Sept. 4, 1951 E. O. OLSON 2,566,532

COMBUSTION SPRAY NOZZLE

Filed Aug. 20, 1947

Fig. 1

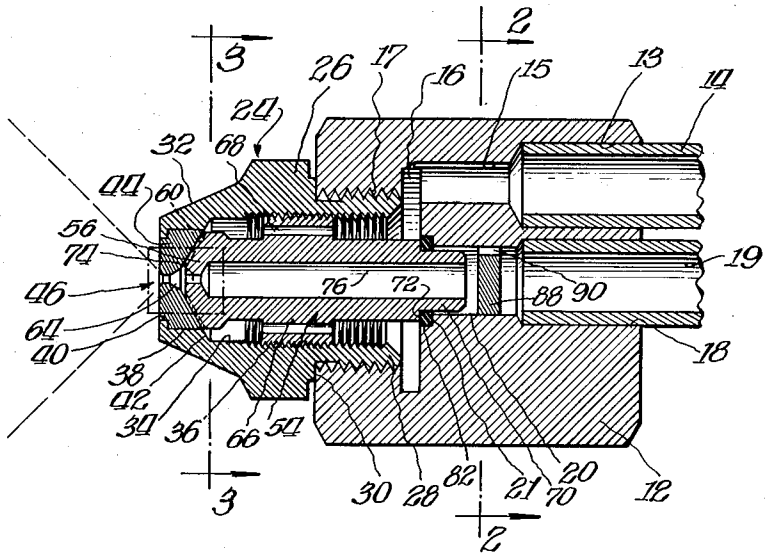


Fig. 3

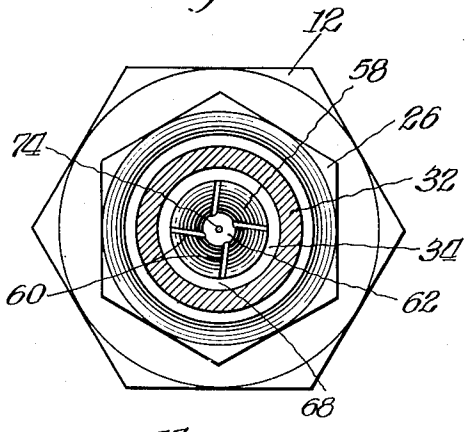
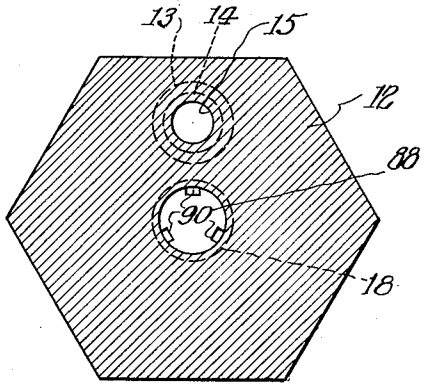


Fig. 2



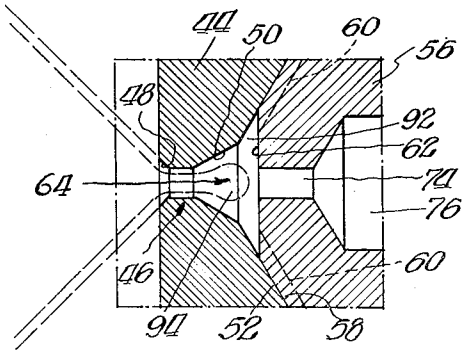


Fig. 4

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COMBUSTION SPRAY NOZZLE

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4 Claims. (Cl. 299—120)

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The present application relates to combustion spray nozzles of the type used for combustion engines, and particularly to an improvement for effecting more efficient operation of the nozzles.

The general type of nozzle to which the present invention is applied is one in which fuel is supplied to the nozzle under pressure and only a portion thereof enters the combustion space desired, the remaining being withdrawn through a by-pass channel and returned to the source of fuel supply. The purpose of such an arrangement is to accomplish flow of fuel into the combustion space with some independence from the feed line pressure in order that the flow-pressure characteristic can be made to conform to a straight line graph or otherwise varied as desired. Without the provision of such by-pass feature, the flow of fuel into the combustion space is approximately proportional to the square root of the pressure applied.

For the purposes of explaining the effectiveness of the present invention, a brief statement of the operation of such nozzles is here given. Fuel is supplied under pressure to a swirl chamber through tangential passages. The fuel entering the swirl chamber swirls around the periphery thereof and passes into the combustion chamber through a nozzle orifice which is disposed axially of the swirl chamber. The by-pass channel leads from the swirl chamber axially thereof and from a position opposite the nozzle orifice. A hollow vortex forms in the swirl chamber and, by withdrawing fuel from the swirl chamber through the by-pass channel, in instances where the present invention has not been applied, air from the hollow vortex is withdrawn with the by-passed fuel, and interferes with proper operation of the fuel nozzle when the by-passed fuel is returned to the source of supply.

