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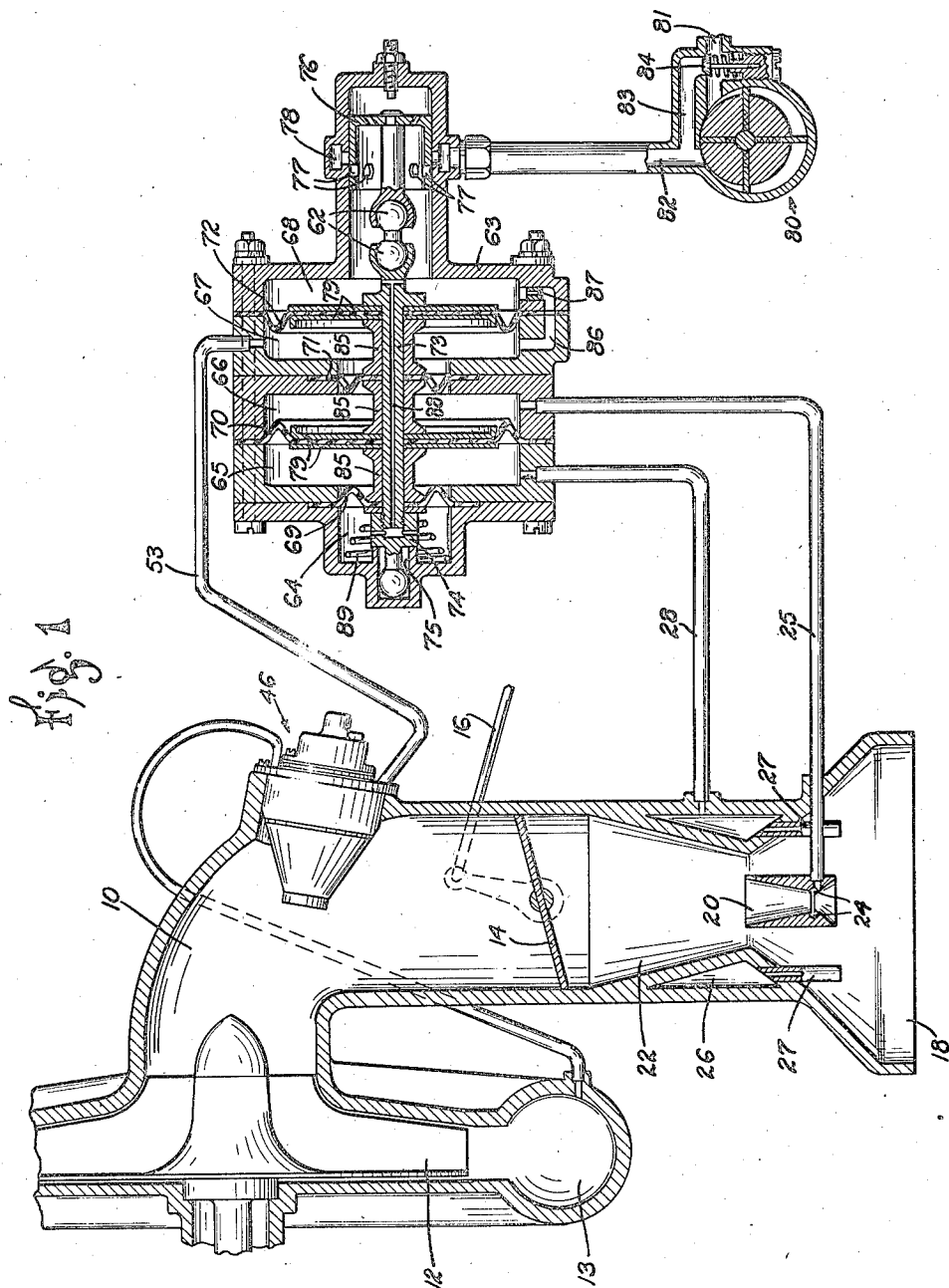
F. C. MOCK ET AL.

