June 3, 1941. R. W. HAUTZENROEDER 2,244,394

SPRAY NOZZLE

Filed March 15, 1938

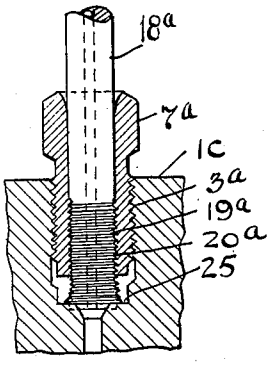


Fig. 10

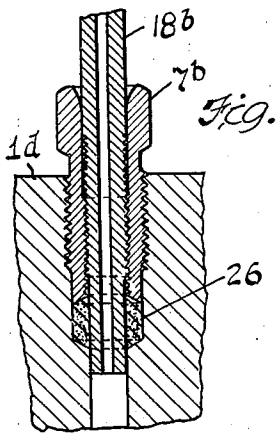


Fig. 11

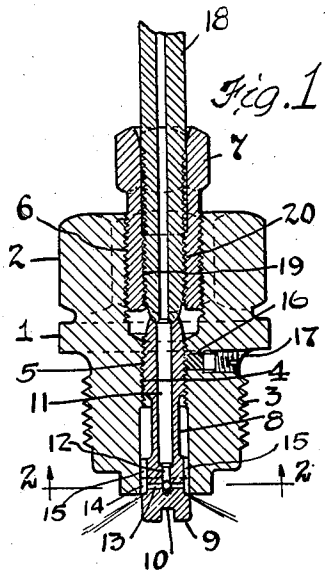


Fig. 1

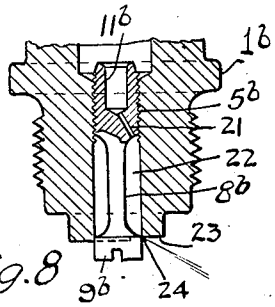


Fig. 8

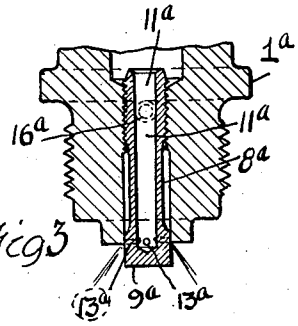


Fig. 3

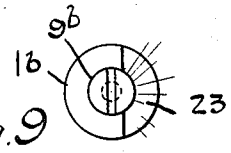


Fig. 9

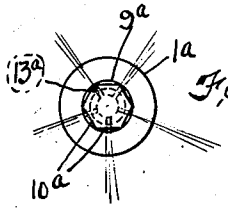


Fig. 4

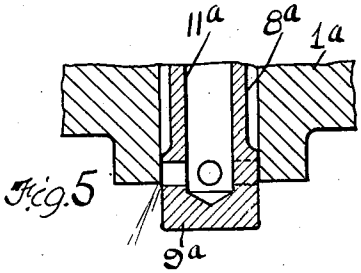


Fig. 5

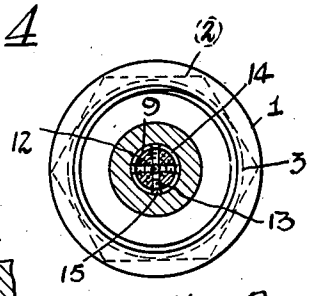


Fig. 2

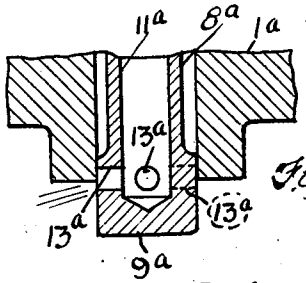


Fig. 7

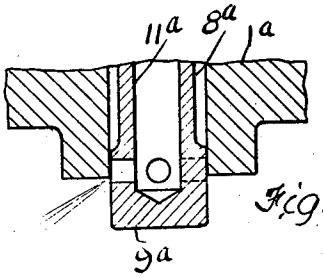


Fig. 6

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SPRAY NOZZLE

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Application March 15, 1938, Serial No. 196,021

4 Claims. (Cl. 299—107.6)

This invention relates, as indicated, to spray nozzles, but has reference more particularly to improvements in spray nozzles or injection valves of the type used in internal combustion engines, such for example, as those illustrated in Figs. 1 to 5 inclusive of Patent No. 2,101,064, granted to me December 7, 1937.

