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SPILL TYPE FUEL INJECTION NOZZLE

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FIG 1

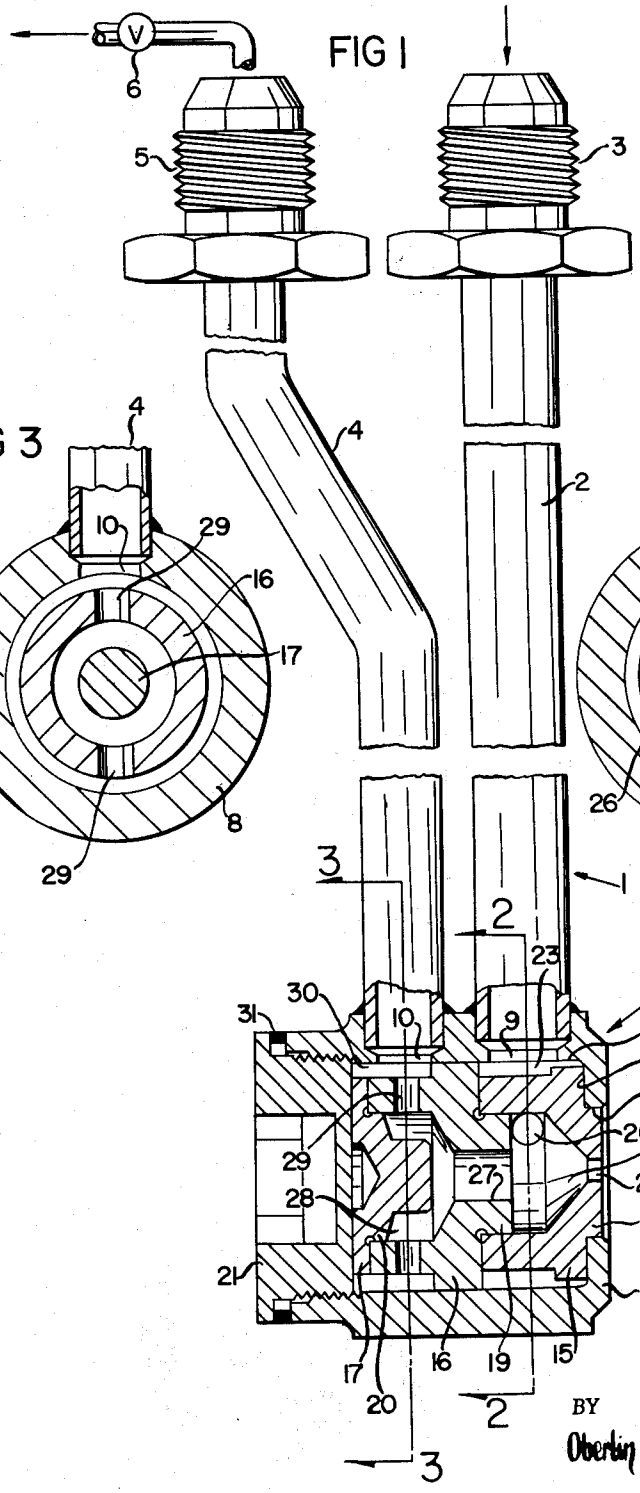
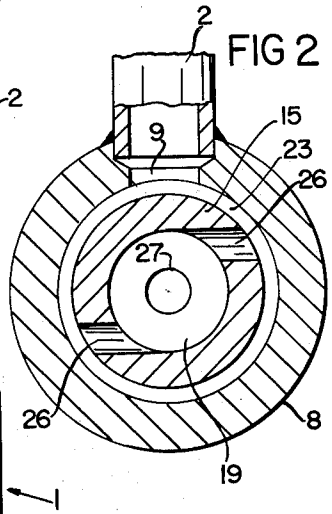


FIG 3

FIG 2



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SPILL TYPE FUEL INJECTION NOZZLE

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The present invention relates generally as indicated to a spill-type fuel injection nozzle and, more particularly, to such nozzle for use as in conjunction with nuclear aircraft and the like wherein each fuel injection nozzle is normally used only during climb and descent, whilst during level flight the fuel supply is shut off. When the nozzle is thus shut off, the ambient temperature may become quite high, for example, 2000° F. Accordingly, when relatively cold fuel is subsequently introduced, the nozzle parts will be subjected to serve thermal shock, with resulting permanent set and malfunctioning thereof.

With the foregoing in mind, it is a principal object of this invention to provide a spill-type fuel injection nozzle in which the delicate metering parts and the holder therefor are so made that stresses are relieved when the nozzle is subjected to high temperatures whereby to avoid such permanent set and malfunctioning owing to temperature changes or thermal shock.

