# United States Patent [19]

**Baribeau et al.**

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[45] **Sept. 10, 1974**


[54] **FUEL INJECTION NOZZLE FOR INTERNAL COMBUSTION ENGINE**


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[21] Appl. No.: **318,376**

**Related U.S. Application Data**

[63] Continuation-in-part of Ser. No. 146,627, May 25, 1971, abandoned.

[52] **U.S. Cl.** ..... **261/41 D**, 261/78 R, 239/567

[51] **Int. Cl.** ..... **F02m 7/02**

[58] **Field of Search** ..... 261/78 R, DIG. 38, 76, 261/41 B, 41 R, 41 D, 116, 51, 62; 239/596, 567



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*Primary Examiner*—Tim R. Miles

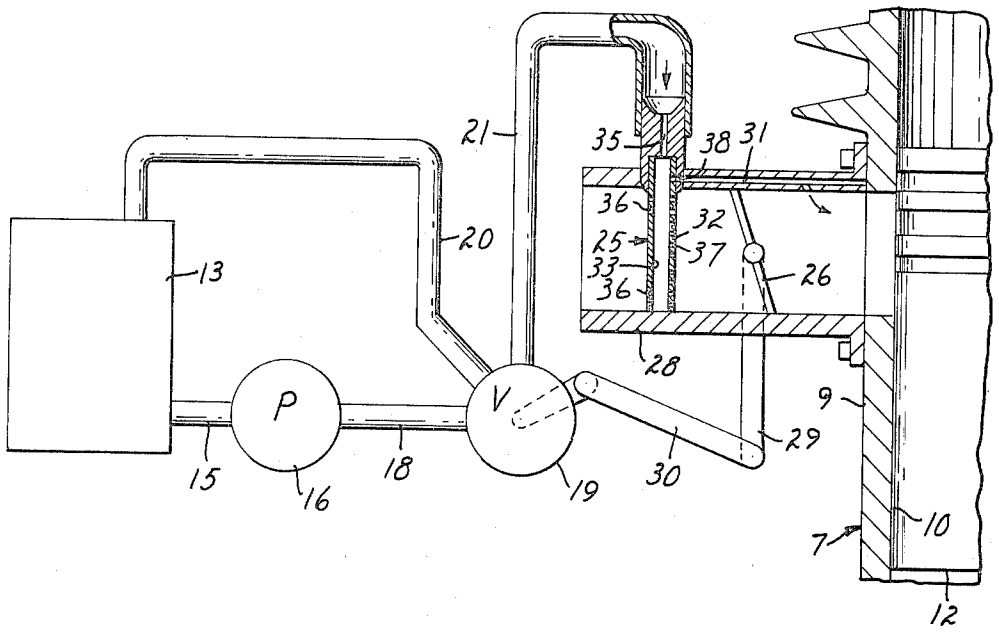
*Attorney, Agent, or Firm*—John C. Barnes, Esq.



[57] **ABSTRACT**

A fuel injection nozzle for an internal combustion engine wherein the nozzle is disposed in the air intake passageway generally diametrically. The fuel is directed to the nozzle under pressure by a pump and metering valve. The nozzle has a central bore and transverse bores spaced along the length of the nozzle and at intervals from the wall of the intake manifold.


