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FUEL INJECTION NOZZLE

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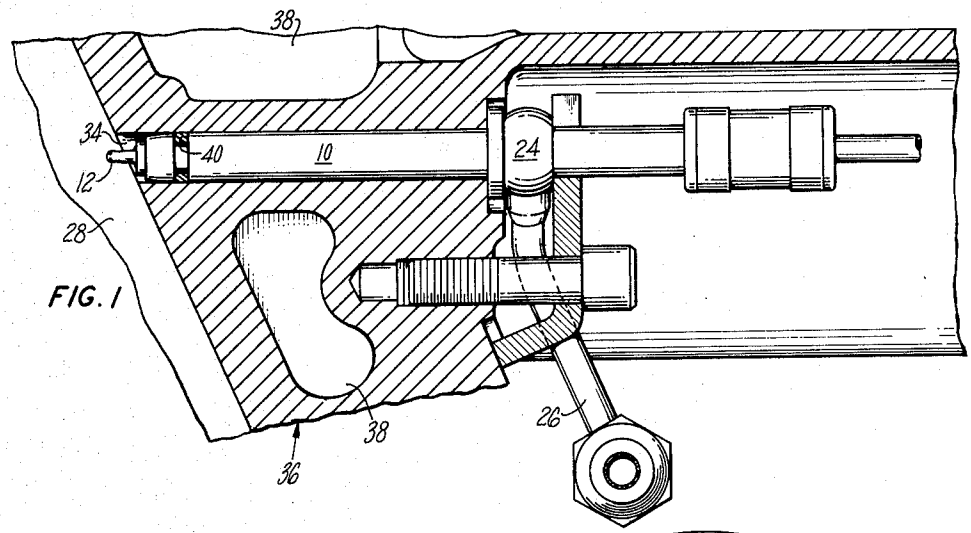


FIG. 1

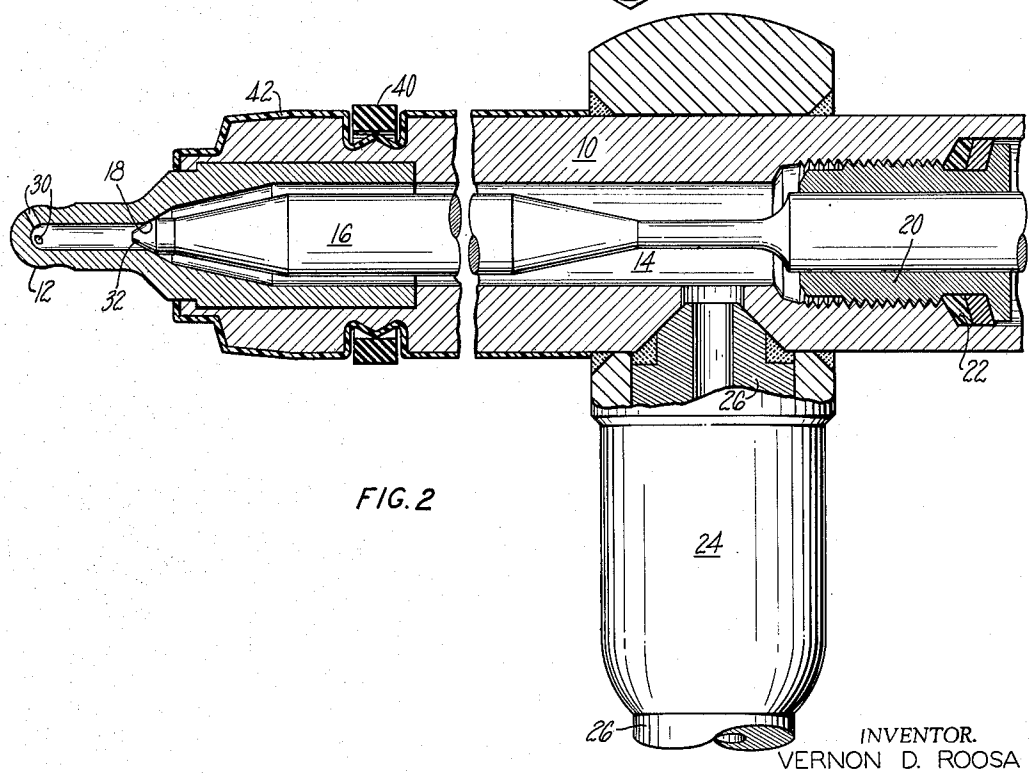


FIG. 2

INVENTOR.
VERNON D. ROOSA

BY Lindsey, Prutzman and Hayes
ATTORNEYS

United States Patent Office

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FUEL INJECTION NOZZLE

Vernon D. Roosa, % Hartford Machine Screw Co., P.O. Box 1440, West Hartford, Conn.

