May 27, 1947. J. F. HOFFER 2,421,329

FUEL INJECTION NOZZLE

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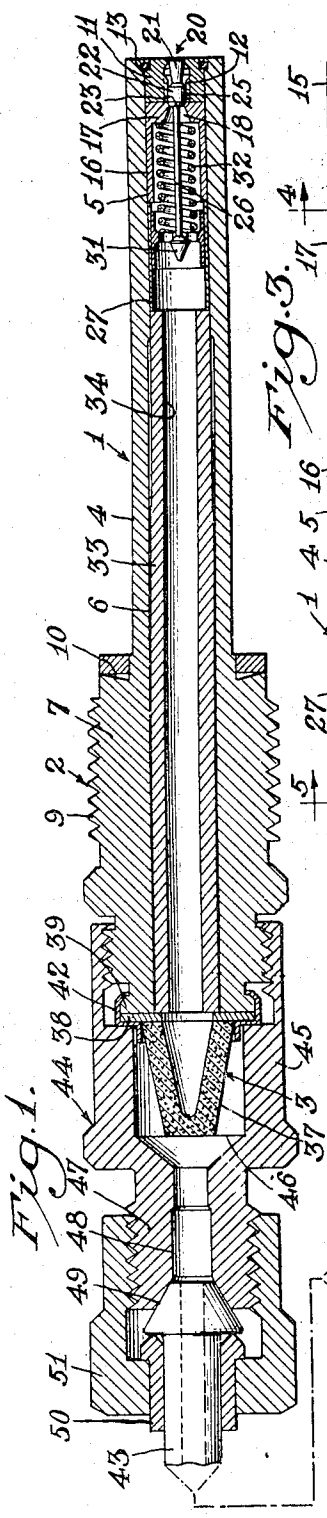

Fig. 1.

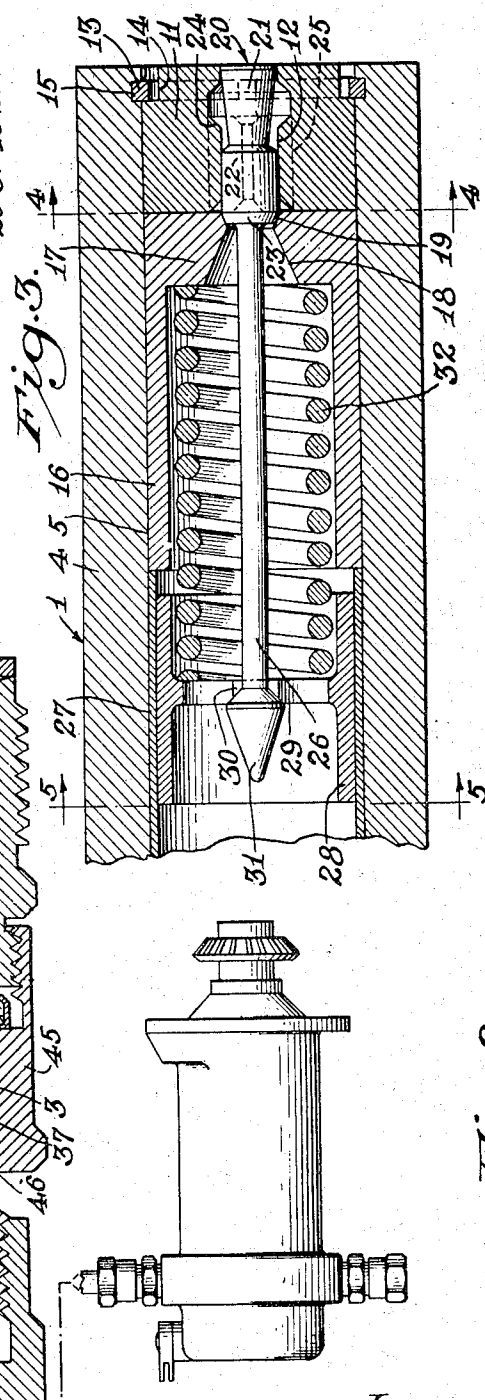

Fig. 3.

