Sept. 3, 1940. S. B. GOLD ET AL 2,213,928

FUEL INJECTION NOZZLE

Filed Nov. 4, 1936

Fig. 1.

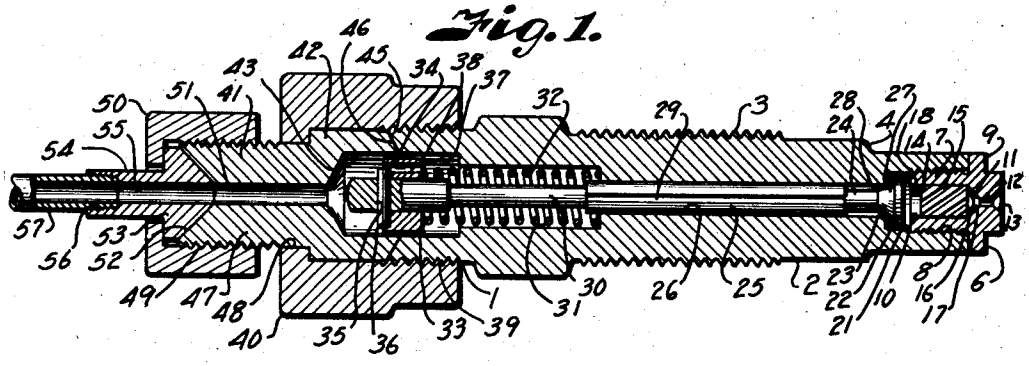


Fig. 2.

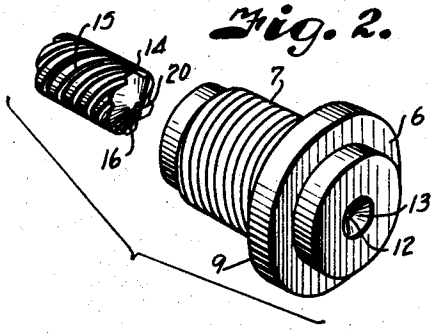


Fig. 3.

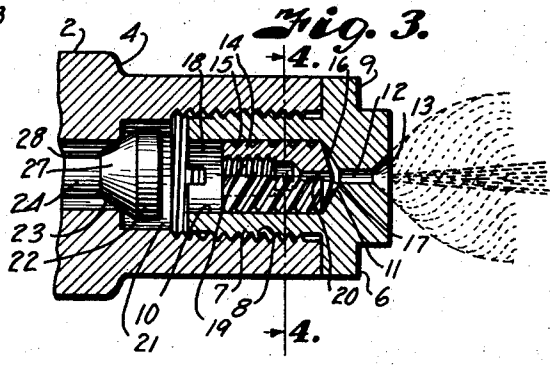
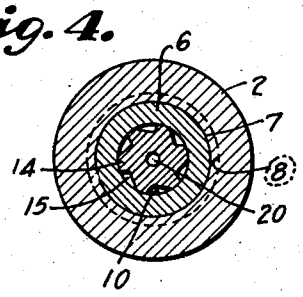


Fig. 4.



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FUEL INJECTION NOZZLE

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2 Claims. (Cl. 299—107.1)

This invention relates to fuel injection nozzles for internal combustion engines and particularly to those wherein solid fuels are injected directly into the combustion chamber. In engines of this character it has been found difficult to obtain maximum efficiency because of peculiarities incidental to the fuel injection. In most instances it is difficult to effect proper ignition of the injected fuel relatively to the piston travel because of slow burning qualities of the injected fuel. When attempts have been made to hasten burning of the fuel by injecting it in finely atomized form, it has been impossible to obtain sufficient penetration thereof into the combustion chamber to distribute a full fuel charge uniformly therein and when the fuel is injected in spray or jet form to obtain the desired penetration, then the combustion is excessively retarded because of slow ignition. It is, therefore, the present practice to effect initial ignition before top dead center in order that it may be completed by the time that the piston is ready to move on its power stroke. It is thus obvious that when the ignition begins and progresses during top dead center position of the piston, the pressures in the combustion chamber rise momentarily above the maximum desired pressure and then as the piston moves over top dead center this excessive pressure suddenly drops with the result that full force of the explosive charge is not applied as useful energy. On the contrary, the sudden peak of excessive pressure results in loss of power and exerts thrusts which are extremely detrimental to the working parts of the engine, moreover this excessive initial pressure interferes with complete combustion and results in fuel waste.

It is, therefore, the principal object of the present invention to inject a fuel charge and to effect ignition thereof so as to control the combustion without creating excessive peak pressures and at the same time utilize all of the combustion forces as useful energy.

