into a gaseous fluid, the combination of a fuel spray nozzle and a mixing tube for receiving and conducting therein an atomized fuel stream from said nozzle, the fuel nozzle comprising a tubular member containing an inlet section and an outlet section, said tube having at the inlet portion thereof a restricted section at which the outlet section of the nozzle is positioned for optimum operation, fuel conveying means communicating between a source of fuel supply and said inlet section, said conveying means terminating in orifices in substantially facing relation to the inner wall of said tubular member whereby fuel ejected through the orifices will be directed transversely with respect to the axis of the said tubular member for impingement upon said inner wall, the said outlet section of the nozzle containing in the lateral wall thereof a plurality of spaced circumferentially disposed elongated slots extending to the terminal edge of the nozzle, whereby the said optimum operation is obtained by positioning the said slotted outlet section with the slots thereof in predetermined intersecting relation with respect to the inlet edge of the mixing tube.

5. In an apparatus for converting a liquid fuel into a gaseous fluid, the combination of a fuel spray nozzle and a mixing tube for receiving and conducting therein an atomized fuel stream from said nozzle, the nozzle comprising a tubular member containing an inlet section and an outlet section, jet means within the said inlet section of said tubular member and containing orifices in substantially facing relation to the inner wall of the member whereby fuel ejected through the orifices will be directed transversely with respect to the axis of the said tubular member for impingement upon said inner wall, said mixing tube having at the inlet portion thereof a restricted section at which the outlet section of the nozzle is positioned for optimum operation; said outlet section containing a plurality of circumferentially disposed elongated slots extending to the discharge terminal edge of said member, whereby the said optimum operation is obtained by positioning the said slotted outlet section with the slots thereof in predetermined intersecting relation with respect to the inlet edge of the mixing tube.

6. In an apparatus for converting a liquid fuel into a gaseous fluid, the combination of a fuel spray nozzle and a mixing tube for receiving and conducting therein an atomized fuel stream from said nozzle, the nozzle comprising a tubular member containing an inlet section and an outlet section, the wall of the member adjacent the said inlet section being recessed to form an annular chamber, fuel-conveying means leading from a source of fuel supply to an inlet port in said chamber, said tubular member containing a plurality of circumferentially disposed orifices communicating between the interior of the tubular member at said inlet section thereof and the said chamber at points farther removed than said inlet port from the terminal edge of the tubular member, said mixing tube having at the inlet portion thereof a restricted section at which the outlet section of the nozzle is positioned for optimum operation; said outlet section containing a plurality of circumferentially disposed elongated slots extending to the discharge terminal edge of said member, whereby the said optimum operation is obtained by positioning the said slotted outlet section with the slots thereof in predetermined intersecting relation with respect to the inlet edge of the mixing tube,

7. In an apparatus for converting a liquid fuel into a gaseous fluid, the combination of a fuel nozzle and a mixing tube for receiving and conducting therein an atomized fuel stream from said nozzle, said nozzle comprising a tubular member containing an inlet section and an outlet section, the outlet section being positioned at the inlet of the mixing tube, a pipe extending transversely through the inlet section of said member and closed at one end, fuel conveying means communicating between a source of fuel supply and the other end of the pipe, and orifices within said pipe in substantially facing relation to the inner wall of said tubular member where-

by fuel ejected through the orifices will be directed transversely with respect to the axis of the said tubular member for impingement upon said inner wall, the said outlet section containing a terminal fuel-discharge edge from which the fuel on said inner wall is adapted to be discharged into the said mixing tube, said outlet section containing a plurality of circumferentially disposed elongated slots extending to said discharge edge and in intersecting relation to the inlet edge of said mixing tube.

8. In an apparatus for converting a liquid fuel into a gaseous fluid, the combination according to claim 7, the orifices within said pipe being diametrically disposed and of a length substantially equal to the diameter of the inlet section of said tubular member.

9. In an apparatus for converting a liquid fuel into a gaseous fluid, the combination according to claim 7, the said tubular member being of Venturi construction, and the said inlet section being substantially in the region of the restricted portion of the venturi.

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