

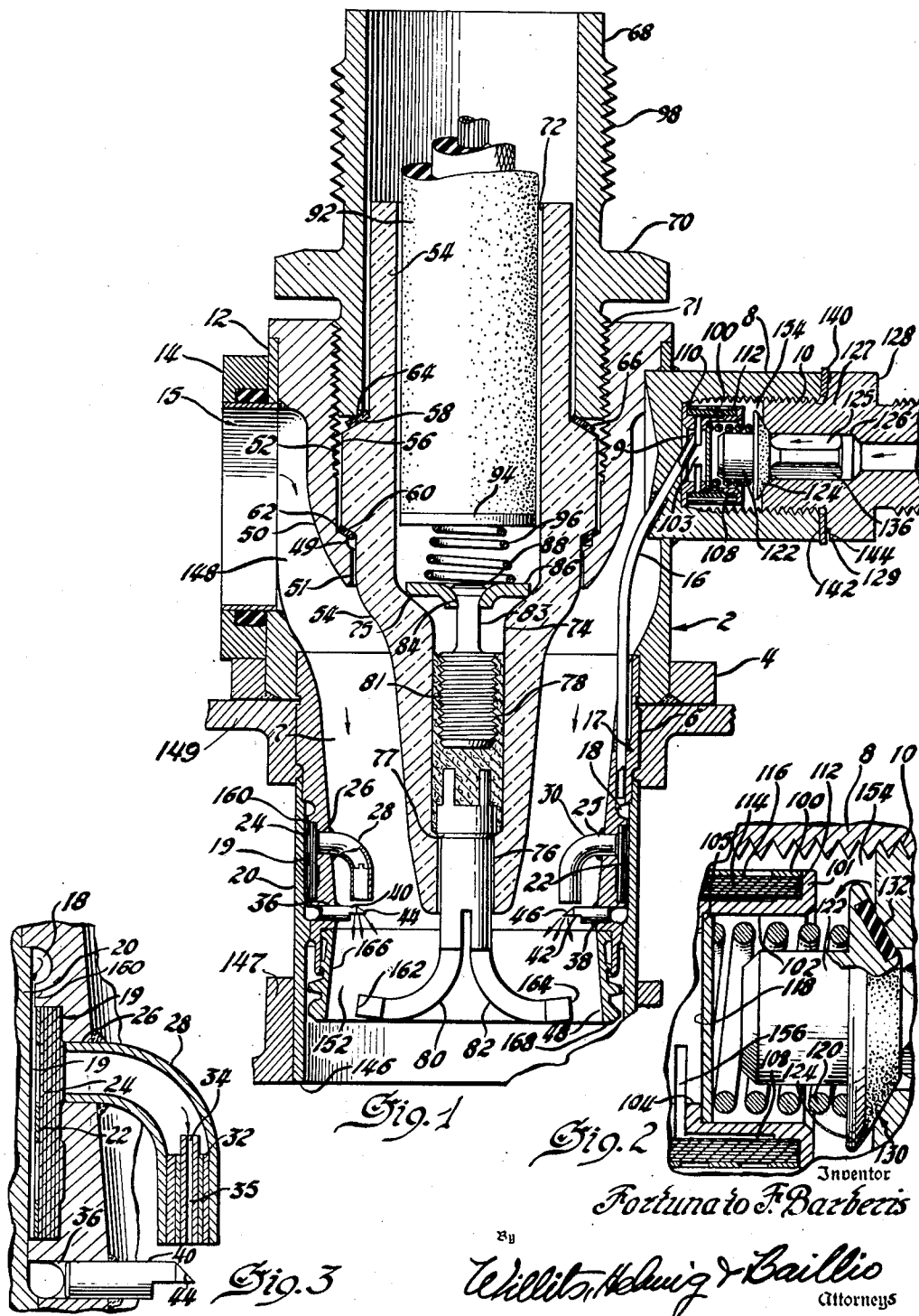
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INJECTOR IGNITER PLUG

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INJECTOR IGNITER PLUG

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9 Claims. (Cl. 60—39.82)

This invention relates to injector igniter plugs for gas turbine engines. More particularly, although not exclusively, the invention is directed to aircraft turbine engines employing main fuel injection devices adjacent a main combustion chamber and incorporating means for initiating combustion comprising auxiliary fuel and air jets and an ignition device associated therewith for initiating combustion of fuel and air issuing therefrom to produce a torch-like flame which extends into the main combustion chamber and ignites the fuel and air delivered by the main fuel injection devices.