2,404,081

CHARGE FORMING DEVICE

Original Filed Nov. 30, 1938

2 Sheets-Sheet 1



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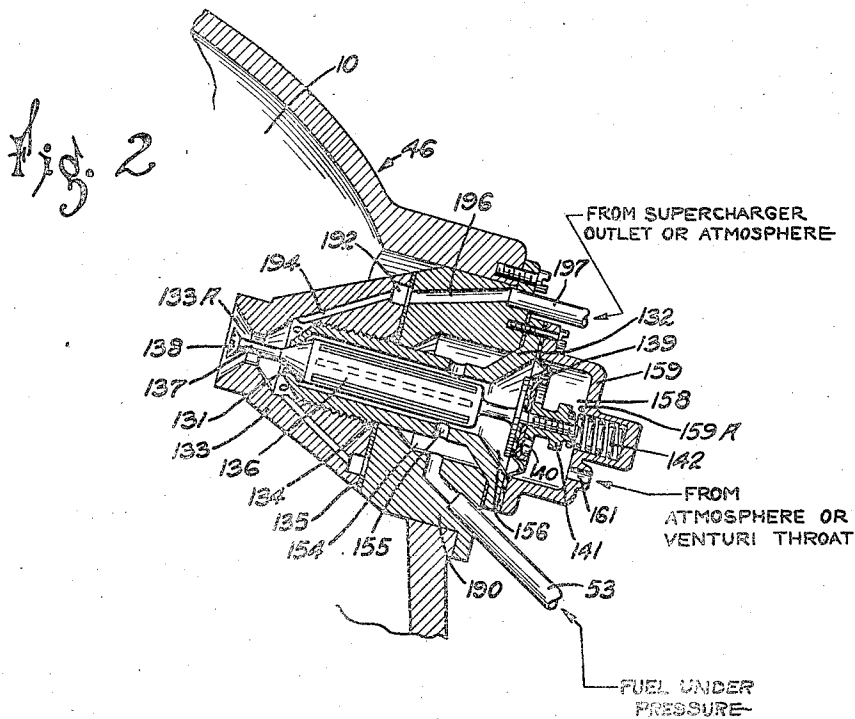
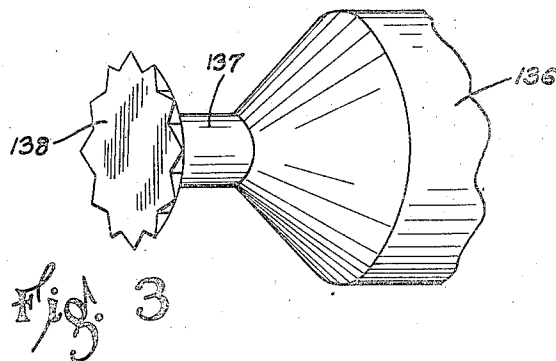
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UNITED STATES PATENT OFFICE

2,404,081

CHARGE FORMING DEVICE

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Original application November 30, 1938, Serial No. 243,067. Divided and this application October 23, 1942, Serial No. 463,064

4 Claims. (Cl. 261-24)

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This invention relates to charge forming devices and more particularly to discharge nozzles for carburetors of the pressure feed type disclosed in Frank C. Mock application Serial No. 202,206, filed April 15, 1938, now Patent No. 2,390,658 issued Dec. 11, 1945. This application is a division of our copending application Serial No. 243,067, filed November 30, 1938, now Patent No. 2,310,984, granted Feb. 16, 1943.

A fuel discharge nozzle is used with carburetors of this type to spray the fuel into the air conduit leading to the intake ports of the engine. From the standpoint of engine performance and operating characteristics it is advantageous to have the fuel delivered from the nozzle in a finely divided or atomized state and uniformly distributed into the air flowing through the conduit.

One of the principal objects of the invention is to provide a discharge nozzle with means for obtaining more nearly uniform distribution of fuel into the air stream.

Another object of the invention is to provide means for obtaining a discharge of finely divided fuel from the nozzle without the use of excessively high fuel pressures.

A further object of the invention is to provide a discharge nozzle which will shut off the flow of fuel when the engine is not running but which will not act as a restriction to fuel flow when the rate of flow is high.

A further object of the invention is to provide a discharge nozzle into which air is introduced and admixed with the fuel flowing therethrough and the resulting mixture of fuel and air is directed against a sharp-edged serrated member whereby the fuel is finely atomized.

Further objects and advantages of the invention will be apparent from the following description, taken in connection with the appended drawings in which:

Figure 1 is a diagrammatic sectional view of a device embodying the invention;

Figure 2 is an enlarged sectional view of the discharge nozzle of Figure 1; and

Figure 3 is an enlarged fragmentary view of the discharge nozzle valve shown in Figure 2.

Although the invention is described in connection with a radial type aircraft engine, it is also applicable to engines of other types or those used for other purposes.

With reference to Figure 1, there is shown an induction passage 10 leading to a rotary blower or supercharger 12 which discharges into an intake manifold 13 of an internal combustion engine. The induction passage 10 is controlled by

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a throttle 14 operated by a rod 16. Anterior to the throttle is an air inlet or scoop 18, which leads to a primary venturi 20 positioned to discharge in the vicinity of the throat of a secondary venturi 22. The primary venturi is provided with an annular chamber 24 opening into the venturi substantially at its throat and communicating through passageway 25 with a control unit hereinafter described. Secondary venturi 22 is provided with an annular chamber 26 which communicates with the air scoop 18 through a plurality of tubes 27, and with said control unit through a passageway 28.