The ideal characteristics for a spray nozzle or injection valve to be used in an internal combustion engine operating on compression ignition (Diesel type) are:

1. Mechanical reliability and freedom from clogging.

2. The production of a fine spray at all rates and pressures of injection, so as to reduce ignition lag to a minimum.

3. The correct form and directional effect to reduce ignition lag and enable the fuel to reach all of the air in the combustion chamber when the engine is operating at full load.

4. High spray velocity.

5. Freedom from "bounce" or secondary discharge.

6. Substantially instantaneous response to pressure fluctuations.

7. Either constant penetrability of the spray irrespective of the degree of pressure or amount of fuel injected, or turbulence of the air, or a "sweeping" spray in order to avoid "burned out" zones and reach all of the air in the combustion chamber.

The present invention has as its primary object the provision of a spray nozzle of the type described having the foregoing characteristics, and consisting of a minimum number of inexpensively manufactured and readily assembled parts.

To the accomplishment of the foregoing and related ends, said invention, then, consists of the means hereinafter fully described and particularly pointed out in the claims; the annexed drawing and the following description setting forth in detail certain mechanism embodying the invention, such disclosed means constituting, however, but one of various mechanical forms in which the principle of the invention may be used.

In said annexed drawing:

Fig. 1 is a cross-sectional view of a preferred form of spray nozzle;

Fig. 2 is a transverse cross-sectional view of the preferred form of nozzle taken on the line 2—2 of Fig. 1;

Fig. 3 is a view similar to Fig. 1, but showing the lower portion of a modified form of nozzle;

Fig. 4 is a plan view of the lower end of the nozzle of Fig. 3;

Figs. 5, 6 and 7 are enlarged views of the end of the nozzle shown in Figs. 3 and 4, showing the effect of variations in the fuel pressure;

Figs. 8 and 9 are views similar to Figs. 3 and 4 respectively, but showing still another modified form of nozzle; and

Figs. 10 and 11 are cross-sectional views of modified forms of nozzle couplings.

Referring more particularly to Figs. 1 and 2 of the drawing, the nozzle therein shown will be seen to comprise a body member 1 having at its upper end a hexagonal head 2 and at its lower end an exteriorly threaded portion 3 of reduced diameter, whereby the nozzle may be secured in a threaded aperture formed therefor in the wall of the cylinder of the engine to which the nozzle is applied, the nozzle being thus applied as by applying a wrench to the head 2 thereof. The body member 1 has a cylindrical bore extending axially therethrough, the wall of the central portion of this bore being threaded as at 4 to receive the upper threaded portion of a valve member 5, and the wall of the upper portion of the bore, which is of greater diameter than the central and lower portions thereof, being threaded as at 6 for the reception of a nut 7, the function of which will be presently described. The body member 1 is preferably formed of hard steel.

The valve member 5 is preferably formed from a highly elastic material, such as tool steel, which is resistant to the eroding effect of fuel flowing therethrough at high velocities. It has a central portion 8 of reduced diameter, so as to localize the elastic deformation of the valve member resulting from the pressure of the fuel flowing therethrough, and a spray head 9, the lower end of which is slotted as at 10 for engagement by a screw driver, whereby the valve member is secured within the body member 1. The valve member has an axial bore or passageway 11 extending from the upper end thereof to a point just below the central portion 8, where it communicates with an axial bore 12 of smaller diameter than the bore 11. The bore 12 extends to approximately the center of the spray head, where it communicates with a plurality of radially extending passages 13, which, in turn communicate with an annular groove 14 in the periphery of the spray head. The portion of the spray head directly above the groove 14 is vertically slotted at points 15 spaced to correspond with the outlets of the passages 13, and this

slotted portion of the head engages the wall of the bore in the member 2 and thereby prevents lateral displacement of the spray head at any time during the spraying operations.

The valve member is maintained in its adjusted position by means of a plug 16 of a malleable metal, such as copper, which is pressed into engagement with the threaded portion of the valve member and expanded by means of a dog point set screw 17, so as to prevent leakage at this point.