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The present invention relates generally to fuel injection nozzles for internal combustion engines and more particularly to an improved nozzle of the type having a valve that is operated by high pressure fuel supplied to the nozzle, such as described in my copending application Serial No. 275,789 filed April 16, 1963 and entitled Fuel Injection Nozzle.

In fuel injection nozzles of the type involved in this invention it is essential that a plunger within the valve be held in precise alignment with the valve seat and be free to "chatter," that is, to reciprocate rapidly between an open and closed position as the fuel is being discharged from the nozzle. While the manufacture of fuel injection nozzles can be controlled so as to insure the precise alignment of the plunger with the valve seat, it has been found that misalignment sometimes occurs as a result of abuse when the nozzle is removed from the engine block. Since removal of the fuel injection nozzles occurs with a frequency normally associated with the removal of spark plugs, it will be appreciated that their useful life span can be substantially increased if the misalignment of the plunger with the valve seat is prevented or substantially minimized. Accordingly, a primary object of the present invention is to provide a fuel injection nozzle constructed and arranged to minimize any misalignment resulting from its removal from the block of an internal combustion engine.

An additional object of the present invention is to provide an improved fuel injection nozzle adapted for easy removal from an engine block without imposing any strain thereon.

Another object of the present invention is to provide an improved nozzle which, due to its ability to be removed from an engine block without distortion, retains the plunger guide and valve seat in precise alignment throughout an extended period of use.

Other objects will be in part obvious and in part pointed out more in detail hereinafter.

The invention accordingly consists in the features of construction, combination of elements and arrangement of parts which is exemplified in the construction hereafter set forth, and the scope of the invention is indicated in the appended claims.

In the drawings:

FIG. 1 is a fragmentary cross section view of a portion of a cylinder of an internal combustion engine showing a fuel injection nozzle embodying the present invention assembled therein; and

FIG. 2 is an enlarged longitudinal sectional view partially broken away and partially in section of the fuel injection nozzle of the present invention.

Turning now to the drawings in which like numerals refer to like parts, the exemplary nozzle shown therein is generally similar to that disclosed in my copending application Serial No. 275,789 filed April 16, 1963, and includes an elongated generally tubular body member **10** having a nozzle tip **12** at one end thereof and a central longitudinal bore **14** extending throughout its length. Located within the central bore **14** is a rod-like plunger **16** which cooperates with a seat **18** formed in nozzle tip **12** to control the discharge of fuel from the nozzle body **10**. Slidably mounting and precisely aligning the plunger **16** so as to permit rapid reciprocal movement thereof within bore **14** is a plunger guide or collar **20** fixedly positioned within the bore **14** of body **10** by a resin sealant **22** in

a manner disclosed in more detail in the above-identified copending application, Serial No. 275,789. Mounted externally on tubular body member **10** and located intermediate plunger guide **20** and tip **12** is a fuel inlet fitting **24** which provides communion between the fuel supply line **26** and the bore **14** of nozzle body **10**.

In operation, fuel under high pressure enters the bore **14** through the fuel supply line **26** filling the cavity within bore **14** and urging the plunger **16** away from the valve seat **18** of tip **12** against the bias of a spring (not shown) acting along the axis of the plunger. The pressurized fuel thereby actuates the plunger resulting in discharge of the fuel into the firing chamber **28** of the engine through the outlet passages **30** located in nozzle tip **12**. As mentioned hereinbefore, it is essential to the efficient and smooth operation of the fuel injection nozzle that the plunger **16** be at all times properly and precisely aligned so as to produce the proper "chatter" of the valve and consequently the desired atomized spray within the firing chamber of the internal combustion engine. This precision is initially obtained by first providing a lapped fit between the bore of the plunger guide **20** and the portion of the plunger **16** slidably received therein and then positioning the guide **20** in precise coaxial alignment with the valve seat **18**. It will be appreciated that a slight misalignment of the plunger guide **20** will cause a significant lateral dislocation of end **32** of plunger **16** with the valve seat **18** thereby imposing a lateral force between the plunger guide **20** and the lapped portion of the plunger **16** to increase the friction forces therebetween causing seizure or jerky and erratic operation of the nozzle.