Other objects of the invention are to provide a nozzle for injecting the fuel so as to obtain quick initial ignition as well as penetration of the fuel charge into the combustion chamber, and to provide a nozzle construction whereby a portion of the fuel is introduced in atomized form to promote ignition and the remaining portion is injected in jet form to obtain desired penetration and uniform distribution of fuel in a main combustion chamber.

In accomplishing these and other objects of the invention, as hereinafter pointed out, we have provided improved details of structure, the preferred form of which is illustrated in the accompanying drawing, wherein:

Fig. 1 is an enlarged longitudinal section through our improved fuel injecting nozzle.

Fig. 2 is a detail perspective view of the orifice members of the fuel injecting nozzle.

Fig. 3 is a detail section through the discharge end of the jet nozzle illustrating the orifice members in operative position and showing the discharge of the fuel in combination atomized and jet form.

Fig. 4 is a cross-section through the discharge end of the nozzle on the line 4—4 of Fig. 3.

Referring more in detail to the drawing:

1 designates a fuel injecting nozzle constructed in accordance with the present invention and wherethrough fuel is delivered into a combustion chamber of an internal combustion engine. The nozzle is shown as including a nozzle body 2 having threads 3 for engaging a threaded opening in the engine combustion chamber or head (not shown). Formed on the nozzle body and spaced from the threads 3 is an annular seat 4 for engaging against an internal seat of the opening to effect a seal about the nozzle and provide a stop to maintain the nozzle tip 6 in definite relation to the combustion or ignition chamber.

The nozzle tip includes a threaded shank 7 that is engaged in an internally threaded bore 8, and has annual stop collar 9 engaging the inner end of the nozzle body. Formed in the shank of the nozzle tip is a cylindrical recess 10 terminating short of the outer end of the tip to provide a conical guide portion 11 sloping toward an orifice 12 having its outer end counterbored to form an outwardly flaring outlet 13. Pressed into the bore 10 is an insert 14 having a plurality of spiral grooves 15 cut at approximately a 45° angle in the outer cylindrical surface thereof. The spiral grooves extend the full length of the insert and communicate with the respective ends of the bore 10. The end of the insert adjacent the orifice 12 is slightly crowned, as at 16, at a lesser angle than the surface 11 to provide a space 17 connecting the outlet end of all of the grooves with the orifice 12. The opposite end of the insert terminates short of the open end of the bore to provide a space 18 connecting the inlet ends of the respective grooves. It is thus obvious that with the insert applied, the grooves cooperate with the inner surface of the bore to form a plurality of spiral channels through which a portion of the liquid admitted to the nozzle is discharged through the nozzle orifice into the ignition chamber. The fuel passed through these

passages furnishes the finely atomized particles of fuel that are needed for quick ignition, as hereinafter described.

Formed within the insert and opening from the rear end thereof is a recess 19 terminating short of the forward end in an orifice 20 of a predetermined diameter relative to the orifice 12 and which aligns directly therewith so that a portion of the fuel admitted to the space 18 is passed directly through the insert and through the orifices 20 and 12 to the ignition chamber. The orifices are of definite size to maintain the required pressure on the injected fuel so as to produce the desired fuel penetration into the air charge in the engine. However, the length and diameter of the orifices is not critical for good operation of the engine as in nozzles of the conventional type, since the nozzle in the present case does not depend upon the length of the orifice to govern the type of spray formed. Attention is here directed to the fact that the single orifice at the outlet end of the nozzle may be comparatively large since only one orifice is used. An orifice of such size will not readily clog and will remain in service over long periods without cleaning.

The threaded bore 8 in the nozzle tip terminates at its inner end in a reduced cylindrical bore forming a chamber 21 for accommodating the head 22 of a fuel control valve 23. The valve 23 includes a stem 24 having an enlarged bearing portion 25 slidably mounted in a guide opening 26 extending longitudinally of the nozzle body to retain the bevelled face 27 of the valve head in concentric seating relation with a seat 28 that is formed at the juncture of the guide opening 26 with the chamber 21. In order to provide flow of fuel into the chamber 21, the bearing portion 25 of the stem is spaced from the head of the valve and has a plurality of longitudinal grooves 29 arranged about the periphery thereof.

The end 30 of the valve stem is of smaller diameter than the bearing portion and projects through a recess 31 of substantially larger diameter to accommodate a valve spring 32 that is sleeved over the stem and has one end bearing against the bottom of the recess and its opposite end against a stop collar 33 that is retained on the stem by a cross pin 34. The pin 34 extends through an opening 35 in the stem and has its ends seated within a recess 36 in the stop collar. The stop collar is preferably slidably mounted within a large counterbore 37 of the recess 31 to assist in centering the free end of the stem, and to permit flow past the collar, the collar is provided with a plurality of flow openings 38, as shown in Fig. 1.