Experience has shown that certain flight conditions tend to extinguish the fire in the main combustion chamber, commonly referred to as a "flame-out." The same condition heretofore affected the operation of the igniter, thereby impeding in-flight attempts to re-ignite the main combustion chamber.

An object of the present invention is to provide an injector igniter device which is unaffected, within certain limits, by the same atmospheric conditions which control the operation of the engine.

Another object is to provide an igniter device which produces a flame which is, under all conditions, self supporting and capable of re-igniting the main combustion chamber.

A further object is to provide a device of the type described which is adapted to produce at all altitudes an optimum fuel-air mixture regardless of atmospheric conditions existing in the main combustion chamber.

A still further object is to provide a device of the type described in which the ignition means may be readily removed and replaced without disassembling the remainder of the device.

Still another object is to provide a device of the class described having thermal means for sustaining continuous combustion of the fuel-air mixture.

Further objects and advantages of the invention will more fully appear hereinafter from the following detailed description when read with reference to the accompanying drawings wherein:

Fig. 1 is a side elevation, in section, of the injector igniter plug showing the details of construction and the arrangement of the parts thereof.

Fig. 2 is an enlarged fragmentary elevational view, in section, of the fuel connector portion; certain parts being broken away to more clearly show the structure thereof, and

Fig. 3 is an enlarged fragmentary sectional elevational view showing structural details of the fuel discharge elements.

Referring to Fig. 1, an injector igniter plug is shown in which the numeral 2 designates the main body shell thereof. At its lower edge, main body shell 2 is press-fitted into a flange 4 and then secured thereto by welding, brazing or other suitable means. The lower end of shell 2 has a tubular extension 6 press-fitted therein and secured thereto by brazing or other suitable means. The

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interior of the shell 2 and extension 6 are formed to provide a venturi passage 7. Extending outwardly from one side of the main body portion 2 and secured thereto by brazing, is a cup shaped fuel connector 8 having an internally threaded flat bottom bore 10 formed therein. Diametrically opposite the fuel connector 8, the shell 2 is provided with a milled face 12 to which a flange 14 is secured by brazing or other suitable means. Flange 14 is provided with an aperture 15 centrally thereof of which is adapted to receive an oval air supply pipe, not shown, for supplying air from an external source in a controlled ratio relative to the fuel delivery. The base 9 of fuel connector 8 is drilled, milled and recessed for receiving one end of a seamless tube 16 which is secured thereto by brazing. Tube 16 extends downwardly into a drilled recess 17 in the side wall of the lower extension 6 of the shell 2. Lower extension 6 is provided with an annular groove 18 of semi-circular cross-section, formed immediately adjacent the lower extremity of tube 16, whereby the fuel discharge of said tube is circulated in an annular path around the external circumference of lower extension 6. Immediately below annular groove 18, extension 6 is provided with a wide, relatively shallow annular groove 19. A long strip of fine wire mesh cloth 24 is tightly wound around groove 19 to provide a filter for the fuel and is securely held in place by circular perforated light gage metal strip 22. Between annular grooves 18 and 19, lower extension 6 is stepped inwardly slightly to provide an annular passage 160. An annular sleeve 20 is press-fitted over the lower half of lower extension 6 to close the outer sides of annular grooves 18 and 19 except for the annular communicating passage 160 therebetween. Diametrically opposed radial bores 25 and 26 are provided in lower extension 6 which extend into filter groove 19 for receiving the upper ends of tubular elbow discharge elements 28 and 30, respectively. Discharge elements 28 and 30 may be secured in fluid tight relation in bores 25 and 26, respectively, by brazing or other suitable means. At their inner down turned extremities the elbow discharge elements 28 and 30 are provided with bushings 32 into which are press-fitted calibrated discharge orifices 34 having fine annular bores 35 for metering fuel and accomplishing high velocity discharge. Immediately below the elbow discharge orifices 32 and 34 the lower extension 6 is provided with diametrically opposite radial bores 36 and 38 having discharge target pins 40 and 42 mounted therein by brazing or other suitable means. Directly below and in axial alignment with discharge orifices 34 the end portions of the target pins 40 and 42 are provided with inclined surfaces 44 and 46 for breaking up and atomizing the high velocity fuel discharged from orifices 34. At its lower extremity the lower extension 6 has press-fitted therein a heat absorbing sleeve-like element 48 of generally frusto-conical form having a smooth internal surface 166 and spaced annular projections of varying lengths around the outer surface. The sleeve-like tubular element 48 may be made of inconel or similar metals having the desired heat absorbing characteristics.