It is another object of this invention to provide a simplified form of spill-type fuel injection nozzle in which interfitting metering parts are assembled in a holder in such a way that when the holder and the metering parts are hot, the initial room temperature assembly stresses are relieved, whereby thermal shock of the relatively cold fuel as aforesaid will not, even though it may contract the holder before it contracts the metering parts, impose excessive stresses on the metering parts.

Other objects and advantages of the present invention will become apparent as the following description proceeds.

To the accomplishment of the foregoing and related ends, the invention, then, comprises the features hereinafter fully described and particularly pointed out in the claims, the following description and the annexed drawings setting forth in detail a certain illustrative embodiment of the invention, this being indicative, however, of but one of the varous ways in which the principle of the invention may be employed.

In said annexed drawing:

FIG. 1 is a side elevation view partly in cross-section showing a spill-type fuel injection nozzle embodying the present invention; and

FIGS. 2 and 3 are transverse cross-section views taken substantially along the lines 2—2, and 3—3, FIG. 1, respectively.

Referring now in detail to the drawings, the fuel injection nozzle 1 herein comprises an inlet tube 2 having a fitting 3 welded or otherwise secured thereto, and a spill tube 4 having a fitting 5 welded or otherwise secured thereto, return flow of fuel through the spill tube 4 being controlled as by means of a spill valve 6 represented diagrammatically in FIG. 1. For use in nuclear aircraft the fittings 3 and 5 are preferably made of AISI type No. 321 austinetic stainless steel which has excellent heat resistance and which has the following composition:

C (max.)	.08
Cr	17–19
Ni	8–11
Ti (min.)	5C
Fe	Balance

The nozzle holder 7 comprises a body 8 formed with lateral openings 9 and 10 in which the lower ends of the respective tubes 2 and 4 are fitted and welded as shown. The body 8 is formed with a nozzle-locating bore 11 and a nozzle-receiving counterbore 12 which forms the stop shoulder 14.

With the body 8 are the nozzle metering parts 15, 16, and 17 of which the first part 15 has a cylindrical boss or extension 18 which is closely fitted in the bore 11, of which the second part 16 is a close fit in the counterbore 12 and has a cylindrical pilot or extension 19 slidably fitted in the end of the first part 15, and of which the third part 17 has a pilot or extension 20 telescoped in the end of the second part 16. The third part 17 is formed with a plane end face adapted to be engaged by the plane end face and the holder plug 21 which has threaded engagement with the body 8 as shown.

The first and second parts 15 and 16 define with the body 8 an annular fuel inlet chamber 23 which communicates with the inlet tube 2. The nozzle part 15 is formed with a central fuel discharge orifice 24 from which the fuel is adapted to be discharged in finely divided spray form. Upstream of the orifice 24 is a spin or swirl chamber 25 to which the peripheral tangential swirl passages 26 lead from the inlet chamber 23, whereby fuel under pressure flowing through the inlet tube 2 into the chamber 23 flows through the tangential swirl passages 26 to impart to the fuel a spinning velocity in the spin chamber 25. Accordingly, the fuel will be discharged through the discharge orifice 24 in finely divided spray form due to axial and tangential velocity components in the fuel.

The intermediate or second nozzle part 16 is formed with a central spill passage 27 at the rear center of the spin chamber 25 through which varied amounts of fuel may be bled or returned to vary the rate of discharge of fuel through the orifice 24. The spill passage 27 is preferably of diameter smaller than that of the large end of the spin chamber 25 but larger than that of the discharge orifice 24.

The intermediate and third parts 16 and 17 aforesaid, define an annular diffusion chamber 28 from which the return flow of fuel passes through the radial openings 29 formed in the skirt of the intermediate part 16 into the annular spill chamber 30 and thence through the spill tube 4 and spill valve 6 back to the fuel tank.

When the nozzle herein is in operation the fuel flowing into the spin chamber 25 through the tangential passages 26 imparts a spinning motion to the fuel in said spin chamber. If the spin valve 6 is wide open the swirling fuel will leave the spin chamber 25 through the spill passage 27 and flow through the diffusing chamber 28 and through the openings 29 into the spill tube 4. However, if the spill valve 6 is partly or fully closed, some, or all, of the swirling fuel in the spin chamber 25 will flow through the discharge orifice 24 to form a finely divided conical spray. As the fuel, or part of it, flows into the diffusing chamber 28 its swirl, or spin velocity, is decreased to some extent and, of course, spinning is arrested when the fuel flows through the radial openings 29 that lead into the periphery of the annular diffusion chamber 28.