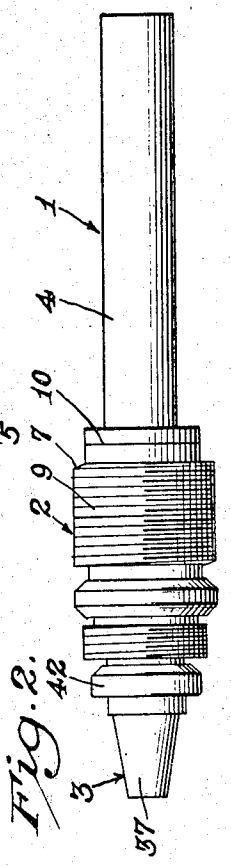

Fig. 2.

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Fig. 4.

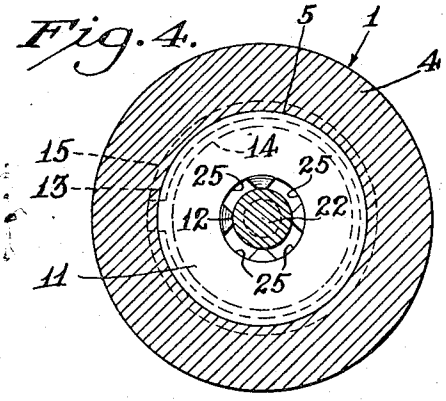


Fig. 5.

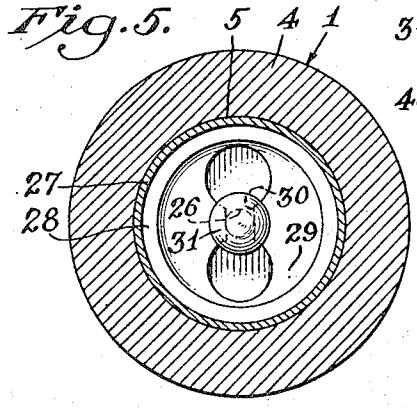


Fig. 6.

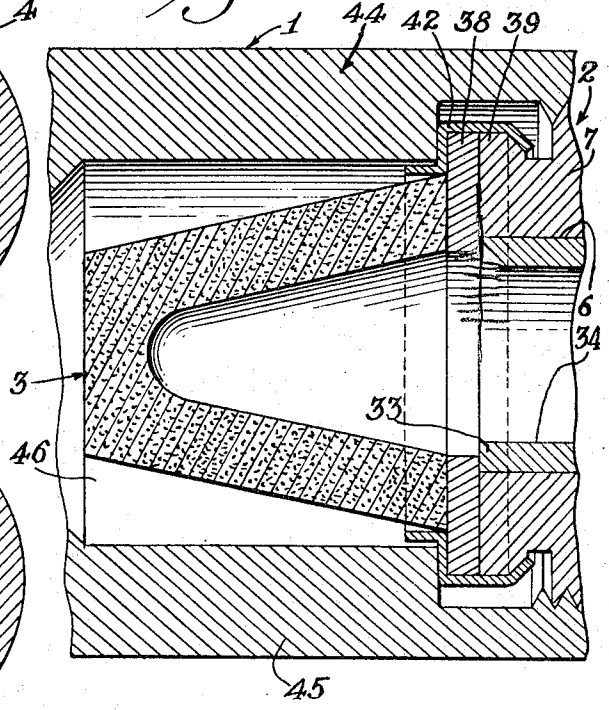
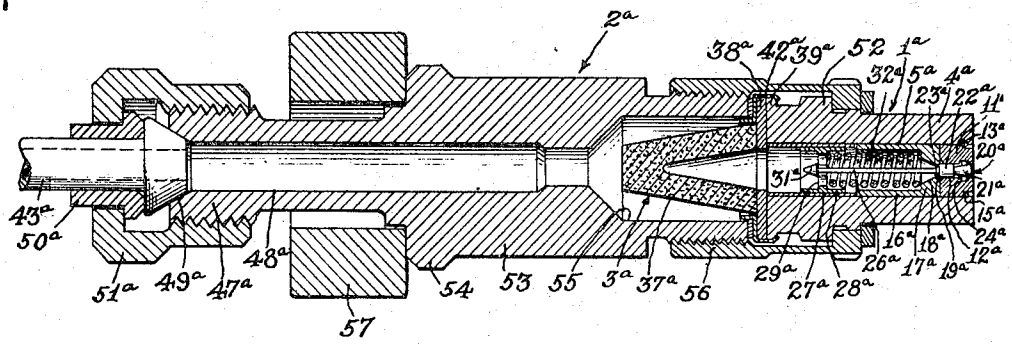


Fig. 7.