At its upper end, the main body shell 2 is provided with an annular insulator shell 50, which is press fitted into the upper end thereof and secured in position by brazing. Insulator shell 50 is provided with internal threads 52 at its upper end and inwardly stepped annular reduced portions 49 and 51 at its lower extremity. On its outer surface the shell 50 is of gradually increasing cross section terminating in the flange 53 at its upper end which is press fitted into the upper end of shell 2 as previously described.

The spark plug proper is a separate unit and is readily inserted and removed from the insulator shell 50. The

numeral 54 designates generally a ceramic insulator comprising an elongated irregular shaped hollow annular body portion which is located axially in the insulator shell 50 and supported by an enlarged annular rib 56 having beveled shoulders 58 and 60. Metal gaskets 62 and 64 are disposed between the beveled shoulder 60 and the stepped lower edge 49 of shell 50 and between the beveled shoulder 58 and the lower edge 66 respectively of the insulator shield 68. Insulator shield 68 comprises a sleeve-like annular body having an integral hexagonal flange 70 formed intermediate the ends thereof and is provided with external threads 71 of the lower portion thereof which are adapted to engage the internal threads 52 of the insulator shell 50 thereby firmly seating and retaining the ceramic insulator 54 in position in shell 50. The gaskets 62 and 64 provide a gas tight seal when shield 68 is tightened on shell 50. As its upper end, insulator shield 68 is provided with external threads 98 which are adapted to receive an ignition cable cap, not shown, for securing an ignition cable 92 firmly in position. Ceramic insulator 54 has formed in substantially axially alignment therein an enlarged upper bore 72 and a reduced lower bore 74 with a downwardly inclined annular shoulder 75 therebetween. Reduced lower bore 74 has positioned therein a center electrode 76 having a slightly enlarged shoulder 77 near its upper end. The lower portion of electrode 76 is bifurcated and the bifurcations 80 and 82 are curved and extend outwardly away from each other. Electrode 76 is axially positioned in the tip of the insulator 50 by shoulder 77 and is sealed in position by fusing a mixture of glass and metal powder in the conventional manner as shown at 78. The bifurcated ends 80 and 82 of the electrode 76 are symmetrically formed and gapped after the glass sealing. A center wire screw 81 is positioned above electrode 76 in the upper end of reduced annular bore 74 and secured therein by the glass seal 78. An upstanding stub 83 is formed on the center wire screw 80 and extends upwardly through a dimpled central aperture 84 in the contact cap 86. The end portion 88 of the stub 83 is crimped over and secures the contact cap on annular shoulder 75. Ignition wire 92 extends downwardly through insulator shield 68 into the upper bore 72 of the insulator 54 and is provided with a metal cap 94. A spring 96 extends between and contacts caps 94 and 86, thereby establishing electrical contact between wire 92 and contact cap 86. Ignition wire 92 is held in position by a screw cap, not shown, which is adapted to threadably engage the external threads 98 of the insulator shield 68.

