April 21, 1964 J. W. VDOVIAK 3,129,891

FUEL NOZZLE

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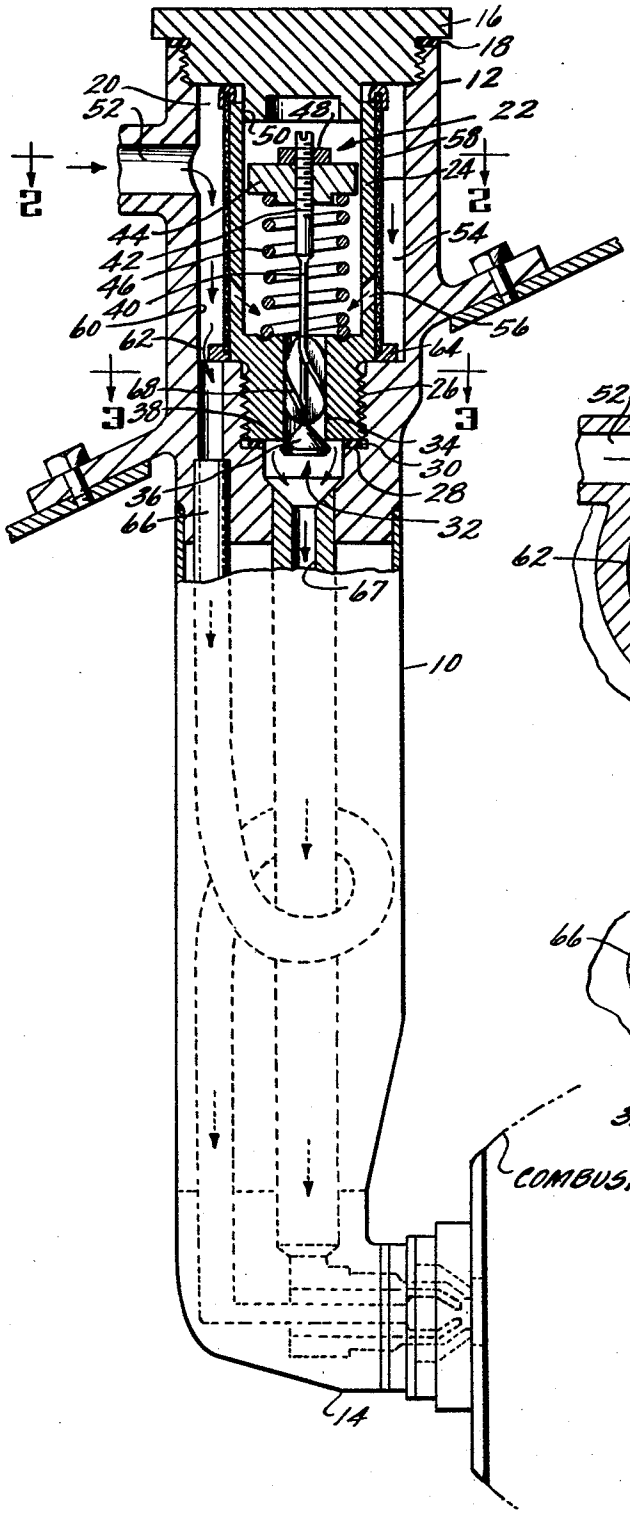


FIG 1

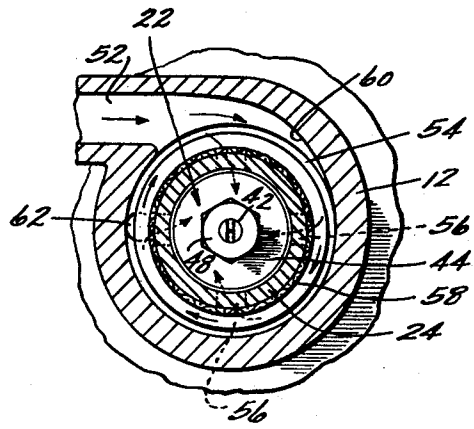
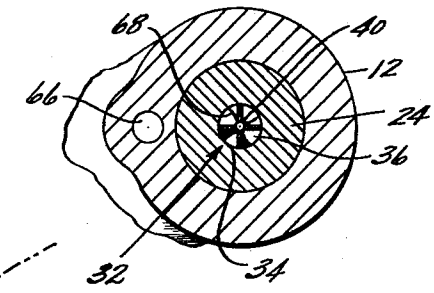


FIG 2



COMBUSTOR

FIG 3

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FUEL NOZZLE

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This invention relates to a fuel nozzle and, more particularly, to a fuel nozzle having dual flow pasages, a flow divider, and means to prevent clogging thereof, by fuel borne contaminates.

