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FUEL NOZZLE

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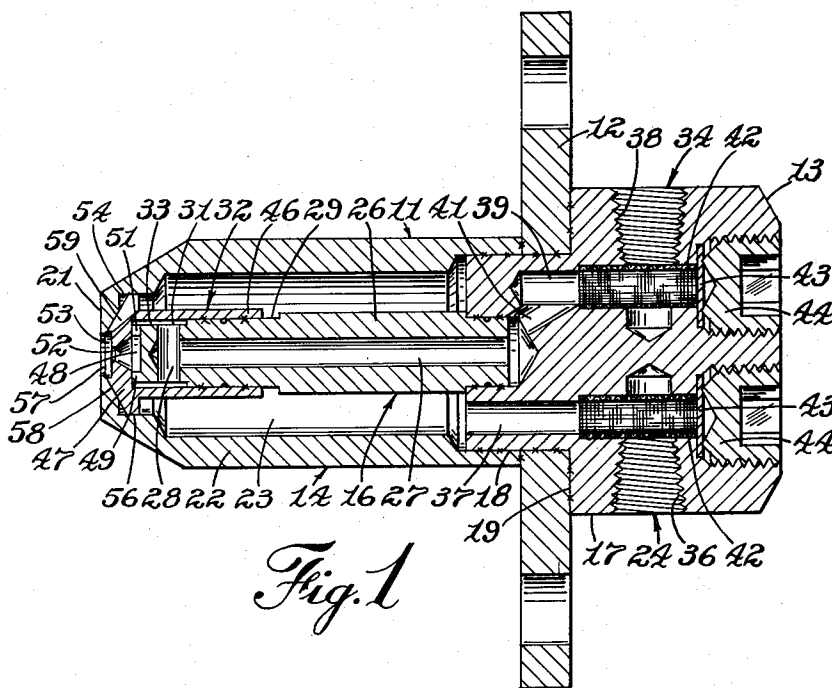


Fig. 1

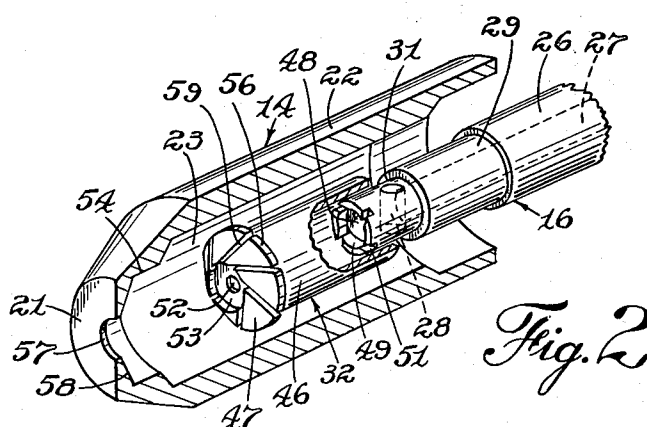


Fig. 2

WITNESS:

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## FUEL NOZZLE

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The present invention relates to a fuel nozzle for use in a combustion chamber of jet engines, gas turbines or other like purposes and, more particularly, relates to a new and improved air atomizing liquid fuel nozzle.

Several prior art types of air atomizing nozzles are known which are effective to provide a combustible spray pattern of liquid fuel particles. Generally these nozzles have been provided with separate air and fuel passages and have (1) an internal mixing chamber within the nozzle assembly or (2) an atomizing point externally of the nozzle. In the nozzles internally mixing the fuel and air, considerable restriction is encountered by the fuel-air mixture before it is discharged from the nozzle discharge orifice. The air is introduced to the fuel branch portion in such a manner as to "shear" or "break up" a controlled flow of liquid fuel at the point of intersection. The shearing or breaking up of the fuel by the air does provide the spray pattern having an improved fuel atomization but the air rather than adding to the rotary and axial motion of the flow of liquid fuel will materially reduce the rotary and axial motion of the fuel flow and unfavorably influence the overall nozzle characteristics. Those types of nozzles externally mixing the fuel and air attain a resulting spray pattern comprised of fuel particles which are more finely dispersed although the drop-let size is not the optimum reduction. The spray pattern itself in this latter type nozzle is not materially improved by the rotary or axial components of the added air.