As shown particularly in Fig. 2, fuel connector 8 is provided with a core filter unit 100 recessed at the bottom of the threaded bore 10. Filter unit 100 comprises a hollow substantially cylindrical frame 101 which is disposed in substantially spaced relation with the threaded interior of connector 8. The frame 101 has aligned large and small bores 102 and 104 providing an annular shoulder 105 therebetween. Inwardly of shoulder 105, filter frame 101 is milled across its axis in three locations 156 to provide for fuel passages. The outer cylindrical surface of the frame 101, is provided with a wide groove or annular recess 108 terminating at the ends in annular flanges 110 and 112. A long ribbon of screen cloth 114 is wound about groove 108 and is bound in place by perforated light gage metal strips 116. A sealing disc 118 is tightly fitted in bore 102 and abuts annular shoulder 105. A coil spring 120 engages disc 118 at one end and the inner face of plunger valve 124 at the other end, the reduced cylindrical extension 122 of said valve holding said spring in position. The guide stem 125 of valve 124 is slidably disposed in an axial bore 126 of the threaded end 127 of the fuel connector nipple 128. The conical face 130 of valve 124 is recessed to provide for a flat rubber ring 132, to seal the valve against leakage when in closed position. The guide stem 125 of valve 124 is formed with three longitudinal flats 136 to provide

fuel passages through the bore 126 of the fuel nipple 128 when the plunger valve 124 is in open position. The mid-portion 129 of the fuel nipple 128 is provided with an integral flange of hexagonal cross section for tightening the said nipple into the fuel connector 8. Gasket 140 is interposed between the outer face 142 of the fuel connector 8 and the inner face 144 of the fuel connector nipple 128 to provide a leak-proof juncture.

When the device is installed in an engine, the lower edge 146 of annular sleeve 20 on the lower extension 6 is flush with the burner wall of the engine casing 147, while the flange 4 abuts the outer wall 149 of the engine casing. From a suitable air control, not shown, air under suitable pressure is piped to the juncture formed at flange 14. Fuel is also piped through an appropriate external control, also not shown, to the fuel connector nipple 128. The fuel control, not shown, controls only the pressure of the fuel, the metering of the fuel being determined by the diameter of discharge orifices 34.

Air piped to the flange 14 enters annular chamber 148 and flows through the venturi 7 and diffuser cone 152. Fuel piped into the connector nipple 128 is blocked by the valve seat 132 of the plunger valve 124 until a predetermined operating pressure is built up. The valve 124 is adjusted to open, for example, at 30 pounds per square inch but is intended only to keep the fuel line under light pressure and not for metering of fuel, as previously described. By keeping the fuel under light pressure the tendency towards fore and aft dripping at the discharge orifices 34 is minimized. When plunger valve 124 opens, fuel flows through the spaces between the flats 136 on the valve stem 125, past the seal 132 and enters chamber 154 within fuel connector 8. Fuel then flows through the filter mesh 114 and the milled slots 156 into reduced bore 103 of frame 101. From bore 103 the fuel enters tube 16 and passes downwardly into the circumferential groove 18 in lower extension 6. Circumferential groove 18 discharges the fuel downwardly through reduced annular portion 160 into the annular groove 19 where it passes through the circular filter mesh 24 into velocity traps in elbow discharge members 28 and 30 and is discharged at high velocity through discharge orifices 34. The fuel discharges through orifices 34 in needle-like jets and strikes the inclined surfaces 44 and 46 of target pins 40 and 42 and is finely atomized into a mist which mixes with the air and is promptly ignited by sparks passing between the tips 162 and 164 of the center electrode 76 and the inner surface 166 of the frusto-conical sleeve 48. Because of the heat absorbing characteristic of the frusto-conical sleeve 48, sparks from the center electrode 76 are required only for initially igniting the mixture. After ignition, the flame will form an outer envelope starting at and heating the extreme lower edge 168 of the sleeve 48. The heat gradually diffuses upwardly in the cone throughout the entire sleeve and is absorbed by the boundary layer of fuel-air mixture which, on reaching the lower edge of the sleeve 48, is brought to the flashing point and thereafter ignites without the assistance of the electric spark. Spark ignitions, if desired may thereafter be discontinued.