An object of the present invention is, therefore, the provision of means to prevent the withdrawal of air from the swirl chamber through the by-pass channel.

Another object is the provision of such means which can be inserted in a standard nozzle without the necessity of re-designing the nozzle.

Still another object is the provision of such a means which is simple and economical in manufacture as well as being easily placed in the nozzle.

With these and other objects in view, my invention consists in the construction, arrangement, and combination of the various parts of my device whereby the objects contemplated are attained, as hereinafter more fully set forth, pointed out in my claims, and illustrated in the accompanying drawings, wherein:

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Figure 1 is an axial, sectional view through a spray nozzle illustrating the application of my invention thereto;

Figure 2 is a sectional view taken on line 2—2 of Figure 1; and

Figure 3 is a sectional view taken on line 3—3 of Figure 1; and

Figure 4 is an enlarged view of that portion enclosed in dot-dash lines at the left in Figure 1.

Referring in detail to the drawings, Figure 1 includes an adaptor 12, which, for convenience, will also be referred to as a nozzle block and may be formed of any metal commonly used in nozzles. The adaptor or nozzle block 12 is preferably polygonal in cross-section for convenience in applying it in an installation. The nozzle block 12 is provided with a bore 13 formed in the rear thereof eccentric to the axis which is adapted for attaching by soldering, brazing or screwing a pipe or lead 14 for the flow of fuel under pressure from a convenient source (not shown), into the bore 13 and through the nozzle assembly. Ahead of the bore 13 and communicating therewith is a reduced bore 15 leading to and communicating with a circular space or cavity 16 which, in the final nozzle assembly, becomes an annular space. Ahead of the space 16 is a threaded opening 17 of a diameter less than the space 16 and interiorly threaded to receive the nozzle proper.

The adaptor or nozzle block 12 is provided with an axial bore 18 for the reception by means of a press fit of a pipe 19 which forms a return conduit to the source of fuel. A reduced bore 20 leads inwardly from the bore 18 and communicates with the space 16 and opening 17. An annular seat 21 surrounds the inner end of the bore 20.

The nozzle proper includes a nozzle body 24 having a central portion 26 which may also be polygonal in cross-section, and a rearward reduced portion 28 exteriorly threaded and adapted to be threaded into the threaded opening 17. A shoulder 30 is formed on the rear face of the central portion 26 for seating against the front face of the nozzle block 12 around the threaded opening 17. Ahead of the central portion 26 is a tapered front portion 32. The whole nozzle body 24 has a central bore, the main portion of which is indicated at 34 and extends to the rear of the nozzle body 24 where it communicates with the space 16. The rear portion of the bore 34 is threaded as indicated at 36. The forward end of the bore 34 has a reduced portion 38 terminating in a still further reduced portion 40. A tapered shoulder 42 is formed between the reduced portion 38 and the rear main portion of the bore 34.

An insert or nib 44 is press fitted into the portion 38 of the bore 34, and has an extension fitted in the portion 42 of the bore, the front face of the nib being substantially flush with the front face of the front portion 32 of the nozzle body. The nib 44 is provided with an axial orifice 46 having a central cylindrical portion, a diverging outlet 48 and a rearward diverging surface 50 from which leads another diverging surface 52. The diverging surface 52 is of wide angle conical formation and terminates at a point slightly short of the shoulder 42.

A distributor indicated as a whole at 54 is inserted in the bore 34 of the nozzle body 24. The distributor 54 includes a head portion 56 having a truncated, conical front surface 58 in which are provided a plurality of slots or channels 60. The slots 60 lead from the space around the head 56 in the bore 34 to points adjacent the diverging surface 50 in the nib 44. The center of the front face 58 of the head 56 is flattened as indicated at 62 and forms with the conical surface 50 a swirl chamber 64. The slots 60 are disposed tangentially with respect to the true radius of the head 56, as will be evident from Figure 3. It will be noted that the slots 60 form substantially a continuation of the shoulder 42, leading from the bore 34 to the swirl chamber 64.