**9 Claims, 7 Drawing Figures**



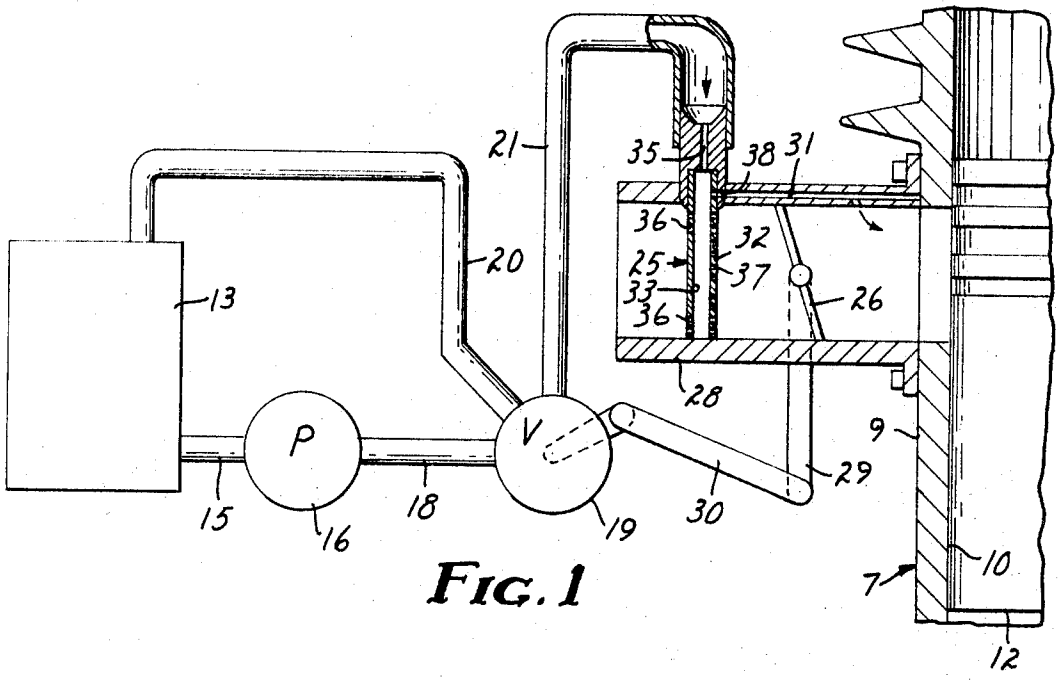



FIG. 1

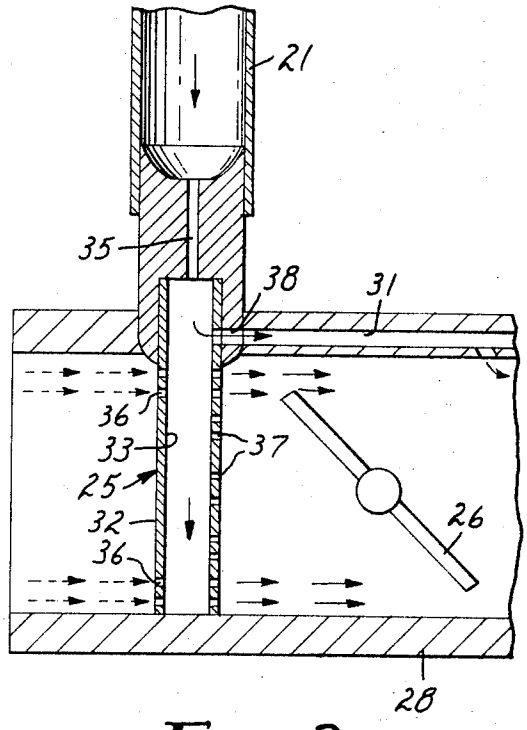



FIG. 2

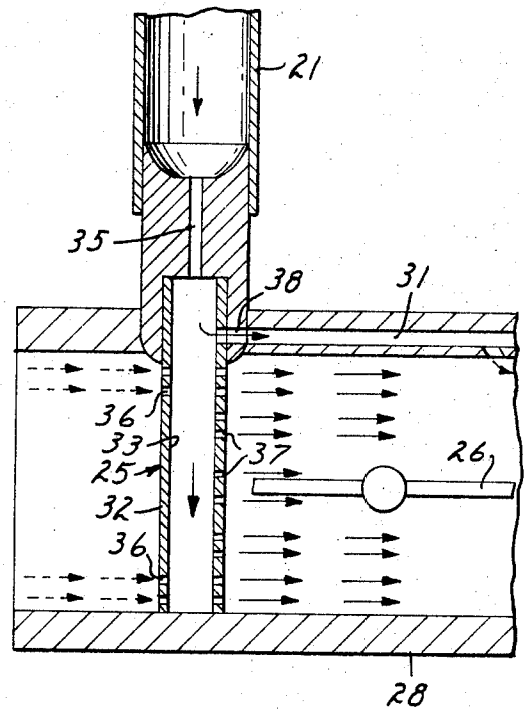



FIG. 3

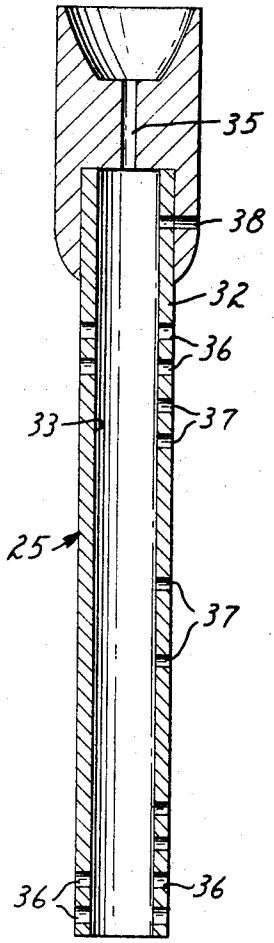



FIG. 4

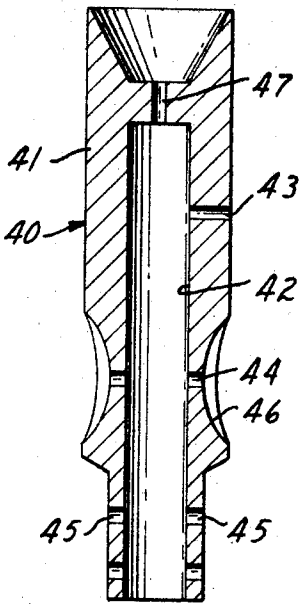



FIG. 5

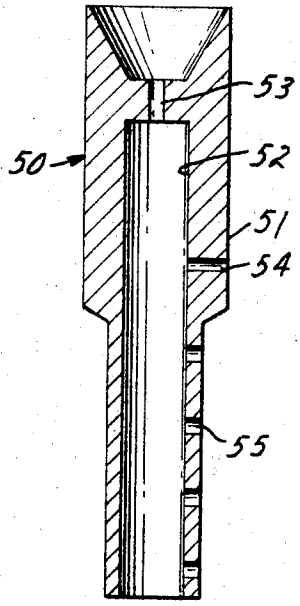



FIG. 6

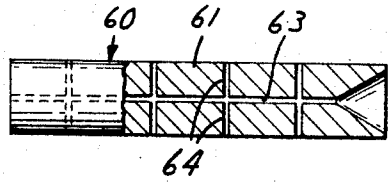



FIG. 7

# FUEL INJECTION NOZZLE FOR INTERNAL COMBUSTION ENGINE

## CROSS-REFERENCES TO RELATED APPLICATIONS

This application is a continuation-in-part application of application Ser. No. 146,627, filed May 25, 1971, for Fuel Injection System now abandoned.

## BACKGROUND OF THE INVENTION

This invention relates generally to an improvement in fuel injection nozzles for internal combustion engines and in one aspect to an improved nozzle for distributing the fuel to mix with the air in moving through the intake manifold.

Fuel control systems for internal combustion engines have included nozzles for atomizing the fuel injected under pressure into the intake manifold. Most nozzles have a discharge opening of reduced size to cause a spray type of discharge and others have one nozzle disposed within a holder wherein air is permitted to enter the holder around the nozzle to atomize the fuel discharged into the air stream under pressure. U.S. Letters Pat. No. 3,416,738 discloses a nozzle which varies from the other nozzles and is believed more closely related to the present invention. In this nozzle fuel is atomized by discharge from a tube extending into the manifold. The tube has a closed end and the fuel is discharged from the tube toward an opening in a jacket tube surrounding the tube. The jacket tube is vented to the atmosphere however and changes in the inlet manifold vacuum level have little effect on the fuel discharge.

The present invention relates to nozzles designed to balance the atomization and fuel discharge to changes in the amount of air moving into the intake manifold.