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UNITED STATES PATENT OFFICE

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FUEL INJECTION NOZZLE

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Application July 8, 1941, Serial No. 401,499

3 Claims. (Cl. 210—166)

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The present invention relates to improvements in nozzles adapted particularly for delivering timed metered injections of liquid fuel in connection with the operation of internal combustion engines.

One of the objects of the invention is to provide a novel fuel injection nozzle comprising a self-contained nozzle tip and filter unit adapted to be removably and interchangeably mounted in different nozzle holders.

Another object is to provide a new and improved nozzle tip and filter unit which is sealed and tamper-proof so that the unit after proper assembly and adjustment at the source of manufacture cannot be subjected to maladjustment by inexpert users or service men, and so that the unit can be bodily removed from its environment in normal use and handled without injury of the working parts and without the entry of dirt and other foreign matter.

Another object is to provide a novel fuel injection nozzle having a nozzle tip and filter assembled into a self-contained unit by means of a tamper-proof connection which does not utilize screw threads and which must be mutilated in order to separate the parts.

Further objects and advantages will become apparent as the description proceeds.

In the accompanying drawings,

Figure 1 is a longitudinal sectional view of a fuel injection nozzle and filter embodying the features of my invention.

Fig. 2 is a side elevational view on a reduced scale of the nozzle and filter assembly.

Fig. 3 is an enlarged axial view of the nozzle tip.

Fig. 4 is a transverse sectional view taken along the line 4—4 of Fig. 3.

Fig. 5 is a transverse sectional view taken along line 5—5 of Fig. 3.

Fig. 6 is an enlarged fragmentary axial sectional view illustrating the means for connecting the filter.

Fig. 7 is a view similar to Fig. 1 of a modified form of self-contained nozzle and filter unit.

While the invention is susceptible of various modifications and alternative constructions, I have shown in the drawings and will herein describe in detail the preferred embodiment but it is to be understood that I do not thereby intend to limit the invention to the specific form disclosed, but intend to cover all modifications and alternative constructions falling within the spirit and scope of the invention as expressed in the appended claims.

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Referring more particularly to the drawings, the fuel injection nozzle constituting the exemplary embodiment of my invention (Figs. 1 to 6) comprises generally a nozzle tip 1, a holder 2 and a filter 3. In the present instance, the nozzle tip 1 and the holder 2 are assembled in an integral casing structure, and the filter 3 is permanently and hermetically connected to the base end of the holder in the path of fuel flow to the nozzle tip.

The nozzle tip 1 may be of any suitable type and form, and preferably comprises few and light working parts quickly responsive to pressure changes. In the present instance, the nozzle tip 1 is geneerally like that disclosed in my copending application Serial No. 259,088, filed March 1, 1939, now Patent 2,351,965, granted June 20, 1944.

In the preferred construction, the nozzle tip 1 and holder 2 comprise an elongated tubular shell or sleeve providing an outer casing 4 having a discharge end and a base end. The discharge end of the casing 4 has a bore 5 housing the operating parts of the nozzle tip 1, and the base end has a slightly larger bore 6 through which fuel under pressure is adapted to be supplied to the tip. The casing 4 is formed with an enlargement 7 having peripheral screw threads 9 adapted for engagement with a suitable support and defining a clamp shoulder 10.

Tightly fitted into the outer end of the bore 5 is a cylindrical orifice block 11 formed with an axial discharge bore 12. A snap ring 13 engages in a peripheral edge notch 14 in the block and is seated in a groove 15 in the bore 5 to confine the block in position. Closely fitted within the bore 5 is a tubular valve seat member 16 having an end wall 17 in pressure tight engagement with the orifice block 11. The end wall 17 is provided with an axial passage 18 adapted for connection with the source of fuel supply, and the outer end of this passage is formed with an outwardly facing valve seat 19 adapted for communication with the bore 12.