Referring now particularly to FIG. 1, the bore in the cylinder head **36** is preferably of a size substantially the same as the outer diameter of the nozzle in order to provide an arrangement in which the size of the engine may be minimized or the size of cooling passages **38** increased. However, some unused space is present between the outer surface of the nozzle and the walls of bore **34** thereby providing an area into which the exhaust products can enter. Although the forward sealing ring **40** provides a barrier to the passage of these products of combustion from the combustion chamber **28**, some seepage nevertheless occurs and there is accumulated along the extent of body **10** within the bore **34** a sufficient amount of these products of combustion to form a carbonaceous deposit. The deposit which comprises tacky and tar-like components, tends to cause adherence between the tubular body member **10** and the walls of bore **34** preventing the easy and smooth removal of the nozzle therefrom. Under such circumstances it is generally necessary to utilize a tool to remove the nozzle from the cylinder head **36**, and in practice, lack of care may result in the slight bending of the nozzle body **10**. This bending results in misalignment of the rod-like plunger **16** within the valve seat **18** rendering the injection nozzle unsatisfactory for further use.

According to the present invention it has now been found that misalignment caused during removal of the nozzle from the bore **34** of the cylinder head can be substantially minimized by applying to the tubular body member **10** an external, thermally stable plastic covering **42**. Covering **42**, as shown in FIG. 2, extends along the outer surface of body **10** from the forward tip end thereof up to fuel inlet fitting **24**. Certain polymeric materials and particularly fluorocarbon polymers are extremely well suited to this application due to their excellent thermal stability over an extremely wide temperature range as well as their relative resistance to corrosive materials, their high strength and low coefficient of friction. A coating of tetrafluoroethylene polymer

sold under the trade name "Teflon" by E. I. du Pont de Nemours and Co., Wilmington, Delaware, has been found particularly advantageous due not only to its ability to withstand the normal operating temperatures encountered in internal combustion engines but also to the fact that its surface exhibits high lubricity and unctuosity preventing the adherence thereto of carbonaceous deposits. For example, a coating of about 0.35 mil was found to be substantially unaffected after a prolonged operating period at 500° F. and permitted removal of the nozzle without the aid of a tool.

According to the preferred method, the coating 42 is applied subsequent to the assembly of the tubular body 10 and the fuel inlet fitting 24 but prior to the incorporation of the nozzle tip, plunger and guide member. For best results, it is essential that the nozzle body be cleaned prior to the coating operation in order that a uniform and secure plastic covering be obtained. For example, the nozzle body may be degreased by normal cleaning accompanied by a 750° F. bake for fifteen minutes to remove any residual oil present thereon. Subsequently, the surface of body 10 may be prepared by blasting with No. 120 aluminum oxide grit in order to provide high surface area to the clean surface, after which the plastic coating is applied.

According to the present invention it is preferred to use a spray-coating technique since thin, firmly adhering films or coatings generally are required. Accordingly, the surface-prepared nozzle body 10 is spray coated utilizing an aqueous dispersion of "Teflon" or other suitable fluorocarbon dispersion which contains a solids content of less than 15 percent. After uniformly applying the dispersion, it is quickly set or cured at elevated temperatures to provide the tenaciously adhering covering. Good results have been obtained with a cure of about 10 to 15 minutes at 750° F.

While the exact thickness of the coating 42 is not critical in the sense that minor variations are objectionable, it is essential that the coating be of sufficient thickness to resist abrasive destruction upon the repeated removal of the injection device from the passage 34. According to the present invention, we have found that coatings of greater than 1 mil thickness are not utilized since they tend to provide no additional advantageous characteristics. The previously described spray-coating operation has been found to consistently produce films or coatings having a thickness of approximately 0.2 to 0.6 mil which readily adhere to the nozzle body and resist any shear forces therebetween.

From the foregoing it will be apparent that the present invention provides a new and improved injection nozzle which substantially minimizes the misalignment caused during removal of the nozzle from the cylinder head of an internal combustion engine. Additionally, the present invention substantially eliminates seizing of the nozzle within the passage of the cylinder head by providing a coating to which the carbonaceous exhaust products will not readily adhere thereby permitting extensive reuse of the nozzle device and effectuating a substantial economic saving to the user.

As will be apparent to persons skilled in the art, various modifications and adaptations of the structure above described will become readily apparent without departure from the spirit and scope of the invention, the scope of which is defined in the appended claims.