With either downdraft or horizontal intake carburetors the fuel is drawn from the fuel bowl into the intake manifold by atomization using a venturi throat located at the outlet opening of the fuel bowl, thus drawing the fuel into the intake air. The decreased pressure at the venturi is used to draw the fuel from the bowl and supposedly atomizes the fuel before it is injected into the cylinders. These systems depend on the engine vacuum to draw the air through the venturi and to draw the fuel into the cylinders. Since the venturi restricts the amount of air that can be drawn into the engine it is less efficient as the speed of the engine increases.

The present invention provides an improved fuel injection system in that the fuel is discharged under pressure from a nozzle disposed in the intake manifold mounted on the engine. Except for the presence of the nozzle itself the intake manifold is not incumbered. The fuel is pumped to the nozzle and the flow of fuel into the nozzle increases as the speed of the engine increases and as the amount of air allowed into the cylinder increases under control of the throttle. All of which are balanced by design to increase efficiency of the engine.

It is an object of the present invention to increase the efficiency of the engine by providing a nozzle affording a positive fuel injection and mixing in the intake manifold in response to increased demands of the engine.

## SUMMARY OF THE INVENTION

The fuel injection system of the present invention utilizes a fuel injection nozzle extending into the intake manifold in advance of the butterfly air control valve. The nozzle of this fuel control system comprises a slender tubular member having a reduced or restricted central bore and a plurality of passageways or bores disposed transverse to and communicating with said central bore. Fuel is inserted into one end of the nozzle and directed through the central bore and as the intake air moves over the tubular member, which is preferably cylindrical, the air draws the fuel from the transverse bores, atomizes it and carries it into the combustion chamber of the engine. An additional high speed fuel metering valve may be disposed between the flow control valve and the nozzle to obtain the ideal fuel and air ratio at open throttle position. This high speed metering valve is preferably adjustable to tune the high speed operation of the engine.



## DESCRIPTION OF THE DRAWING

The present invention will be more fully described with reference to the accompanying drawing wherein:

FIG. 1 is a schematic view of a fuel injection system for an internal combustion engine and includes a nozzle all constructed according to the present invention;

FIGS. 2 and 3 are detail sectional views of the operation of the nozzle of the system;

FIG. 4 is an enlarged detail view of the injection nozzle shown in FIGS. 1 to 3;

FIG. 5 is a detail view of another embodiment of the injection nozzle;

FIG. 6 is a detail view of a further embodiment of the injection nozzle; and

FIG. 7 is a detail view of another injection nozzle having portions thereof broken away and portions illustrated in section.

## DESCRIPTION OF THE INVENTION

Referring now to the drawing, there is illustrated a single cylinder of an internal combustion engine **7.** The engine 7 includes a crank case secured to a head or frame formed with the cylinder wall **10.** A piston **12** is connected by a rod with a crank of a crank shaft. The head 9 is also formed with cooling fins and suitable manifolds for intake and exhaust.

The fuel injection system of the present invention for the engine 7 serves to inject fuel under pressure into an open throat of the intake manifold which is joined to the intake opening in the cylinder wall. The fuel control system includes a storage reservoir **13** for a supply of fuel. A line **15** is connected to the discharge opening of the reservoir 13 and carries fuel to a fuel pump **16.** The fuel pump 16 pumps the fuel through a fuel line **18** to a control valve **19** having an inlet port and a pair of discharge passageways leading to lines **20** and **21.** The discharge line 20 is connected to the supply reservoir **13.** The line 21 is directed to the injection nozzle **25.** Within the fuel line **20** is disposed a restriction which serves to maintain an injection pressure in the fuel supply system.

The flow control valve **19** adjusts the amount of fuel pumped into line 21 in response to the opening of the air inlet butterfly valve **26** by the throttle, which valve 26 is disposed in the intake manifold **28** between the nozzle 25 and the cylinder intake port or intake valve. A linkage **29** and **30** connects the valve **26** to the valve **19.** As indicated in FIGS. **1, 2** and **3,** the valve **26** controls the amount of air to enter the cylinder. With the

valve 26 closed, the inlet manifold vacuum level draws air and fuel through the idle passageway 31 in the wall of manifold 28, bypassing the valve 26. As the valve opens, FIG. 2, the air is drawn around the nozzle 25 drawing fuel therefrom and as it opens, FIG. 3, the fuel is withdrawn from the full length of the nozzle. As the valve 26 opens the air pressure increases from adjacent the walls of the manifold 28 toward the center. This pressure is accommodated by nozzle design.