The lower edge 168 of the conical sleeve 48 is recessed slightly in the outer sleeve 20. Since the lower edge 146 of the sleeve 20 is flush with the burner wall, not shown, the lower edge 168 of the conical sleeve 48 is protected from the impact of the air stream entering the burner chamber as well as the liquid spray of the main jets which would tend to reduce the temperature of the conical sleeve and impair the self-igniting characteristics just described.

If the fire in the burner chamber is extinguished by any of the numerous conditions encountered in flight, the igniter flame generated at the lower edge 168 of the conical sleeve 48 will not be affected since an ideal fuel-air ratio is maintained by an independent fuel and air supply

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and the igniter flame is therefore available for re-igniting the jet at will, whenever flight conditions permit.

While but a single embodiment is shown and described herein, it is apparent that certain changes and modifications may be made without departing from the invention. It is therefore to be understood that it is not intended to limit the invention to the single embodiment shown but only by the scope of the claims which follow.

I claim:

1. In an injector igniter plug, the combination of an outer shell, a tubular extension secured to the lower end of said shell having a plurality of axially spaced annular grooves provided therein, a sleeve fitted over said extension and cooperating with said grooves to form annular chambers, means defining an opening in said shell for the admission of combustion air, fuel inlet means attached to said shell having a control valve provided therein, means connecting said fuel inlet means with said annular chambers, means formed in said extension providing communication between said annular chambers, filter means secured in one of said annular chambers, nozzle means mounted in said extension and adapted to receive filtered fuel, means for atomizing said fuel, and means for igniting the fuel so atomized.

2. The structure, as claimed in claim 1 wherein the inner walls of said shell and extension are so formed as to provide a venturi passage for the air flowing therein, and means for mounting said fuel igniting means interiorly of said shell and extension.

3. In an injector igniter plug, the combination of a main body shell having an upper body portion and a lower body portion, said upper body portion having an air admitting aperture formed therein at one side thereof, a flange member secured to said upper body portion around said aperture for coupling with an air supply conduit, a second aperture formed in said upper body portion, said second aperture having a fuel supply connector secured therein, filter means recessed in said fuel supply connector, means on said lower body portion forming a closed annular chamber, additional means forming a second annular chamber between said fuel connector and said closed annular chamber, filter means in said annular chamber, fuel discharge members extending out of said closed chamber, target members for atomizing said fuel from said discharge members, a spark producing member mounted in said shell for initiating combustion of said fuel air mixture, and a heat absorbing member tightly sleeved in said lower body portion adjacent said target members for inducing continuous combustion of said fuel and air mixture.

4. In an injector igniter plug, the combination of a main body shell having an upper body portion and a lower body portion having a plurality of external annular grooves formed thereon, said upper body portion having an air admitting aperture formed therein at one side thereof, and air conduit coupling flange secured to said upper body portion around said aperture, a second aperture formed in said upper body portion, said second aperture having a fuel supply connector member secured therein, filter means recessed in said connector member, a sleeve member disposed about said lower body portion whereby said annular grooves form closed annular chambers, a conduit connecting said fuel connector and said closed annular chambers, a plurality of fuel discharge members spaced about the inner periphery on said lower body portion, each of said discharge members being adapted to receive fuel from said closed chambers, reduced metering orifices mounted in said fuel discharge members adapted to discharge said fuel at high velocity, a plurality of target elements secured in said lower body portion, each of said target elements being in alignment with said discharge orifices whereby said high velocity fuel discharge is finally atomized and mixed with said air, and electrical ignition means disposed in said shell for initiating combustion of said fuel air mixture.