It is frequently necessary or desirable to employ more than one fuel passage in a fuel nozzle in order to be able to increase or decrease fuel flow rates while maintaining a good spray pattern. It is also desirable in the case of combustion systems such as are utilized in gas turbine engines, where a wide range of flow is required, to employ a flow divider valve between dual fuel passages or slots to provide the necessary flow-pressure characteristics and the necessary atomization of the fuel. Such nozzles while of sound design from a combustion standpoint suffer from reliability problems, particularly with respect to dirt contamination. Primarily, this is a result of the fact that the flow divider valve must operate reliably all the way from a no-flow, or closed, setting to its maximum open position. Particularly, at flow settings where the divider valve is open only a few thousandths of an inch, there is a tendency for dirt particles to clog the opening, which will alter the overall fuel flow pattern. A second mode of failure can occur when the valve is closing, i.e., as flow decreases from a maximum opening of the valve, a contaminant particle may become trapped in the opening thereby preventing necessary further closure. The problem is not solved merely by placing a filter screen upstream of the valve opening since clogging of the screen would ultimately have the same effect as blockage of the valve.

The principle of the centrifugal separator or purifier has been utilized in filters to remove dirt, dust, and the like. This so-called "dynamic" filtration process embodies separation of dirt particles by whirling the fluid about inside a container to cause the contaminant to be thrown outwardly against the walls of the container where it is trapped or caught in some suitable manner, the clean fluid passing out through the center and bottom of the container.

Accordingly, it is the primary object of my invention to provide a dual slot fuel nozzle which is reliable over a wide range of fuel flow settings.

A further object of my invention is to provide a dual slot fuel nozzle having flow divider means which is reliable over a wide range of fuel flow settings.

Briefly stated, in carrying out my invention in one form I provide in a fuel nozzle having a primary flow passage, a secondary flow passage, and a flow divider therebetween, contaminant eliminating means producing a vortex of fuel and including a filtering element whereby clogging of the flow divider is prevented.

The features of my invention which I believe to be novel are set forth with particularity in the appended claims. My invention itself, however, both as to its organization and method of operation, together with further objects and advantages thereof, may best be understood by reference to the following description taken in connection with the accompanying drawings in which:

FIGURE 1 is a side view, partially in cross-section, of a fuel nozzle embodying my invention, and

FIGURE 2 is an end view taken along line 2—2 of FIGURE 1, and

FIGURE 3 is an end view taken along line 3—3 of FIGURE 1.

Referring now more specifically to FIGURE 1, my invention is shown incorporated in a fuel nozzle for use with a combustor, the nozzle having a main body portion, indicated generally at 10, the body portion having a head 12 and a tip 14. The tip 14 will provide dual slot or dual cone fuel spray patterns and may be any one of a variety of known designs having means providing good high dirt-contamination capability (e.g., relatively large fuel orifices) and is no part of the present invention. Directing attention now to the head portion 12, I provide means for enclosing the constituent parts of the means whereby fuel flow is modulated to the tip orifices including a cap 16 and a gasket 18 for fluid tight sealing of the cap to the head 12. The cap forms one wall of a cavity 20 in the head, which cavity is adapted to receive a flow-dividing means indicated generally at 22. The flow-dividing means includes a body 24 adapted to be securely fastened to the head by a threaded neck portion 26, or by more permanent means such as welding or brazing, if desirable. The neck portion seats on a reduced portion 28 at the inner end of the head, there being interposed between the flow-divider body and the head a gasket 30 to provide a fluid-tight seal.

In order to secure variation in the flow through the divider, I provide a valve member indicated generally at 32 which rides in a bore 34 in the body 24. The valve member includes an enlarged, conical portion 36 on the lower end thereof which is adapted to seat in an opening 38 at the lower end of the bore 34. A stem portion 40 extends into the upper portion of the flow divider body 24 and includes an enlarged threaded portion 42. Means are provided for causing movement of the valve member 32 including a piston 44 and a piston or valve spring 46. As will be clear from the drawing, the spring rests on and locates the piston with respect to the body, the piston being held against the spring by means of a nut 48 engaged with the threaded portion of the stem. The cap 16 is flanged at 50 to provide locating means for the upper portion of the body 24.

In carrying out my invention fuel is supplied to the nozzle through an inlet 52 which is tangential with respect to a swirl chamber 54 located in the upper portion of the head 12 and in a concentric relationship with the flow-divider body 24. The body 24 includes a plurality of apertures 56 through which fuel will flow radially into the lower interior of the body after it passes through a filtering element, such as a screen 58. Due to the high tangential velocity given the fluid in the chamber 54, a vortex is created which causes contaminant, such as dirt particles, or the like, to be thrown outwardly along the wall 60 of the swirl chamber. The portion of the vortical fuel flow which entrains the contaminant then passes through a slot 62 in the lower portion of the chamber 54. The slot is formed by suitable means, such as a ring 64, which can also provide means for securing the filtering element 58, as is shown in the drawing. The slot 62 leads to a primary fuel flow passage 66 and is sized so that major size particles of contaminant will be restricted at this point, thereby preventing blockage of the primary fuel orifices in the tip 14. The circumferential length of the slot is such that a considerable number of such particles can be restrained at this point without affecting the pressure-flow schedule. Smaller particles which, however, might still present a blockage problem at the opening 38 at minimum flow rates, will be forced to pass through the larger fixed area primary slot 62 and into passage 66. The fuel which passes through the apertures 56 since it is at the apex or "eye" of the vortical flow, is clear of any contaminant which could cause blockage of the flow divider valve at minimum secondary fuel flow settings. This flow passes through the bore 34, out

through the opening 38 of the body 24, and into the secondary passage 67. Before this occurs it will be necessary, of course, for the fluid pressure on the cavity 20 to overcome the biasing action of the spring 46 a sufficient amount to crack the valve portion 36 away from the opening 38.