Nozzle 25 has a length to extend into the inlet manifold 28 in a position normal to the axis of the manifold. The inlet manifold 28 is disposed on the head 9 and communicates with the inlet opening into the cylinder to permit the intake of the fuel and air mixture into the crank case to be transferred by the piston bypass ports to the compression chamber upon completion of the power stroke. The intake manifold may be provided with an intake horn to enhance the flow of air into the intake manifold 28. The intake manifold is otherwise cylindrical, hollow and of generally uniform inside diameter and has a diameter not less than the inlet opening into the engine.

The nozzle 25, as most clearly shown in FIG. 4, comprises a slender cylindrical rod 32 formed with an axial center bore 33 extending substantially therethrough. One end of the rod has an enlarged end or sleeve to define a fitting at the inlet to join the nozzle to the fuel line 21. The fitting has a bore or main jet 35 smaller in diameter than the bore 33. A plurality of parallel transverse bores 36 and 37 connect the outer surface of the rod with the central bore 33. The rod is disposed in the intake manifold 28 in a direction with its axis generally normal to the axis of the manifold and to the path of the air through the intake manifold. The bores 36 and 37 may be aligned with the axis of the manifold, which is generally the position, however they may be disposed normal to the direction of the moving air through the intake manifold as this aids in drawing the fuel from the central bore of the nozzle into the air stream after the fuel is injected under pressure into the nozzle. An idle bore 38 is disposed to align with the idle passageway 31. The first transverse bores 36 extend diametrically through the rod 32 and communicate with and are positioned adjacent the ends of the central bore 33. These bores are positioned to be adjacent the walls of the manifold 28 to supply and atomize plenty of fuel as the engine is accelerating and sufficient fuel when fully open since the pressure adjacent the walls is slightly less. These bores 36 adjacent the ends of the rod may also be slightly larger than the radial bores 37 which extend part way through the rod from the central bore 33 to the side of the rod. This nozzle 25 is adapted for use with large snowmobile engines, i.e., those having 440 cubic centimeters displacement and for larger engines as in the familiar Volkswagen.

An injection nozzle 40 in FIG. 5 comprises a rod 41 having a central bore 42. The rod 41 has two outer diameters along its length. The rod has an idle bore 43, and transverse bores 44 and 45. The transverse bores 44 adjacent the wall of the manifold are disposed in the larger part of the rod and are chamfered as at 46 to aid in atomization where air pressure is lowest. A main jet 47 leads into the central bore 42. The nozzle 40 is adapted for use with engines having lower displacement as used in chain saws or small snowmobiles, perhaps up to 300 cubic centimeters displacement.

The injection nozzle 50 shown in FIG. 6 is formed of a rod 51 with a central bore 52, a main jet 53, an idle bore 54 and a plurality of spaced transverse bores 55, all parallel and extending in the same direction from the bore 52 on one side of the diametrical line through the axis thereof. The nozzle 50 is adapted for engines having between 300 and 400 cubic centimeters displacement.

The nozzle 60, shown in FIG. 7, comprises a slender cylindrical rod 61 formed with an axial center bore 63. One end of the rod is formed with a counter sink bore to form an inlet end to the axial bore 63. A plurality of transverse bores 64 connect the outer surface of the rod with the axial bore 63. The bores 64 all extend diametrically through the rod 61. The size of the axial bore 63 and transverse bores 64 may vary depending on the size of the engine. For example, in a 90cc engine the bore diameters may be 0.010 inch, for the 400cc engine the diameters may be 0.030 inch, and with a 650cc engine the bore diameters may be between 0.070 and 0.090 inch.