Centrally of the distributor 54 is an enlargement 66 having exterior threads for securing the distributor in the threaded interior of the bore 34. The enlargement 66 is provided with a plurality of openings 68 disposed substantially parallel with the axis of the device. Rearwardly of the enlargement 66 of the distributor 54 is a reduced end 70 forming a shoulder 72. The distributor 54 is provided with a passage 74 communicating axially with the swirl chamber 64. A passage 76 formed in the distributor communicates with the passage 74, extends through the distributor 54, and communicates with the bore 20. Sealing means 82 is interposed between the shoulder 72 and the annular seat 21.

The following passages together form a by-pass channel, namely, 74, 76, 20, and 18, which lead directly from the swirl chamber 64 to the return conduit 19, and the means for returning the by-passed fuel to the source of supply.

An interceptor plug 88 is interposed in the by-pass channel by inserting it in the bore 20 between the reduced end 70 of the distributor 54, and the inner end of the pipe 19. The interceptor plug 88 is in the form of a disk having substantial thickness in axial direction and, as viewed in Figure 2, is provided with a plurality of openings 90 formed around the periphery thereof. In the preferred form of the interceptor plug 88, the openings 90 are three in number and disposed at the periphery of the disk, although other positions may be desired on occasion, and a different number may be preferred. The total net cross sectional area of the openings 90 is less than the cross sectional area of the passage 74.

The interceptor plug 88 is inserted in the bore 78 by means of a press fit securement and the nozzle assembly is otherwise a standard article of production whereby it will be seen that the nozzle assembly does not need to be re-designed for the inclusion of the interceptor plug 88.

Operation

Fuel under pressure is supplied by any convenient means through the pipe 14 from which it passes through various passages, such as bore 15, space 16, bore 34, holes 68, and finally through

the slots 60 into the swirl chamber 64. The tangential disposition of the slots 60 produces a swirling action of the fuel whereby, by centrifugal force, it follows the periphery of the swirl chamber. The quantity or mass of fuel in the swirl chamber is indicated at 92 in Figure 4. In the swirling motion of a quantity of fuel, such as here described, the velocity of the liquid increases toward the center of the swirl chamber, i. e., it varies inversely as the distance from the center of rotation. Also, at any point of the radius of the swirl chamber, the mathematical product of the velocity times the pressure is constant, or substantially so, except for friction losses. Since the velocity increases toward the center, the pressure must decrease and, at a certain point, the pressure at the center may reach a minus quantity. In such a condition, air enters the orifice of the nozzle to fill the vacuum and forms a hollow vortex. Such a hollow vortex is illustrated at 94 in Figure 4.

Considerably more fuel is injected or forced through the nozzle assembly than is intended to be used in the combustion space. The by-pass channel is utilized for withdrawing that portion of the fuel from the nozzle assembly which is not intended to be used in combustion. By retaining constant the pressure forcing the fuel through the nozzle, and varying the withdrawal of fuel through the by-pass channel, the amount of fuel emerging from the orifice of the nozzle into the combustion space can be regulated in constant ratio to the quantity of fuel withdrawn through the by-pass channel. This arrangement is in contrast with other types of fuel nozzles in which the fuel emerging from the orifice is in proportion to the square root of the pressure applied.

Heretofore and before the present invention, when fuel was withdrawn through the by-pass channel, a portion of the fuel indicated at 92 was drawn through the passage 74 in the head 56 of the distributor 54. When a considerable quantity of fuel was so withdrawn, the wall of fuel 92 covering the passage 74 became depleted, and the air from the hollow vortex 94 passed into the by-pass channel and interfered with the desired procedure of directly returning the by-passed fuel into the source of supply. When such air was permitted to enter the by-pass duct 19, it caused operating difficulties by being ultimately conveyed to the fuel pump, where it collected, impairing the functioning of the pump, and also by being conveyed into the fuel supply line where it interfered with the precise control of fuel flow rate and positive shut off.

In the present instance, the interceptor plug 88 prevents the passage of air from the hollow vortex 94 into the by-pass channel. The openings 90 in the interceptor plug 88 are of less total cross-sectional area than the cross-sectional area of the passage 74 and, of course, less than the cross-sectional area of the passage 76. This restriction amounts to a temporary obstacle in the flow of fuel through the by-pass channel and produces a backing-up pressure through the passage 76 and into the passage 74 and exerting itself at the point of communication between the passage 74 and the swirl chamber 64. This backing-up pressure prevents the emergence of air from the hollow vortex 94 into the by-pass channel. However, the effect of this backing-up pressure upon the rate of fluid discharge from the nozzle's orifice 46 is negligible because an increase in fluid pressure at the center of the

by-pass opening **74** does not produce an equal increase in pressure at the periphery of the discharge orifice **46**.