The conduit 18 which conducts the fuel from the distributor of the fuel pump to the valve member of the nozzle is secured to the latter by means of the nut 7, the nut having an axial bore 19, the wall of the lower portion of which is threaded for engagement by the externally threaded end 20 of the conduit 18.

With the valve member in proper position within the body member of the nozzle, the groove 14 will normally be covered by the lower portion of said body member, but will be uncovered as the valve member becomes elongated in response to increasing pressure of the fuel against the spray head of the valve member. The spray will then be defined by the outermost edge of the lower wall of the annular groove 14 and the adjacent end of the wall of the bore in the body member 1, and will be in the form of a cone or conical sheet, the thickness and cone angle of which will vary, depending on the extent to which the valve member is elongated, or, in other words, on the extent to which the valve is opened.

The fit between the spray head of the valve member and the bore of the body member should be tight enough to prevent "dribble," but not so tight as to create undue frictional resistance to the movement of the spray head. This fit need not be nearly as tight as is required in valves embodying the conventional type of lapped plungers, which must remain leakproof, since any leakage is inward instead of outward.

In that form of the invention shown in Figs. 3 to 7 inclusive, the valve member of the nozzle is generally similar in construction to that shown in Fig. 1, but the central portion 8a thereof is considerably longer than the corresponding portion of the valve member in Fig. 1. This valve member has a spray head 9a, the upper cylindrical portion of which fits closely within the bore of the body member 1a, and the lower portion of which has flats 10a in its side, whereby the valve member may be engaged by a wrench to secure it in position. The valve member has an axial bore or passageway 11a extending from the upper end thereof to approximately the center of the spray head, where it communicates with a plurality of radially extending passages 13a, which extend to the peripheral surface of the spray head. In the present valve member five such passages are provided.

With the valve member in proper position within the body member 1 of the nozzle the outlet ends of the passages 13a will normally be covered by the lower end of said body member, but will be uncovered as the valve member becomes elongated in response to increasing pressure of the fuel against the spray head of the valve member. The spray will then be defined by the outermost ends of the lower walls of the passages 13a and the adjacent end of the wall of the bore in the body member 1a, and will be in the form of a series of jets spaced circumferentially of the spray head, instead of a cone, as in Fig. 1. The cross-sectional area of the jets and cone angle formed thereby will vary, depending on the extent to which the valve member is elongated, that is to say, the extent to which the valve is opened. Figs. 5, 6 and 7 show the change in area of the jets and the manner in which the cone angle increases in response to increase in pressure of the fuel on the spray head.

In that form of the invention shown in Figs. 8 and 9, the valve member of the nozzle is generally similar in construction to that shown in Figs. 1 and 3, but the axial bore or passageway 11b extends only from the upper end of the valve member to approximately the center of the threaded portion 5b thereof, where it communicates with an inclined passage 21, which extends to the upper end of the annular chamber 22 between the reduced central portion 8b of the valve member and the wall of the bore in the body member 1b. In this case, the central portion 8b of the valve member is solid instead of tubular, and the fuel flows through passages 11b and 21 into the chamber 22. A portion of the lower end of the body member 1b is ground or cut away, as at 23, so as to provide an outlet orifice between the inner edge of the cut-away portion and the adjacent upper edge 24 of the spray head 9b. The spray, in this case, will be confined to an arc determined by the extent of the cut-away portion.

Here again, the thickness and cone angle of the spray will vary, depending on the extent to which the valve member is elongated.

In Fig. 10 is shown a somewhat modified form of coupling, in which the conduit 18a is not brought into contact with the upper end of the valve member, but instead, a portion of the bore in the body member 1c is utilized to conduct the fuel to the valve member. In such case, it is necessary to provide a fluid tight joint between the outlet end of the conduit and the bore in the body member. This is accomplished by providing a nut 7a with an axial bore 19a, the wall of the lower portion of which is provided with fine threads for threaded engagement by the externally threaded end 20a of the conduit 18a. The nut 7a has threads 3a on its external surface, which are coarser than the internal threads of the nut. The nut is first threaded onto the conduit 18a in such manner that a portion of the conduit projects below the nut. The nut is then secured to the body 1c, and since the threads 3a are coarser than the threads 20a, as the nut is drawn down, the lower end of the conduit is forced against a shoulder 25 in the body member and is caused to be flared, as shown, thus providing a fluid-tight joint.