Basically, the present invention comprises a simplex fuel metering device in which the atomization of fuel is materially aided by a separate supplementing metered air system. Fuel under pressure passes through tangential fuel metering slots into an initial fuel swirl or a first spin chamber and thence emerges through a metering orifice into a second spin chamber where it is picked up and further atomized by a supplementing air supply. Prior to its introduction into the second spin chamber the fuel has gained rotational velocity by reason of the tangential fuel metering slots and the fuel has gained axial velocity by reason of a swirl or spin chamber. The component velocity resulting from the rotary and axial velocities combined with appropriate sizing of the metering orifice will atomize the fuel. The above description of operation presupposes that the fuel is initially under sufficient pressure. Atomization at low fuel pressure or improved atomization at high fuel pressure is accomplished by introducing air into a mixing area or the second spin chamber immediately beyond the point where the fuel is discharged from the metering orifice. Metered air is introduced into the mixing area through tangential air metering slots leading to the air swirl chamber. The air metering slots and air swirl chamber impart rotary and axial motion to the supplementing air. The air with a component velocity resulting from the rotary and axial velocities is adapted to pass through the fuel spray pattern to pick up and further atomize the fuel and add the air's component velocity to that of the fuel flow velocity. The combined fuel-air mixture thence is discharged through a common discharge port. Thus each of the mediums has its own component velocity resulting from each medium having its separate tangential metering slots and swirl chambers with the component velocities being additive to provide a fuel-air mixture dischargeable through a

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common discharge port. The described nozzle thus has an improved controllable spray pattern in which fuel particles are finely dispersed.

It is an object of the present invention to provide a fuel-air atomizing nozzle which is facile, efficient and reliable in use, inexpensive to manufacture, which has improved mixing characteristics and possesses an improved controllable spray pattern.

It is another object of the present invention to provide a dual system atomizing nozzle having separate tangential metering slots and swirl chambers for each of the mediums to be intermixed within the nozzle but having a common discharge port for the blended mixture.

Other objects and advantages will be apparent from the following detailed description and claims taken in conjunction with the appended drawing, in which:

FIGURE 1 is a side sectional elevation of a nozzle embodying the present invention; and,

FIGURE 2 is a fragmentary, exploded, detailed view, with portions in section and broken away, of the nozzle illustrated in FIGURE 1.

Referring now to the drawing wherein like reference numerals and characters indicate like parts in the two views, in FIGURE 1 numeral 11 generally designates a fuel-air atomizing nozzle embodying the present invention. The nozzle consists of a support or mounting flange 12, an adapter 13, a tip housing generally designated 14 and fuel metering means generally designated 16.

The adapter 13 comprises a large diameter portion 17 and a small diameter body portion 18 which form a shoulder 19. An appropriately sized opening in the support embraces the body portion 18 and abuts the shoulder 19 with the support being securely affixed to the adapter by means of brazing.

The tip housing 14 is a substantially cup-shaped member having an end wall 21 and a cylindrical side wall 22. The open end of the tip housing embraces the adapter body portion 18 and abuts portions of the support being fixedly secured to both the adapter and the support by brazing. The tip housing in combination with the adapter forms a housing which defines a central cavity 23. An air inlet generally designated 24 is formed in the adapter body portion 17 and communicates in a hereinafter described manner with the central cavity.

The fuel metering means 16 consists of an elongated cylindrical member 26 coaxially disposed in the central cavity and secured by brazing to the adapter body portion 18. An axial fuel passage 27 extends throughout the major portion of the longitudinal length of the member 26 and terminates in a lateral passage 28. The member 26 is reduced in diameter in steps as at 29 and 31 with the lateral passage opening to the exterior surface of the member at the reduced diameter portion 31. A metering tip member generally designated 32 wholly embraces the cylindrical member's portion 31 to define a spatial separation 33. The metering tip is secured to the cylindrical member's portion 29 by brazing. A fuel inlet generally designated 34 is formed in the adapter body portion 17 and communicates in a hereinafter described manner with the fuel passage 27.

The air inlet consists of a threaded opening 36 leading to a passage 37 which, in turn, communicates with the central cavity 23. The fuel inlet consists of a threaded opening 38 leading to passages 39 and 41 which, in turn, communicate with the fuel passage 27 of the fuel metering means. The passages 37 and 39 both house identical filter screens 42 and both passages are externally closed by a sealing washer and a set screw 43 and 44, respectively.