It will be clear that when the flow-divider first opens in response to a higher pressure, i.e., a requirement for additional fuel flow, the flow area of the divider valve will be much smaller than the area of the primary slot 62. My invention has therefore provided means for assuring that little or no dirt will flow through the secondary opening by means of the vortex created by the swirl chamber directing the dirt entraining flow through the relatively large primary slot. When the effective area of the divider valve opening is at its maximum, dirt sensitivity is no longer as critical and if dirt should get through the filter element 58 under high pressures it is not likely to cause an undesirable disturbance on the total fuel flow pattern.

If smaller dirt particles, or the like, should tend to periodically accumulate after repeated operation, additional swirl inducing means such as guide vanes 68, may be utilized forward of the valve seat if desired. The presence of swirl or turbulence in this area will tend to prevent the build-up or accumulation of particles so that the vanes 68 in providing a circumferential velocity component to the fluid flow, in addition to the low axial velocity at low secondary flows, help to keep the valve opening clean.

While I have described in detail a specific embodiment of my invention, it is understood that the appended claims are intended to cover all changes and modifications to the disclosed example which do not depart from the spirit and scope of the invention.

What I claim is:

1. A dual-flow fuel delivery nozzle comprising, a body portion having primary and secondary fuel discharge passages therein, a head portion carried by said body portion having an outer cylindrical wall defining an annular fuel swirl chamber therein, said annular swirl chamber having an annular restrictive slot in the bottom portion thereof adjacent said outer wall in flow communication with said primary fuel discharge passage and a tangential fuel inlet opening in the upper portion of said outer wall for admitting fuel tangentially into said swirl chamber for creating a vortical fuel flow in said chamber, a cylindrical fuel filter element coaxially fixed in said swirl chamber between said primary and secondary fuel discharge passages, a concentric cylindrical flow divider inner wall in said swirl chamber surrounded by said cylindrical filter element dividing the total nozzle fuel flow between said primary and secondary fuel discharge pasages, said cylindrical wall having at least one fuel passage opening therethrough, valve means within said cylindrical flow divider wall openable by fuel pressure for fuel flow communication between the interior of said concentric cylindrical wall and said secondary fuel discharge passage, biasing means for biasing said valve means toward closed position, whereby said valve means is openable in response to predetermined fuel pressure admitted through said filter and cylindrical inner wall for overcoming said biasing means to admit fuel from the apical portion of said vortical fuel flow passing through said cylindrical fuel filter element only to said secondary fuel discharge passage while the remainder of the outer portion of said vortical flow passes directly through said annular restrictive slot only into said primary fuel delivery passage, in order that relatively large fuel borne contaminant particles capable of blocking said valve means and clogging said filter means are thrown outwardly in said swirl chamber by centrifugal force away from said filter means to prevent clogging said fuel filter element or entering said secondary fuel discharge passage, and are directed toward said annular restrictive slot and said primary discharge passage.

2. A dual-flow fuel nozzle having a head end and a fuel discharge end, primary and secondary fuel outlet passages in said nozzle for discharging fuel from said fuel discharge end, a cylindrical swirl chamber in said head end having a circumferential restricted fuel delivery slot in the bottom thereof adjacent the inner wall of said chamber in flow communication with said primary fuel outlet passage, said chamber having a tangential fuel inlet passage in the upper portion thereof for discharging fuel tangentially into said chamber to create a vortical fuel flow in said swirl chamber, concentric cylindrical flow dividing means in said swirl chamber separating fuel delivery from said inlet passage into said primary and secondary fuel outlet passages, said flow-dividing means including an inner concentric cylindrical chamber spaced materially inwardly from the aforesaid inner wall of said swirl chamber having a plurality of fuel delivery openings therethrough, having a valved passage therein in communication with said secondary fuel outlet passage, valve means in said valve passage opening downstream toward said secondary fuel outlet passage, a piston in said concentric cylindrical chamber, means connecting said piston to said valve means, spring means in said cylindrical chamber biasing said piston for yieldably closing said valve means to control fuel delivery to said secondary fuel outlet passage, a cylindrical filter element surrounding said concentric cylindrical chamber in materially inwardly spaced relation to said circumferential restricted fuel delivery slot, said slot being sized to retrict predetermined relatively large heavier fuel borne particles driven outwardly in the vortical flow in said swirl chamber by centrifugal action from passing into said primary fuel outlet passage, concentric swirl-inducing guide vanes between said valve means and said piston for inducing swirl of fuel passing said valve means, for preventing periodic build up of relatively small contaminant particles in the fuel passing through said filter element on said valve means to permit complete closing thereof.

References Cited in the file of this patent

UNITED STATES PATENTS

2,099,502 Stockdale ..... Nov. 16, 1937
3,022,954 Davies et al. ..... Feb. 27, 1962