In Fig. 11 is shown still another modification of coupling in which the conduit 18b is not brought into contact with the upper end of the valve member. In this case, the conduit 18b extends down into the bore in the body member 1d, and packing 26 is interposed between the lower end of the nut 7b and a shoulder 27 on the body member, this packing providing an effective fluid-tight seal when compressed upon drawing down the nut 7b.

It will be apparent that all of the spray nozzles which have been described embody all or substantially all of the desirable characteristics which have been hereinbefore enumerated.

The nozzles are mechanically reliable, since the only movement is the elastic deformation or

elongation of the valve member, which does not exceed a few thousandths of an inch, and which takes place easily in view of the relatively loose fit of the parts. Moreover, the nozzle is reasonably free from liability to become clogged, because the accumulation of any foreign matter in the nozzle would tend to increase the resistance to flow of the fuel, thereby creating more pressure and causing the valve member to become further elongated than normally, so that the outlet orifice or orifices would become enlarged to the point where such foreign matter would be blown out.

A fine spray is secured at all pressures because of the variable orifice in each of the nozzles.

The correct form of spray can be readily obtained by varying the location and nature of the orifices during manufacture.

The high spray velocity is obtained at all pressures due to the presence of the variable orifice or orifices.

The nozzles are free from "bounce" or secondary discharge since the free fit of the coacting parts and the rapid reduction in orifice area as the valves close permit the valves to "pinch off" the fuel positively and without shock, and without setting up "rebound" waves in the fuel line.

The nozzles are instantaneously responsive to pressure variations, since the free fit of the parts reduces friction to a minimum, and the small mass of the spray heads, in conjunction with their extremely short range of movement, reduces inertia effects to a negligible minimum.

Although the penetrability of the nozzles will vary with the pressure, the "sweeping" action obtained through variation in cone angle will permit reaching all of the air in a correctly proportioned conventional combustion chamber.

In addition to the foregoing functional advantages of the spray nozzles, they have the additional practical advantage of being adapted to economical production thereof in either large or small quantities. The low cost of manufacture results directly from their small size, small number of parts, simplicity of machining operations, and comparative freedom from costly precision.

Other modes of applying the principle of my invention may be employed instead of the one explained, change being made as regards the structure herein disclosed, provided the means stated by any of the following claims or the equivalent of such stated means be employed.

I therefore particularly point out and distinctly claim as my invention:

1. In a spray nozzle for internal combustion engines, the combination of a valve body having a cylindrical open-ended bore and provided with an opening for fluid under pressure, a valve member in said bore having a cylindrical head forming a fluid tight seal with the cylindrical wall of said bore, and yieldable means under substantially zero initial tension maintaining said head in sealing engagement in said bore but permitting displacement of said head out of such sealing engagement upon the application of fluid pressure in said bore.

2. In a spray nozzle for internal combustion engines, the combination of a valve body having a cylindrical open-ended bore and provided with an opening for fluid under pressure, a valve member in said bore having a cylindrical head forming a fluid tight seal with the cylindrical wall of said bore, a fuel discharge opening in the cylindrical surface of said head so formed that it will be progressively uncovered as said head is moved out of said bore, and yieldable means under substantially zero initial tension maintaining said head in sealing engagement in said bore but permitting displacement of said head to progressively uncover said discharge opening upon the application of fluid pressure in said bore.

3. In a spray nozzle for internal combustion engines, the combination of a valve body having a cylindrical open-ended bore and provided with an opening for fluid under pressure, a valve member in said bore having a cylindrical head forming a fluid tight seal with the cylindrical wall of said bore, a plurality of fuel discharge openings in the cylindrical surface of said head communicating with said bore in the space behind said head and so formed that they will be progressively uncovered as said head is moved out of said bore, and yieldable means under substantially zero initial tension maintaining said head in sealing engagement in said bore but permitting displacement of said head to progressively uncover said discharge openings upon the application of fluid pressure in said bore.

4. In a spray nozzle for internal combustion engines, the combination of telescopically engaged relatively axially movable valve members, one of which is provided with a fuel discharge opening which is progressively uncovered upon relatively axial movement of said members, and yieldable means under substantially zero initial tension maintaining said members in such relation that such fuel discharge opening is closed, but permitting relative axial displacement of said members to progressively uncover said fuel discharge opening.

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