Posterior to the throttle 14 is a fuel discharge nozzle, indicated generally at 46, mounted in the wall of the air conduit 10 and adapted to receive fuel from the control unit through a conduit 53.

The control unit casing 63 is divided into five chambers, 64, 65, 66, 67 and 68 by four flexible diaphragms 69, 70, 71 and 72. The diaphragms are secured at their centers to a control rod 73 by washers 79 and hubs 85 slidably mounted on said rod and locked in position by tightening nut 74 on the end of rod 73. The nut 74 is provided with a ball end which slidably engages bearing recess 75 in the end of casing 3. Control rod 73 is connected through two ball type universal joints 62 with a slide valve 76 having ports 77 so arranged that axial motion of rod 73 regulates the effective area for fuel flow from an annular fuel chamber 78 into the unmetere fuel chamber 68.

Any suitable fuel pump may be used to supply fuel to chamber 78, the one shown at 80 being of the sliding vane type having a fuel inlet 81, fuel discharge passage 82 and a by-pass channel 83 controlled by a pressure responsive valve 84. Unmetered fuel chamber 68 communicates with metered fuel chamber 67 through a passageway 86 containing a calibrated metering orifice 87. Chamber 68 also communicates with chamber 64 through a centrally drilled passage 88 in the control rod 73. Chamber 67 communicates with the discharge nozzle through the passageway 53. Chamber 65 communicates through passageway 28 with chamber 26 in venturi 22 and is therefore subjected to the pressure obtaining in the air scoop 18. Chamber 66 communicates through passageway 25 with the chamber 24 in the primary venturi 20 and therefore is subjected to the pressure at the throat of said venturi.

The differential in pressure between chambers 65 and 66, created by air flow through the conduit 10, under any given set of operating conditions, will produce a resultant force on the con-

control rod 73 tending to move said rod to the right in a direction to open valve ports 77. Since the differential pressure between air scoop and Venturi throat is proportional to the square of the rate of air flow, the resultant force on the control rod created by this differential acting on opposite sides of a diaphragm of constant area will also be proportional to the square of rate of air flow.

Fuel admitted through ports 77 into chamber 68 will flow through passage 86, metering orifice 87, into chamber 67, and thence through passageway 53 to the discharge nozzle 46 from whence it is discharged into the air conduit 10 posterior to the throttle valve 14. Flow of fuel through the metering orifice 87 results in a pressure differential across said orifice, which creates a resultant force on control rod 73 which acts to the left in a direction to close valve ports 77 and thereby tends to oppose the previously mentioned force created by air flow through the conduit. Since the pressure differential across the metering orifice 87 is proportional to the square of the quantity of fuel flow, the resultant force on rod 73 will also be proportional to the square of the quantity of fuel flowing. Thus, for any given condition of engine speed and load, the control rod 73 and attached valve 76 will move to a position such that the force on said rod resulting from fuel flow will exactly balance the force applied to said rod resulting from air flow. The squares of the quantities of air and fuel flowing, and hence the quantities themselves, are therefore held in constant proportion to each other, the absolute value of the ratio depending upon the relative sizes of the fuel metering orifice 87 and the venturis 20, 22 in the induction passage.

A constant mixture ratio can therefore be obtained throughout the range of air flows used unless otherwise varied by extraneous means such as those disclosed in the Mock application above referred to. One such extraneous means is spring 89, shown in Figure 1 as a weak spring, which when the engine is idling, moves valve 76 toward open position and thus enriches the mixture as is required for idling operation.

The discharge nozzle 46, as best shown in Figure 2, includes a primary nozzle assembly comprising a discharge nozzle body 132 having a seat portion 131, a valve member 136 secured to a diaphragm 139 by a washer 140 and locking nut 141, and a nozzle cap 159 enclosing a compression spring 142 which urges the valve 136 against the seat 131. The assembly is fastened and sealed in an adapter 190 received in an opening in the wall of conduit 10 by means of a nozzle retaining nut 133, packing 134 and gasket 135. Nut 133 is formed at its discharge end with a Venturi shaped internal contour as indicated at 133A. An annular groove 192 is provided in nut 133 which communicates through a plurality of passages 194 with the interior of said nut in the vicinity of the entrance of said Venturi shaped portion. Annular groove 192 is in communication either with the atmosphere, the outlet of the supercharger, or some other source of air by means of a passage 196 and a pipe 197. The chamber 158 within the cap 159 is vented through port 161 either to atmosphere or to the pressure at the Venturi annulus 24, the latter arrangement being particularly described and claimed in our above mentioned joint application Serial No. 243,067, of which this application is a division.