In the present case the body 8 and the plug 21 of the holder 7 and the inlet and spill tubes 2 and 4 are preferably made of corrosion and heat-resisting alloy such as that known as N–155 obtainable from Haynes Stellite Company which is suitable for the making of jet engine parts,

gas turbine blades, etc. and which has the following composition:

C	.1–.2
Ni	18–22
Cr	18–22
Mo	2.5–3.5
W	2–3
Cb	.7–1.2
N^2	.1–.2
Co	18–22

The aforesaid alloy N–155 has a coefficient of thermal expansion of 10.14 micro-in./in./° F. at 68 to 1830° F. (See page 490 American Society for Metals, Metals Handbook, 8th edition 1961, vol. 1, Properties and Selection of Metals.)

With reference to the nozzle parts **15**, **16** and **17**, these are preferably made of a nickel alloy which has a very low coefficient of thermal expansion less than the coefficient of thermal expansion of the body **8** and plug **21**. As an example, good results have been obtained by making the nozzle parts **15**, **16**, and **17** of Hastelloy X (Haynes Stellite Company) which has the following composition:

C	.15
Cr	22
Ni	45
Mo	9
Fe	Remainder

The aforesaid alloy Hastelloy X has a coefficient of thermal expansion of 9.20 micro-in./in./° F. at 68 to 1800° F. (See page 490 of the above-identified Metals Handbook.)

As previously mentioned, the present nozzle is used only during climb and descent of the nuclear aircraft with which it is associated. Accordingly, during level flight of such aircraft the fuel supply is shut off and therefore the ambient temperature may reach a very high value, for example, about 2000° F. Now, when the fuel nozzle is to be put in operation for climb or descent, the relatively cold fuel will impose a thermal shock on the holder **7** and the metering parts therewithin. Except for the fact that the metering parts **15**, **16**, and **17** have a lower coefficient of thermal expansion than that of the holder body **8** and plug **21** there would apt to be a permanent set of the parts if, for example, the body **8** and plug **21** were cooled more rapidly than the metering parts **15**, **16**, and **17**. By reason of the selection of alloys as herein in relation to their coefficients of thermal expansion the metering parts **15**, **16**, and **17** are in wholly unstressed condition under such high ambient temperature conditions and, of course, the differential in coefficients minimizes or eliminates the stresses which would otherwise be introduced by thermal shock. Preferably, the intermediate part **16** which is a close fit in the counterbore **12** of the body **8** will provide a slight clearance therebetween when the body **8** and the intermediate part **16** are in heated condition but this is of no moment, since the nozzle is not at that time in operation. Moreover, this slight clearance in the heated condition of the nozzle **1** enables relative axial movement of

the parts as caused by the relatively greater axial expansion of the body **8** and plug **21** as compared with that of the metering parts **15**, **16**, and **17**. Preferably, the clearance between the metering part **16** and the counterbore **12** of the body **8** is about .0002" at room temperature so as to preclude leakage of fuel during normal operating conditions of the nozzle.

In assembling the metering parts **15**, **16**, and **17** in the body **8** the plug **21** will be screwed in to apply an initial compression of these parts against the shoulder **14**, thus to eliminate leakage of fuel between the metering part **15** and the body **8**. With the plug thus screwed in, it is welded or otherwise locked in place, as indicated by the reference numeral **31** in FIG. 1.

Other modes of applying the principle of the invention may be employed, change being made as regards the details described, provided the features stated in any of the following claims, or the equivalent of such, be employed.

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

1. A spill-type fuel injection nozzle comprising a holder formed with fuel inlet and return passages leading thereinto; and a coaxial series of interfitting and abutting nozzle parts clamped in said holder and forming therebetween a spin chamber having tangential passages leading into the periphery thereof from such inlet, a central fuel discharge orifice at one end of such chamber, a central spill passage at the other end of such chamber, and an annular diffusion chamber into which fuel passes from such spill passage and from the periphery of which fuel passes to such return passage; said holder and nozzle parts being made of heat-resisting alloy to enable use of the nozzle in nuclear aircraft and the like wherein said holder and nozzle parts become highly heated, the alloy employed for said nozzle parts having a coefficient of thermal expansion of about 9.20 micro-in./in./° F. at 68 to 1800° F. as compared with about 10.14 micro-in./in./° F. at 68 to 1830° F. for the alloy employed for said holder whereby initial clamping stresses of said nozzle parts in said holder are relieved at elevated temperatures and stresses introduced by thermal shock of relatively colder fuel supplied to said nozzle are minimized.

2. The nozzle of claim 1 wherein said holder comprises a hollow body and a plug secured thereto between which said nozzle parts are clamped to impose tensile stress in said body and compressive stress in said nozzle parts at normal room temperature, such stresses being relieved at such elevated temperatures owing to differential expansion.

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