The outer end of the nozzle body terminates in a threaded neck 39 to mount a cap nut 40 carrying a sleeve 41 that forms a continuation of the nozzle. The sleeve 41 has a head 42 provided with a recess 43 conforming in diameter to the counterbore 37 of the recess 31, and extending circumferentially thereof is a bevelled face 45 engaged in a bevelled counterbore 46 of the nozzle body to effect a seal therebetween when the cap is threaded on the body, as shown in Fig. 1. The sleeve 41 has a shank 47 projecting through an opening 48 of the cap and terminates in a threaded portion 49 for mounting a union nut 50. The sleeve is also provided with an axial bore 51 extending therethrough and terminating in a bevelled seat 52 for mounting the bevelled head 53 on a pipe connection 54. The pipe connection 54 also has a bore 55 conforming to the bore 51 and an internally threaded socket 56 into which the fuel supply pipe 57 is threaded.

The union nut 50 is sleeved over the pipe connection and has an inwardly extending flange 58 for engaging the back of the head 53 to draw the bevelled face of the head in sealing engagement with the bevelled seat 49 when the nut is threaded on the sleeve 41. The opposite end of the pipe 57 connects with a fuel supply pump (not shown). The fuel is delivered through the pipe 57 under the pump pressure and unseats the valve 23 to pass into the chamber 21 from where a portion thereof is passed under pressure through the spiral passageways of the insert while another portion is passed through the orifice 20.

The portions of fuel passing through the spiral passageways are given momentum in a spiral direction so that when discharged from the outlet ends of the passages into contact with the conical guide portion 11, across which they move to the outlet orifice at high velocity, they are diverted by the jet of fuel being discharged through the orifice 20, through the outlet orifice of the nozzle. The extremely high velocity imparted to the spiral jets, supplemented by the injecting effect of the jet of fuel issuing from the insert orifice 20, is sufficient to break up and thoroughly atomize the spiral jets so that the particles thereof are readily ignited when they contact the hot surfaces in the ignition chamber.

The shape of the outlet end of the nozzle is such that the spray atomized portion of the fuel is directed in close contact with the inner wall of the ignition or combustion chamber. Since this spray is quickly ignited it begins to burn immediately upon entrance into the ignition chamber, however, it has little carrying value and will not penetrate the high pressure air in the combustion chamber, but it builds up sufficient heat to thoroughly ignite the central jet of fuel passed through the orifice 20 and which has sufficient velocity to penetrate the air contained in the respective chambers.

Attention is directed to the fact that since the fuel starts burning immediately upon its injection it burns progressively. The combustion is, therefore, carried on at a very uniform rate to prevent sudden peak pressures, as above mentioned.

From the foregoing, it is obvious that we have provided a fuel injection nozzle whereby the fuel is injected in a manner to provide for better and more efficient ignition of the charge so as to obviate objectional peak pressures and provide for smoother engine operation.

What we claim and desire to secure by Letters Patent is:

1. A fuel injection nozzle including a nozzle body having a valve chamber, a nozzle tip supported by the valve body and having a bore terminating in a conical seat and an unobstructed port in the apex of said seat, a cylindrical insert having pressed fit within the bore of the tip and having a coned end of less angle than the seat so that the periphery of the coned end engages against the outer edge of the conical seat and a passageway is formed at the conical end of the insert in communication with said port, said insert having a cylindrical port arranged coaxially with and of smaller diameter than the unobstructed port to discharge a straight jet of fuel at high velocity centrally through said port, and a spiral passageway in the cylindrical sur-

face of said insert and connecting the valve chamber with said end passageway whereby a jet of fuel is moved spirally through said spiral passageway and circumferentially and individually of said straight jet to issue from said nozzle tip in a conical spray circumferentially and individually of said straight jet.

2. A fuel injection nozzle including a nozzle body having a valve chamber, a tip in said valve chamber provided with a bore terminating in an unobstructed cylindrical port having an outwardly flaring counterbore, a cylindrical insert having fixed engagement in said bore and forming an end passageway communicating with said port, said insert having a cylindrical port coaxial with and of smaller diameter than the unobstructed port to discharge a straight jet of fuel at high velocity centrally through said port, and a spiral passageway in the cylindrical surface of said insert and connecting the valve chamber with said end passageway whereby a jet of fuel is moved spirally through said spiral passageway and through said end passageway circumferentially and individually of said straight jet to issue from said nozzle tip in a concal spray crcumferentially and individually of said straight jet.

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