I claim:

1. A fuel injection device having a discharge tip with a valve seat and an operating plunger adapted to be seated thereon comprising a nozzle body mounting said tip and said plunger and adapted to be positioned in a passage within the engine block of an internal combustion engine with the tip positioned for discharge of fuel into the firing chamber of said engine; said nozzle body having thereon a thin covering of a polymeric material along at least a portion of the outer surface thereof adapted to be positioned in said passage, said polymeric material being characterized by its thermal stability at the normal operating temperatures of said engine as well as its low surface energy to thereby minimize distortion of the nozzle body as it is removed from the engine.

2. A fuel injection device having a discharge tip with a valve seat and an operating plunger adapted to be seated thereon comprising a nozzle body mounting said tip and said plunger and being adapted for positioning in a passage within the engine block of an internal combustion engine with the tip positioned for discharge of fuel into the firing chamber of said engine; said nozzle body having thereon a thin covering of a tetrafluoroethylene polymer along a substantial longitudinal portion of its outer surface adapted to be positioned within said passage to thereby minimize distortion of the nozzle body as it is removed from the engine.

3. A fuel injection device comprising a nozzle body having a bore defining a valve chamber and a valve seat and adapted to be positioned in a passage within said block communicating with the firing chamber of said engine; a plunger disposed within said bore and having one end thereof cooperating with said valve seat to close a discharge passage thereof, and guide means in said bore supporting said plunger in precise alignment with said valve seat, said nozzle body having an external nonmetallic covering along at least a portion of the outer surface thereof adapted to be positioned within said passage, said covering being characterized by its thermal stability at the normal operating temperature of said engine as well as its resistance to corrosive substances and the adherence of carbonaceous exhaust products to thereby minimize distortion of the nozzle body as it is removed from the engine.

4. A fuel injection device comprising a nozzle body having a bore defining a valve chamber and a valve seat and adapted to be positioned in a passage within said block communicating with the firing chamber of said engine; a plunger disposed within said bore and having one end thereof cooperating with said valve seat to close said bore, and guide means in said bore supporting said plunger in precise alignment with said valve seat, said nozzle body having an external nonmetallic covering along at least a portion of the outer surface thereof adapted to be positioned within said passage, said covering being of sufficient thickness to resist abrasive destruction thereof upon repeated removal of the device from said engine and being further characterized by its thermal stability at the normal operating temperature of said engine and its resistance to the adherence of carbonaceous exhaust products.

5. A fuel injection device comprising an elongated nozzle body having a bore defining a valve chamber and a valve seat and being adapted to be positioned in a passage within said block communicating with the firing chamber of said engine; a plunger disposed within said bore and having one end thereof cooperating with said valve seat to close said bore, and guide means in said bore supporting said plunger in precise alignment with said valve seat, said nozzle body having a thin covering of a polymeric fluorocarbon along at least a substantial portion of the outer surface thereof adapted to be positioned within said passage, said polymeric fluorocarbon being characterized by its thermal stability at the normal operating temperature of said engine as well as its low surface energy.

6. A fuel injection device comprising an elongated generally tubular nozzle body having an outwardly opening bore defining a valve chamber and being adapted to be positioned in a passage within said block communicating with the firing chamber of said engine; a nozzle tip disposed in and secured to said bore opening and having a valve seat formed therein; a plunger disposed within said bore and having one end thereof cooperating with said valve seat to close said bore; and guide means in said bore being secured therein to support said plunger in pre-

cise alignment with said valve seat, said nozzle body having an external nonmetallic covering along at least a portion of the outer surface thereof adapted to be positioned within said passage, said covering being characterized by its thermal stability at the normal operating temperature of said engine as well as its resistance to corrosive substances and the adherence of carbonaceous exhaust products.

7. A fuel injection device comprising an elongated generally tubular nozzle body having an outwardly opening bore defining a valve chamber and being adapted to be positioned in a passage within said block communicating with the firing chamber of said engine; a nozzle tip disposed in and secured to said bore opening and having a valve seat formed therein; a plunger disposed within said bore and having one end thereof cooperating with said valve seat to close said bore, and guide means in said bore being secured therein to support said plunger in precise alignment with said valve seat, said nozzle body having along the outer surface thereof adapted to be positioned within said passage a thin covering of a tetrafluoroethylene

polymer to thereby minimize distortion of the nozzle body as it is removed from the engine.

8. A fuel injection device as set forth in claim 7 wherein the covering of polymer has a thickness of about 0.2 to 0.6 mil.

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MARK NEWMAN, *Primary Examiner.*

RICHARD B. WILKINSON, *Examiner.*