The main jets in the nozzles serve to restrict fuel flow upon rapid changes in throttle position from closed to open. The fuel pump 16 will deliver fuel to the nozzles at pressures between 2 and 6 pounds gauge. The air intake passageway of the intake manifold 28 has an internal diameter of about 1⅝ inches.

The nozzles preferably have the following characteristics within the ranges indicated:

| Nozzle | O.D. Rod Diameter In. | Main Jet In. | Center Bore In. | Transverse No. | Bore Size in In. |
|---|---|---|---|---|---|
| 25 | .060 – .20 | .018 – .10 | .020 – .125 | 36 | .040 – .100 |
| | | | | 37 | .020 – .060 |
| 40 | .250 | .018 – .100 | .030 – .125 | 44 | .080 – .150 |
| | | | | 45 | .040 – .120 |
| 50 | .250 | .018 – .100 | .030 – .125 | 55 | .040 – .120 |
| 60 | .250 | .010 – .090 | .010 – .090 | 64 | .010 – .090 |

The idle jets have a diameter of 0.018 to 0.080 inch.

Having thus described the present invention by reference to the embodiment illustrated in the accompanying drawing, it will be appreciated that various modifications may be made without departing from the spirit or scope of this invention as defined in the appended claims.

What is claimed is:

1. An injection nozzle for use with internal combustion engines which nozzle is adapted to be disposed in a radially extending position in the intake manifold, said nozzle comprising a slender cylindrical rod having a central bore extending substantially the length thereof, means defining a main jet for restricting said central bore at one end of said rod, and having a plurality of axially spaced transverse bores to eject fuel into a said intake manifold, said transverse bores including first transverse bores extending through said rod and

communicating with said central bore adjacent the ends of said central bore and axially spaced smaller radial bores intermediate said first bores.

2. A nozzle according to claim 1 wherein said transverse bores are parallel and are disposed to extend in a direction normal to the axis of said rod.

3. A nozzle according to claim 1 wherein said means defining a main jet is a small bore having a diameter of between 0.018 and 0.10 inch, and wherein said central bore has a larger diameter between 0.02 and 0.12 inch, said transverse bores have diameters between 0.02 and 0.10 inch, and said rod has an outside diameter of between 0.060 and 0.20 inch.

4. A nozzle according to claim 1, including an idle jet communicating with said central bore, said idle jet having a diameter of 0.018 to 0.08 inch, said central bore having a diameter of 0.02 to 0.12 inch and said transverse bores having a diameter of 0.02 to 0.15 inch.

5. A nozzle according to claim 1 wherein said first transverse bores include a pair of bores extending diametrically of said rod adjacent each end of said central bore.

6. A nozzle according to claim 5 wherein said means defining a main jet is a bore smaller than the central bore and has a diameter of between 0.018 and 0.10 inch, said central bore has a diameter between 0.02 and 0.12 inch, said first bores adjacent the ends have diameters of between 0.04 to 0.10 inch and said intermediate radial bores have a diameter of between 0.02 to 0.06 inch.

7. In combination, an intake manifold having an air intake passageway of uniform diameter, and a fuel injection nozzle disposed in a diametrically extending position in the intake manifold passageway, said nozzle comprising a cylindrical rod having a central bore extending substantially the length thereof, means defining a main jet for restricting said central bore at the end of said rod adapted to be connected to the fuel line, and having a plurality of axially spaced transverse bores to eject fuel into the intake manifold passageway, said transverse bores including first transverse bores extending diametrically of said rod and communicating with said central bore adjacent the ends thereof and the walls of said intake manifold defining said passageway and including axially spaced radial bores intermediate said first bores and adjacent the center of said passageway.

8. The combination of claim 7 wherein said manifold passageway has a diameter of about 1⅝ inches and said rod has an outside diameter of 0.060 to 0.20 inch.

9. The combination of claim 8 wherein said means defining said main jet is a bore smaller than the central bore and has a diameter of between 0.018 and 0.10 inch, said central bore has a diameter between 0.02 and 0.12 inch, said first bores have diameters of between 0.04 to 0.10 inch and said intermediate bores are smaller than said first bores and have a diameter of between 0.02 to 0.06 inch.

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