

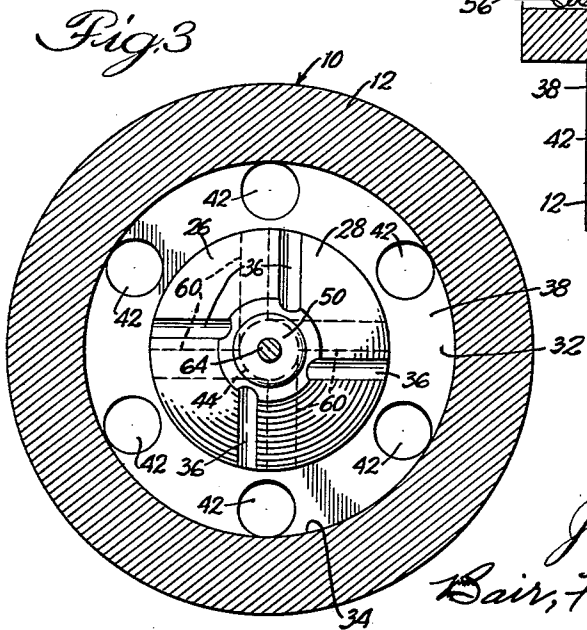
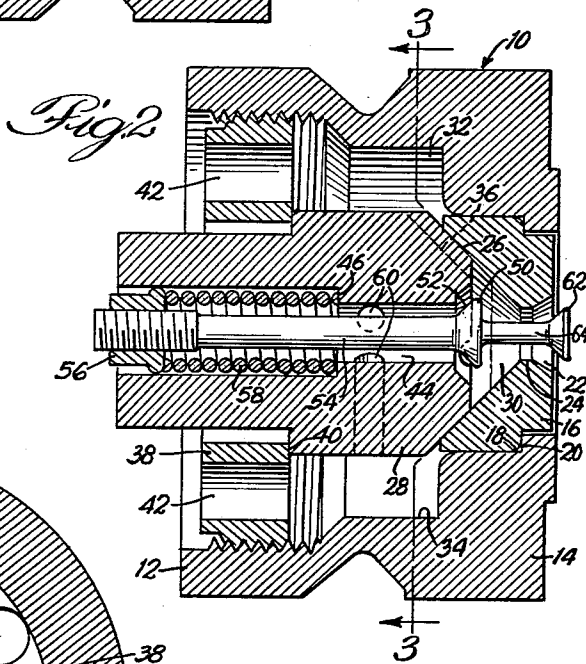
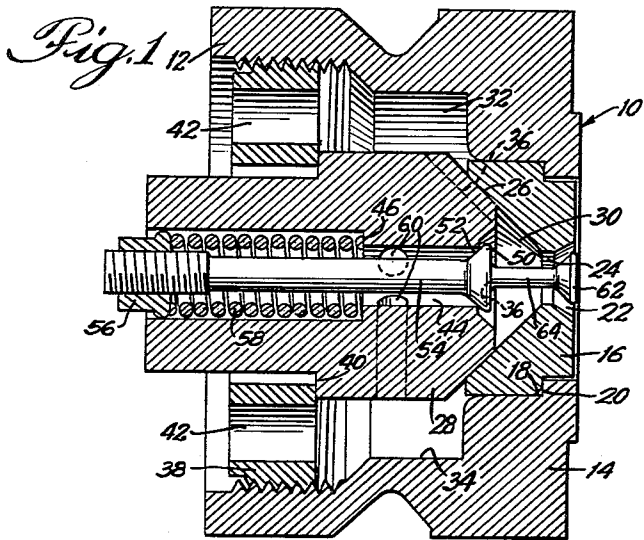
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VARIABLE AREA SPRAY NOZZLE

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1

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VARIABLE AREA SPRAY NOZZLE

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This invention relates in general to an open orifice nozzle construction for use in injecting fluid into a combustion chamber and more particularly to a variable area nozzle controlled responsive to the fuel pressure to provide atomized fuel at both high and low pressures for use in gas turbine engines.

The nozzle construction of the present invention provides improvements over current nozzle constructions used in gas turbine engines by increasing the flow range, permitting lower operating pressures with simpler supply systems together with improved rejection of impurities and spray atomization.

In accomplishing these advantages the present nozzle utilizes a single outlet orifice having a poppet therein and fed by a primary system having a swirl chamber to which fuel is supplied from tangential swirl slots so that fine atomization is achieved during very low flow rates. A secondary system comprising a variable area secondary poppet controlling a passageway aligned with the orifice and fed from the same fuel supply is operated responsive to an increase in the supply pressure to permit an increased volume of fuel to flow axially through the swirl chamber at high pressure. Fine atomization over a wide flow range extending from 100 to 1 is thereby achieved with a smooth transition between primary and secondary operation.