Valve 136 is formed with an extension 137 projecting through the venturi 133A and terminat-

ing in a notched or serrated conical tip 138, shown in detail in Figure 3. Fuel under pressure is received at the nozzle through passage 53 from the control unit, whence it flows into a chamber 154 and through ports 155 into a chamber 156, where it acts on diaphragm 139 causing valve 136 to lift off its seat and allowing fuel to discharge past said seat; excessive opening of said valve being limited by nut 141 striking the stop 159A in the nozzle cap. The vacuum present in the air conduit 10, at the inlet to the supercharger and in the vicinity of the discharge nozzle, coupled with the effect of venturi 133A, induces a flow of air through pipe 197, passages 196, 192 and 194, through venturi 133A and into the conduit 10. The rapidly moving stream of air and fuel flowing through the venturi 133A and striking the notched conical tip 138 results in the fuel being broken up into very fine particles.

The quantity of air drawn through the nozzle depends largely upon the differential in pressure between the air entering the passage 196 and the pressure at the inlet to the supercharger in the vicinity of the discharge nozzle. The pressure at the supercharger inlet is a minimum when the throttle is in a closed position and increases to a value approaching atmospheric pressure as the throttle is opened wide; therefore, if the passage 196 is at atmospheric pressure the quantity of air flowing through the nozzle is maximum when the throttle is closed, and minimum when the throttle is wide open. Since the fuel flow is low at closed throttle and high at wide open throttle, better atomization of fuel is obtained at part than at wide open throttle. This arrangement is therefore particularly suitable for use with an engine which is operated a large percentage of the time at small throttle openings.

By connecting nozzle air inlet 196 to the supercharger outlet 13, as shown in Figure 1, a different operating characteristic is obtained. Since the nozzle air outlet is at supercharger inlet pressure, the quantity of air flowing through the nozzle will depend upon the supercharger rise, that is the differential pressure between supercharger outlet and inlet. Since this differential pressure increases as the throttle is opened, the quantity of air flowing through the nozzle will be low at closed throttle and high at wide open throttle, thereby producing better atomization at wide throttle openings and hence being well suited for use with an engine that is customarily operated at more nearly wide open throttle position.

While the invention has been described with particular reference to a particular embodiment thereof, it should not be inferred that the invention is limited thereto or otherwise except in accordance with the terms of the following claims.

We claim:

1. In a fuel nozzle assembly, an elongated hollow nozzle body provided with a fuel pressure chamber at one extremity and a valve seat at its opposite extremity having a discharge port therein, a valve member having a body portion slidably received in said nozzle body and a seat portion adapted to engage said seat, a member having a Venturi-shaped fuel discharge passage in substantially axial alignment with and spaced from said discharge port, said valve member having an elongated extension projecting through said passage and terminating in an enlarged tip against which fuel is discharged to effect atomization thereof, and means for conducting air under pressure to the space anterior to said Venturi-

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shaped discharge passage for admixture of air with the fuel as the latter is discharged from said port through said passage against said tip.

2. In a fuel nozzle assembly, an elongated hollow nozzle body provided with a fuel pressure chamber at one extremity and a valve seat at its opposite extremity having a discharge port therein, a valve member having a body portion slidably received in said nozzle body and a seat portion adapted to engage said valve seat, an adapter assembly mounting said nozzle body including a member having a Venturi-shaped fuel discharge passage in substantially axial alignment with and spaced from said discharge port, said valve member having an elongated stem projecting from the seat portion thereof through said passage and terminating in an enlarged conical tip against which fuel is discharged to effect atomization, said tip when the valve member is seated lying beyond the restricted portion of said passage and approaching said restricted portion as the valve member is moved clear of its seat, and means for conducting air under pressure to the space anterior to said Venturi-shaped discharge passage for admixture of air with the fuel as the latter is discharged from said port through said passage against said tip.

3. In a charge forming device, an induction passage terminating in an intake manifold, a throttle controlling said passage, a supercharger in the induction passage posterior to the throttle adapt-

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ed to discharge into the intake manifold, a fuel nozzle positioned to discharge atomized fuel into the induction passage between the throttle and the supercharger, means including a conduit for supplying fuel under pressure to the nozzle, a valve in said conduit, means responsive to pressure of the fuel for controlling said valve, and a conduit leading from the intake manifold to the nozzle for admixing atomizing air with the fuel prior to its discharge from the nozzle, whereby the quantity of atomizing air admitted to the nozzle is in direct relation to charging pressure.

4. In a charge forming device, an induction passage, a throttle controlling the same, a supercharger in the passage posterior to the throttle, a fuel nozzle positioned to discharge into the induction passage between the throttle and supercharger, said nozzle having a fuel duct therein terminating in a fuel discharge orifice, means for supplying fuel under pressure to the nozzle, a pressure responsive valve controlling the duct, and a conduit for transmitting atomizing air to the nozzle connecting the passage in the region of the outlet of the supercharger to the duct between the valve and the orifice, whereby the quantity of air flowing through the nozzle is in direct relation to the pressure rise across the supercharger.

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