The metering tip member 32 consists of a substantially cylindrical side wall 46 and has an enlarged frusto-conical extremity 47. The free extremity of cylindrical mem-

ber 26 is provided with a concentric opening or fuel swirl chamber 48 defining an annulus 49. A plurality of slots 51 is formed in the annulus to communicate between the spatial separation 33 and the fuel swirl chamber. The slots meter the fuel flow and are formed to tangentially open into the fuel swirl chamber in a manner well known in the art. The annulus abuts the inner face of the frusto-conical extremity causing the fuel swirl chamber to directly communicate with a coaxial appropriately sized metering orifice 52. An annular opening formed in the free end of the frusto-conical extremity defines a swirl chamber 53 which is located coaxial with the fuel swirl chamber.

The inner face of the end wall 21 of the housing tip is provided with an annular recess 54 adapted to snugly receive the peripheral base portion 56 of the metering tip frusto-conical extremity. A sized discharge port 57 and a conical taper 58 communicate with the annular recess 54 with the conical taper 58 being adapted to complement and abut the conical taper of the metering tip extremity. A plurality of slots 59 is formed in the metering tip frusto-conical extremity to communicate between the annular recess 54 and the air swirl chamber 53. The slots meter the air flow and are formed to tangentially open into the air swirl chamber in a manner well known in the art.

In operation—fuel under variable pressure is introduced into the fuel passage 27 of the fuel metering means 16 through the fuel inlet 34 and its associated passages 39 and 41, thence to the lateral passage 28 and the spatial separation 33 defined by the cylindrical member 26 and the metering tip 32. Fuel is forced to flow through the tangential fuel metering slots 51 into the fuel swirl chamber 48. The tangential metering slots and the configuration of the fuel swirl chamber impart rotary and axial motion to the fuel to increase its component velocity as it moves toward the fuel metering orifice 52. The component velocity of the fuel and the sizing of the metering orifice combine to atomize the fuel and achieve a substantially hollow cone fuel spray pattern as the fuel passes from the metering orifice to the air mixing area which comprises the air swirl chamber 53 and thence is discharged from the discharge port 57. If the fuel pressure is low or if better atomization of the fuel is desired, supplementing air assistance is required. Air is introduced into the central cavity 23 defined by the housing tip 14 and the adapter 13 through the air inlet 24 and its associated passage 37. Air passes into the recess 54 and is metered by the tangential air metering slots 59 before it enters the mixing area or air swirl chamber 53. The tangential air metering slots and air swirl chamber impart rotary and axial motion to the supplementing air which is subsequently directed to pass through the fuel discharge to cause the air to pick up and further atomize the fuel as it passes through the fuel cone. The configuration of the tangential air metering slots and air swirl chamber in combination causes the air to have a component velocity which materially assists the fuel flow velocity with the resultant fuel-air mixture being discharged from the discharge port in a most efficient manner. Thus the nozzle provides a completely atomized fuel-air mixture pattern, has exceptionally good mixing characteristics and is efficient over a wide range of fuel and air pressure variations.

While only one embodiment of the invention has been

described, it will be readily apparent to those skilled in the art that many changes or arrangements of parts may be made without departing from the spirit of the invention.

We claim:

1. In a liquid atomizing nozzle a cylindrical adaptor having two diametrically arranged openings with means for coupling to a source of pressurized liquid and a source of pressurized gas respectively, and with parallel passages extending axially therefrom,
  - a metering means for said liquid comprising a hollow cylindrical member fixedly mounted on the adaptor, extending coaxially therefrom and interiorly connected to said passage for pressurized liquid,
  - said cylindrical member having a fuel swirl chamber formed in its projecting end,
  - a metering tip member fixedly mounted on the projecting end of the cylindrical member having a gas swirl chamber formed in its projecting end, said tip member and cylindrical member having cooperating means for conducting liquid from the cylindrical member into said liquid swirl chamber in the form of a plurality of tangential jets,
  - a tip housing fixedly mounted on the adaptor coaxially with said cylindrical member, providing an annular space which is connected to said pressurized gas passage in the adaptor,
  - said tip housing having a constricted opening in its free end leading from said gas swirl chamber,
  - said metering tip and tip housing having cooperating means for conducting pressurized gas from said annular space into the gas swirl chamber in the form of a plurality of tangential jets, and
  - said metering tip having a central metering orifice admitting nebulized liquid from the liquid fuel chamber into the gas swirl chamber.
2. A liquid atomizing nozzle as set forth in claim 1 in which the jets of liquid into the liquid swirl chamber and the jets of gas into the gas swirl chamber are similarly inclined, whereby the liquid and the gas in their respective swirl chambers are caused to spin in the same direction.
3. A liquid atomizing nozzle as set forth in claim 1 including further
  - filtering means in said passages in the adaptor, said adaptor having openings for removing and replacing the filters, and
  - removable sealing means for said openings.

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