Although swirl slots and chambers have been utilized in previous constructions, such arrangements have had comparatively limited usefulness unless other means such as a bypass to control flow is provided, as the discharge curve in such a construction follows the square root of the pressure. On the other hand, the poppet type nozzle gives unsatisfactory operation at low discharge rates as the fuel emerges from the nozzle in the form commonly known as wires. However, the applicant, by a unique construction, has been enabled to utilize the desirable features of both the swirl slot and poppet type construction while avoiding their disadvantages.

Other advantages flowing from the invention include the ability to utilize high viscosity fuel; the ability to reproduce the components on a mass production basis due to the comparatively simple configurations; and a reduction in the number of components requiring excessively close tolerances, while vapor lock and gumming are also reduced.

These and other objects, advantages and functions of the invention will be apparent upon reference to the following specification and claims, together with the drawings:

FIGURE 1 is a side elevational view of the nozzle assembly in cross section illustrating its condition during primary operation;

FIGURE 2 is a view similar to FIGURE 1 illustrating the nozzle assembly during secondary operation; and

FIGURE 3 is a sectional view taken along the line 3-3 in FIGURE 2.

The nozzle assembly of the present invention is indicated by the reference character 10 in the drawings. It comprises an annular housing or body 12 having a depending annular flange 14 at one end. An orifice disc 16 is press fitted into the annular opening formed in the flange 14 with a shoulder 18 on the disc abutting a shoulder 20 on the flange.

The orifice disc is provided with a frusto conical cen-

2

tral discharge opening or orifice 22 at one end with its smaller diameter terminating in a cylindrical passageway 24. The passageway 24 communicates with another frusto conical opening in the orifice disc. A frusto conical face 26 of a cylindrical distributor 28 is received in this opening to form a swirl chamber 30.

A fuel chamber 32 located between the distributor 28 and the internal wall 34 of housing 12 communicates with the swirl chamber 30 through a series of tangential slots 36 in the surface of the frusto conical face 26. The fuel chamber is closed at one end by a ring element 38 threaded into the housing 12 and seated against a shoulder 40 on the distributor. The ring 38 has a series of circumferentially spaced openings 42 to permit fuel to enter the chamber 32 from a single supply source coupled to one or more of the openings.

The distributor 28 is provided with an axis passageway 44 having a shoulder 46 between its ends and adapted to communicate axially with the swirl chamber 30 and opening 22. A cylindrical poppet 50 having a taper 52 is adapted to be seated against one end of the passageway 44. The poppet is carried on one end of a stem 54 having its other end threaded for receipt in a movable seat 56. A compression spring 58 is mounted between the seat 56 and shoulder 46 to bias the poppet 50 into closed relationship with the passageway 44. Communication between the passageway and the fuel chamber 32 is provided by a series of spaced openings 60 in the distributor 28 between the shoulder 46 and the poppet 50.

The poppet 50 carries a poppet extension 62 on the end of a second stem 64. The poppet extension 62 is located in the opening 22 and is generally shaped to conform to that opening.

In operation fuel is supplied under pressure to the fuel chamber through the passageways 42. It flows under reduced pressure and negligible resistance through the swirl slots 36, which provide a tangential component of velocity at the lowest operating rates so that when the fuel passes through the passageways 24 and 22 it emerges in a state of fine atomization.

If the pressure of the fuel entering the chamber should rise beyond a predetermined amount, increased pressure is exerted against the poppets to cause the poppet 50 to move from its seat against the pressure of spring 58. The result is greatly increased flow with the flow rate determined by the pressure applied against poppet 50 with excellent atomization as the fuel strikes against the poppet 62.

What I claim as new, and desire to secure by Letters Patent of the United States, is:

1. A variable area spray nozzle comprising an annular body having a cylindrical opening at one end terminating in a frusto conical discharge orifice through which atomized liquid is discharged, a distributor centrally disposed within said body with an annular space between said distributor and said body, means for retaining said distributor in said housing, a frusto conical swirl chamber formed between said body and said distributor and communicating with said orifice through said cylindrical opening, swirl slots in the face of said distributor to provide communication between said annular space and said swirl chamber, said distributor having a central axial opening therethrough in alignment with said swirl chamber and orifice, a valve member mounted for axial movement within said axial opening, a tapered first head mounted on the end of said valve member for closing said axial opening, a second extension head projecting from said first head into said orifice, there being a passageway between said extension head and said orifice to permit flow of liquid therethrough when said first head

3

closes said axial opening, and means for biasing said valve member in one direction to hold said first head in closed relationship to said axial opening, whereby liquid charged into said annular space below a predetermined pressure is discharged solely through said swirl slots into said swirl chamber and through said orifice and liquid charged into said annular space above said predetermined pressure is also discharged through said axial opening.