A pintle 20 extends slidably through the bore 12 and coacts therewith to define an annular discharge orifice. By selective variation in the form of the bore 12 or the pintle 20, or both, different spray patterns and characteristics may be obtained as desired to best suit different engine requirements. In the present instance, the pintle 20 is formed in the shape of a spray control cone 21 movable outwardly to obtain a progressively increasing orifice area. The pintle is rigid with a cylindrical valve member 22 slidable in the

bore 12 and formed at the inner end with an annular valve face 23 adapted for engagement with the seat 19. A peripheral groove 24 is formed in the bore 12 about the cone 20 and is connected through peripherally spaced longitudinal downflow grooves or passages 25 to the valve seat 19. It will be evident that the seat 19 and the valve face 23 constitute an outwardly opening valve for controlling the supply of fuel to the orifice.

An actuating stem 26 is formed integral with the valve member 22, and extends axially through the valve seat 19 and passage 18 into and beyond the valve seat member 16. Fitted snugly within the bore 5, in end abutting engagement with the valve seat member 16, is a thin-walled bearing sleeve 27. A valve hanger 28, with opposite end flanges constituting an elongated guide sleeve slidable within the bearing sleeve 27, has a transverse wall 29 formed with a suitable slot 30 in interlocking engagement with the stem 26. More particularly, the slot 30 has two enlarged eccentric holes adapted to receive a head 31 on the end of the stem 26 for assembly, and a central portion adapted to engage under the head so as to restrain opening movement of the valve. A coiled compression spring 32 encircles the valve stem 26, and impinges at one end against the end wall 17 of the valve seat member 16 and at the other end against the valve hanger 28. The arrangement is such that the spring 32 tends to maintain the valve in closed position with a predetermined pressure.

When the valve 19, 23 is closed, the guide sleeve 28 is spaced from the inner end of the valve seat member 16. Upon the supply of fuel under predetermined valve opening pressure, the valve member 22 is lifted from the seat 19 against the pressure of the spring 32 and the control cone 21 is moved outwardly to progressively increase the orifice opening. The maximum height of rise is determined by engagement of the hanger or guide sleeve 28 with the inner end of the valve seat member 16.

Extending through the bore 6 of the body sleeve 4 is an inner spacer sleeve 33 having an axial bore 34 and abutting against the bearing sleeve 27. The various members 16, 27 and 33 are confined in assembled relation within the sleeve 4 against the orifice block 11 by the filter 3 which is rigidly secured to the base end of the holder 2 in abutting engagement with the sleeve 33.

An important feature of the present invention resides in combining the nozzle tip 1 and the filter 3 to form a self-contained sealed unit. In the form of Figs. 1 to 6, the holder also forms a part of the unit, but it is to be understood that the invention contemplates broadly the self-contained nozzle tip and filter construction with and without the holder. In a sense, the tip body instead of being mounted in a separate holder, is itself merely elongated and formed with the threads 9 for securing the nozzle tip to the engine. This permits of a restricted diameter which is advantageous and sometimes necessary when the injector is applied to aircraft engines. By locating the filter 3 at the inlet to the nozzle tip and in permanent fixed relation thereto, instead of at some remote point in the fuel supply line, any particles of foreign matter dislodged in the fuel supply line are precluded from entering the nozzle tip and interfering with the proper functioning of the delicate working parts. When out of normal environment, the nozzle tip is protected against injury and dislocation of the working parts, and against the entry of foreign matter.

The filter 3 may be of any suitable type or form, and in the present instance is shown as comprising a hollow inverted cup 37 of small granular particles of bronze sintered together to form a bond. The cup has a peripheral end flange 38 abutting against a similar flange 39 on the base end of the holder 2. Fuel filtering through the walls of the cup 37 into the interior is discharged into the bore 34.

To secure the filter 3 permanently and tightly in assembled relation with the holder 2, a ring 42 of suitable material, such as copper or soft metal, is tightly pressed about the flanges 38 and 39. One marginal edge of the ring 42 is bent or crimped over the free edge of the flange 38, and the other marginal edge of the ring is similarly spun or crimped over the free edge of the flange 39. As a result, the holder 2 and the filter 3 are rigidly secured together with a sealed connection. To separate the parts so as to obtain access to the interior of the nozzle tip would require mutilation of the ring 42. It will be noted that the connection avoids the use of screw threads which, if provided, would be likely to result in minute particles of metal finding their way into the nozzle tip.