When fuel is drawn through the openings **90** in the interceptor plug **88** it is replaced by additional fuel drawn from the swirl chamber **64** through the passage **74**. Therefore, fuel flows through the by-pass channel as freely as desired, while sufficient pressure is retained between the interceptor plug **88** and the swirl chamber **64** to prevent the passage of air into the by-pass channel.

It will be seen from the foregoing that an efficient and effective device has been produced for accomplishing the purposes of the invention and overcoming objections to previous types of nozzles, namely, to prevent the passage of air into, and admixture with, by-passed fuel being withdrawn from the nozzle and returned to the source of supply, or to the fuel pump inlet.

While I have herein shown and described a preferred embodiment of my invention, manifestly it is susceptible of modification and rearrangement of the parts without departing from the spirit and scope thereof. I do not, therefore, wish to be understood as limiting my invention to the precise form herein disclosed, except as I may be so limited by the appended claims.

I claim as my invention:

1. In a combustion spray nozzle having a nozzle block, an inlet channel formed in said block, a nozzle body secured in said block, said body having a swirl chamber formed therein, tangential passages communicating between said inlet channel and swirl chamber, an axial nozzle outlet from said swirl chamber, a by-pass bore formed in said nozzle block, a by-pass channel formed in said nozzle body leading axially from said swirl chamber and communicating with said by-pass bore, said by-pass channel being of less cross-sectional area than the cross-sectional area of said by-pass bore, the improvement comprising an interceptor plug secured in said by-pass bore at a point remote from said by-pass channel, said interceptor plug having an opening therein of less cross-sectional area than said by-pass channel.

2. In a combustion spray nozzle having a fuel supply inlet channel therein, a swirl chamber in communication with said inlet channel, tangential passages communicating between said inlet channel and said swirl chamber, a nozzle outlet from said swirl chamber, and an axial by-pass channel leading from said swirl chamber, said by-pass channel having a portion of reduced cross-sectional area communicating with said swirl chamber, the improvement comprising an interceptor plug secured in said by-pass channel at a point remote from said reduced portion, said interceptor plug having an opening therethrough, said opening being of less cross-sectional area than the cross-sectional area of said reduced portion of said by-pass channel.

3. A combustion spray nozzle comprising, in combination, a nozzle assembly having a conical swirl chamber, said swirl chamber thereby having a small-diameter end and a large-diameter end, a nozzle outlet leading axially and centrally from the swirl chamber through the small-diameter end thereof, an inlet channel entering tangentially into said swirl chamber and adapted for flow of fuel therethrough into the swirl chamber in a swirling motion, said swirling motion tending to produce a hollow vortex in said swirl chamber, a single by-pass channel leading axially and centrally from the swirl chamber through the large-diameter end thereof and adapted for the withdrawal therethrough of fuel from the swirl chamber, and an interceptor plug in said by-pass channel at a point remote from the point of communication of the by-pass channel with the swirl chamber, said interceptor plug having openings therethrough of less total cross-sectional area than the cross-sectional area of the by-pass channel at its point of communication with the swirl chamber.

4. A combustion spray nozzle comprising, in combination, a nozzle assembly having a conical swirl chamber, said swirl chamber thereby having a small-diameter end and a large-diameter end, a nozzle outlet leading axially and centrally from the swirl chamber through the small-diameter end thereof, an inlet channel entering tangentially into said swirl chamber and adapted for flow of fuel therethrough into the swirl chamber in a swirling motion, said swirling motion tending to produce a hollow vortex in said swirl chamber, a single by-pass channel leading axially and centrally from the swirl chamber through the large-diameter end thereof and adapted for the withdrawal therethrough of fuel from the swirl chamber, said by-pass channel having a portion of reduced cross-sectional area communicating with the swirl chamber, and a portion of enlarged cross-sectional area posterior to said reduced portion with respect to the flow of fuel therethrough, and an interceptor plug in said enlarged portion at a point remote from said reduced portion, said interceptor plug having openings therethrough of less total cross-sectional area than the cross-sectional area of said reduced portion of the by-pass channel.

EUGENE O. OLSON.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
625,466	Randolph	May 23, 1899
748,971	Millspaugh	Jan. 5, 1904
1,326,488	Fisher	Dec. 30, 1919
1,620,209	Ihne	Mar. 8, 1927
2,037,645	Vroom et al.	Apr. 14, 1936
2,079,430	Bargeboer	May 4, 1937
2,315,172	Voorheis	Mar. 30, 1943
2,323,001	Bargeboer	June 29, 1943
2,345,402	Lubbock et al.	Mar. 28, 1944
2,373,707	Peabody	Apr. 17, 1945
2,374,041	Saha	Apr. 17, 1945