2. A spray nozzle comprising an annular housing having an opening in one end, an orifice disc closing said one end of said housing, said orifice disc having a frusto conical orifice opening and a frusto conical face therein, a distributor having a frusto conical face engaging said frusto conical face of said orifice disc so as to define a swirl chamber, said distributor having swirl slots for delivering fuel to said swirl chamber, said swirl chamber communicating with said orifice opening with the smallest diameters of said orifice opening and swirl chamber being in adjacent relationship on a common axis, a fuel chamber formed between said distributor and said housing with said fuel chamber in communication with said swirl chamber through said slots, an end ring adapted to be engaged adjacent the other end of said housing for closing said fuel chamber and having an opening therein to permit the entrance of fuel into said fuel chamber, means for retaining said end ring in said housing, a passageway in said distributor with said passageway communicating with said swirl chamber along said common axis and in communication with said fuel chamber, a tapered poppet mounted for axial movement along the axis of said passageway, means for biasing said poppet into closed relationship with said passageway to prevent fuel in said passageway from entering said swirl chamber, and a poppet extension carried on said poppet with said extension protruding through said orifice opening; whereby fuel passes only through said swirl slots for exit through said opening in an atomized condition at pressures below a predetermined value and fuel passes additionally from said passageway through said swirl chamber and opening in an atomized condition responsive to said poppet being moved out of said closed relationship on said fuel pressure exceeding said predetermined value.

3. A spray nozzle comprising an annular housing having threads on the internal wall thereof adjacent one end and a depending flange on the other end defining an opening, an orifice disc arranged in said opening, a cylindrical passageway defined by said orifice disc and terminating in a frusto conical orifice outlet, a frusto conical swirl chamber communicating with said passageway, a distributor disposed along the central axis of said annular housing and having a frusto conical face at one end arranged to engage said swirl chamber and having swirl slots therein for delivering fuel to said swirl chamber, a fuel chamber formed between said distributor and housing and communicating with said swirl chamber through said slots, an end ring adapted to be engaged with said threads for closing said fuel chamber and having an opening therein to permit the entrance of fuel into said fuel chamber, said distributor having an axial passageway therein with said axial passageway opening into

4

said swirl chamber, said axial passageway communicating with said fuel chamber through said distributor, a stem in said axial passageway carrying a poppet on one end adjacent said swirl chamber, a seat movably carried by said stem in said passageway, a spring engaged against said seat for biasing said poppet to close said axial passageway for preventing fuel flow therefrom into said swirl chamber, and a poppet extension carried on said poppet and normally protruding through said cylindrical passageway and said orifice opening; whereby the fuel below a predetermined pressure in said fuel chamber is discharged solely through said swirl chamber and said poppet is moved into open relationship with said axial passageway responsive to the pressure of said fuel exceeding said predetermined pressure to thereby permit the flow of fuel from said axial passageway through said swirl chamber and orifice opening in an amount depending on the pressure.

4. A variable area nozzle comprising a housing, an orifice disc in one end of the housing defining an outlet opening for fuel passing through said nozzle, a wall on said orifice disc defining a swirl chamber communicating with said opening, a distributor within said housing having a surface adapted to engage said wall and having swirl slots in said surface for delivering fuel to said swirl chamber with a tangential component of velocity, means for retaining said distributor in said housing, an annular fuel retaining chamber formed between said distributor and said housing with said annular chamber in communication with said swirl chamber through said slots for passing fuel to said swirl chamber, a first passageway in said distributor arranged on an axis common to said swirl chamber and outlet opening and in communication therewith, another passageway in said distributor for communicating said first passageway with said annular chamber, a poppet member mounted for movement along said axis, means for biasing said poppet member into closed relationship with said first passageway for preventing the passage of fuel from said first passageway to said swirl chamber, whereby during a first operating condition, said first passageway is closed and fuel passes from said annular chamber through said swirl slots into said swirl chamber and discharges through said outlet opening, and during a second operating condition, said poppet member is opened responsive to the pressure of said fuel rising above a predetermined value to permit the flow of fuel from said first passageway into said swirl chamber and through said outlet opening.

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