The self-contained unit (see Fig. 2) is assembled at the factory where the operating parts of the tip are accurately adjusted for correct operation, and where the unit is then sealed by means of the tamper-proof connection 42. The unit can be transported separately, and, being fully enclosed, is protected against injury and the entry of dirt. Should the unit require repair or readjustment, it can be bodily removed from its normal environment and returned to the factory for expert attention while a replacement unit is employed. In mounting the unit in place, the holder 2 is threaded into the body of the engine (not shown) and a fuel supply conduit or tube 43 is connected to the base end of the holder 2 by means of a hollow coupling member 44.

The coupling member 44 has a hollow cup 45 on one end which is threaded onto the base end of the holder 2 in abutting engagement with the flange 38 and which provides a chamber 46 freely enclosing the filter 3. The other end of the member 44 has a threaded stem 47 formed with an axial bore or passage 48 opening to the chamber 46 and formed with a tapered counterbore 49. The fuel supply tube 43 is clamped at one end in the counterbore 49 by means of a sleeve 50. A nut 51 embracing the sleeve 50 is threaded onto the stem 47 to complete the assembly.

In the modified form of Fig. 7, the self-contained unit consists only of the nozzle tip and filter, and is adapted to be replaceably mounted in different holders which, in turn, are adapted to be supported on the engine. Except for this difference, the construction is substantially the same, and hence like parts are identified by the same reference numerals distinguished by the letter *a*. In this form, the sleeve or casing 4*a* is somewhat shorter than in Fig. 1 and is formed with a mounting flange 52. The self-contained unit is adapted to be secured in a holder 53 which takes the place of the coupling member 44 and which is formed with a peripheral mounting flange 54. One end of the holder 53 is externally threaded, and is formed with a large bore 55 constituting a chamber to enclose the filter 3*a*. The self-contained unit and the holder 53

are tightly clamped in assembled relation by a nut **56** which engages the mounting flange **52** and which is threaded onto the holder. The holder with the attached unit is inserted into the combustion chamber of the engine, and is adapted to be held in position by means of a clamp plate **57** engaging the outer face of the mounting flange **54**. The outer end of the holder body is connected to the fuel supply duct **43** in the same manner as the coupling member **44** of Fig. 1.

The construction of the fuel injection nozzle independently of the filter is disclosed and claimed in my copending divisional application, Serial No. 698,322, filed September 20, 1946.

I claim as my invention:

1. In a fuel injection nozzle, in combination, an elongated sleeve having a base end and a discharge end, and being formed intermediate its ends with screw threads for connection with a suitable support, means in the discharge end of said sleeve defining a discharge orifice, valve means including a stationary tubular valve seat member disposed against said first mentioned means and a valve for controlling the supply of fuel under pressure through said sleeve to said orifice, abutting tubular spacer means in said sleeve engaging said seat member, a filter disposed against said base end and serving to hold said spacer means in position, means rigidly connecting said filter and said sleeve, and a hollow member threaded onto said base end of said sleeve and enclosing said filter and being adapted for connection to a source of fuel supply.

2. In a fuel injection nozzle, in combination, an elongated sleeve having a base end and a discharge end, and being formed intermediate its ends with means for connection with a suitable support, means in the discharge end of said sleeve defining a discharge orifice, valve means including a stationary tubular valve seat member disposed against said first mentioned means and a valve for controlling the supply of fuel under pressure through said sleeve to said orifice, abutting tubular spacer means in said sleeve engaging said seat member, a filter disposed against said base end and serving to hold said spacer means in position, means rigidly connecting said filter and said sleeve, and a hollow member threaded onto said base end of said sleeve and enclosing said filter and being adapted for connection to a source of fuel supply.

3. In a fuel injection nozzle, in combination, an elongated sleeve having a base end and a discharge end, and being formed intermediate its ends with means for connection with a suitable support, means in the discharge end of said sleeve defining a discharge orifice, valve means including a stationary tubular valve seat member disposed against said first mentioned means and a valve for controlling the supply of fuel under pressure through said sleeve to said orifice, abutting tubular spacer means in said sleeve engaging said seat member, a filter disposed against said base end and serving to hold said spacer means in position, a crimped ring rigidly connecting said filter and said sleeve and requiring mutilation to effect separation of said filter and sleeve, and a hollow member threaded onto said base end of said sleeve and enclosing said filter and being adapted for connection to a source of fuel supply.

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