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5. In an injector igniter plug, the combination of a main body shell, having an upper body portion and a lower body portion, a port for admitting air formed in the wall of said upper body portion at one side thereof, means for admitting fuel attached at the other side of said upper body portion, a spark plug secured in said shell, a plurality of gaskets disposed between said shell and said spark plug to form a gas tight seal therebetween, an annular chamber on said lower body portion communicating with said fuel admitting means, a plurality of discharge nozzles for said fuel disposed about said lower body portion and communicating with said closed annular chamber, and a plurality of filters interposed between said fuel admitting means and said discharge nozzles.

6. In a gas turbine having an outer casing and a burner wall, an injector igniter plug comprising a main body shell having an upper body portion and a lower body portion, said lower body portion being adapted to be mounted in a well between the outer casing and the burner wall of said turbine, means forming a venturi throat interiorly of said lower body portion, an air admitting port formed in the wall of said upper body portion at one side thereof, means on said upper body portion at the other side thereof for admitting fuel, said means including a filter for said fuel, a plurality of annular chambers formed in said lower body portion, means connecting said fuel admitting means and said annular chambers, a plurality of fuel discharge nozzles mounted on said lower body portion and adapted to receive fuel from one of said annular chambers, a plurality of target pins mounted on said lower body portion for atomizing and mixing fuel from said discharge nozzles with air from said air admitting port, spark means for initiating combustion of said fuel air mixture, and means attached to said upper body portion for securing said spark producing means in said shell.

7. In an injector igniter plug for use in continuous combustion apparatus having an inner wall surface and an outer wall surface spaced therefrom, said plug comprising in combination a main body shell having an upper body portion and a lower body portion, said lower body portion being adapted to project through suitable openings in said inner wall and outer walls, means on said upper body portion for admitting air, additional means on said upper body portion for admitting fuel, said additional means including a filter for said fuel, a plurality of nozzles on said lower body portion for discharging said fuel at high velocity, means secured in said lower body portion below said nozzles for atomizing and mixing said fuel with said air, and ignition means centrally disposed in said shell for initiating combustion of said fuel and air mixture, said means on said upper body portion for admitting air comprising a flange member having an aperture formed therein communicating with the interior of said main body shell, and said flange being adapted for coupling with an air supply conduit.

8. In an injector igniter plug for use in continuous combustion engines having spaced walls forming a combustion chamber and an outer casing, said plug comprising in combination a main body shell having an upper body portion and a lower body portion, said lower body portion being adapted to project through aligned openings in said spaced walls, means on said upper body portion for admitting fuel, additional means on said upper body portion for admitting air, nozzle means on said lower body portion for discharging said fuel, target means below said nozzle means for atomizing and mixing said fuel with said air, ignition means for initiating combustion of said fuel and air mixture, and an annular heat absorbing member for igniting said fuel.

9. In an injector igniter plug for use in continuous combustion apparatus having an inner wall surface and an outer wall surface spaced therefrom, said plug comprising in combination a main body shell having an upper

body portion and a lower body portion, said lower body portion being adapted to project through suitable openings in said inner wall and outer walls, means on said upper body portion for admitting air, additional means on said upper body portion for admitting fuel, said additional means including a cup shaped member having a threaded internal bore, a filter disposed in said bore, a threaded nipple having an annular bore, said nipple being threadably secured in said cup shaped member, a plunger valve slidably disposed in said last mentioned bore, spring means tending to close said valve and regulate the flow of said fuel past said valve, a plurality of nozzles on said lower body portion for discharging said fuel at high velocity, means secured in said lower body portion below said nozzles for atomizing and mixing

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said fuel with said air, and ignition means centrally disposed in said shell for initiating combustion of said fuel and air mixture.

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