

April 22, 1958

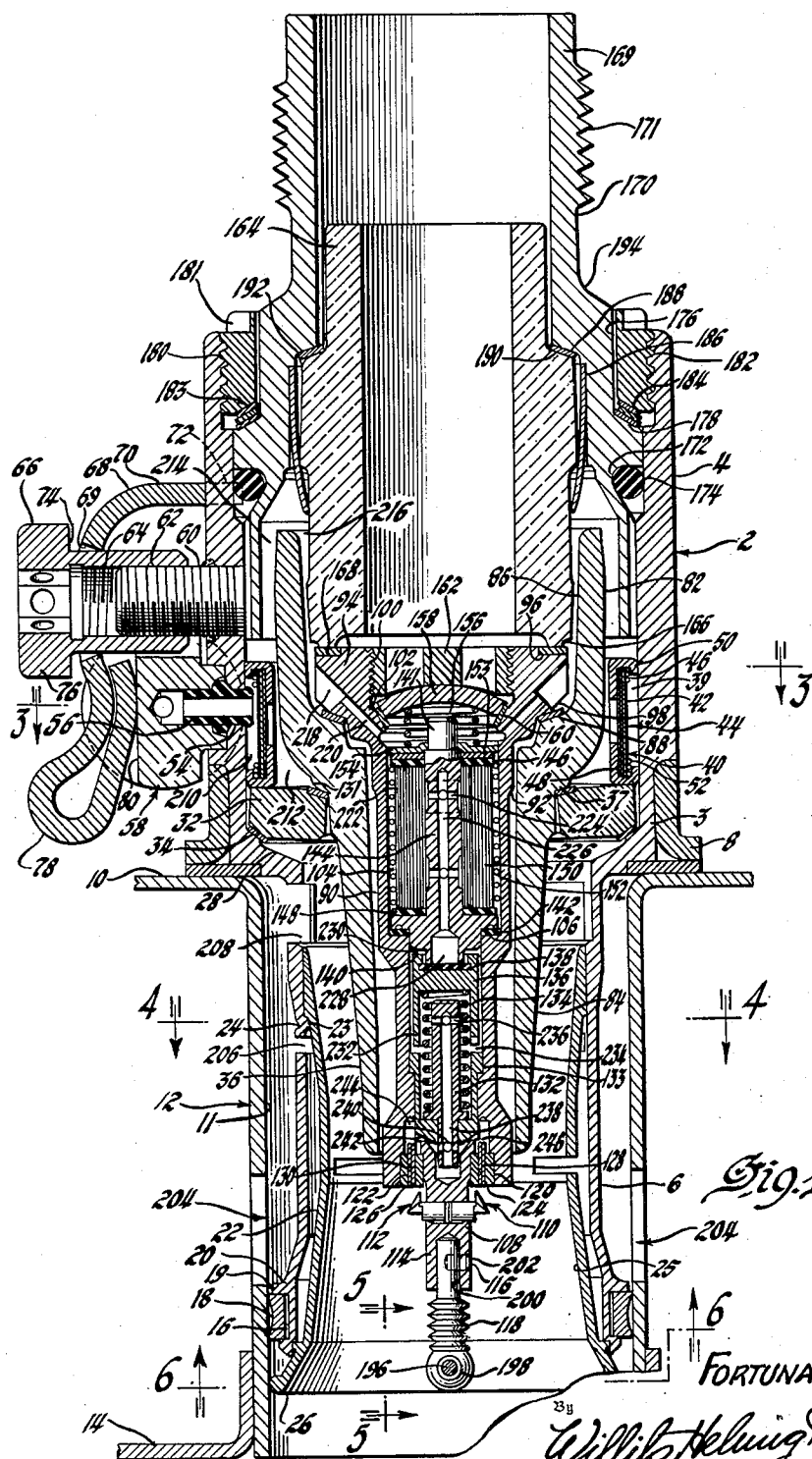
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INJECTOR IGNITER PLUG

Filed Dec. 29, 1952

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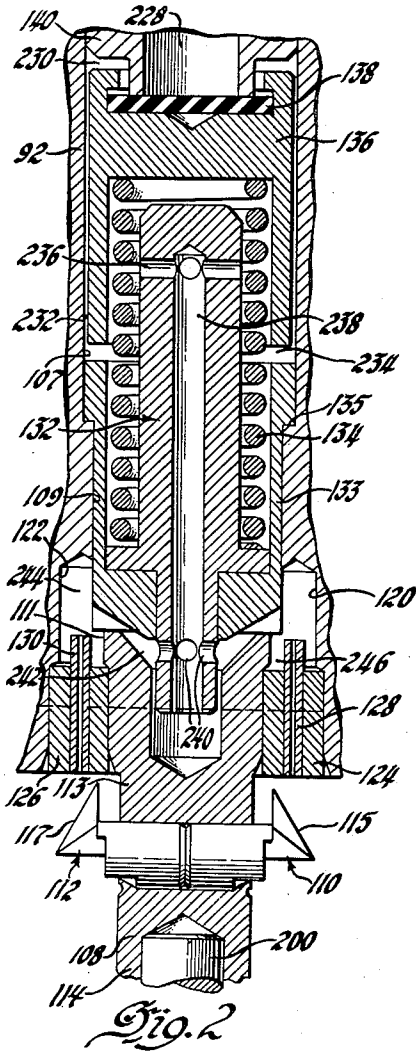
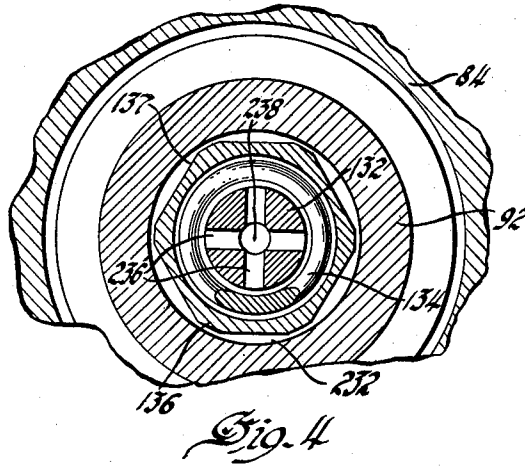
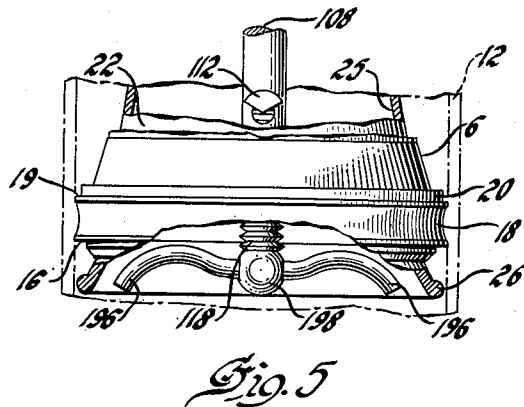
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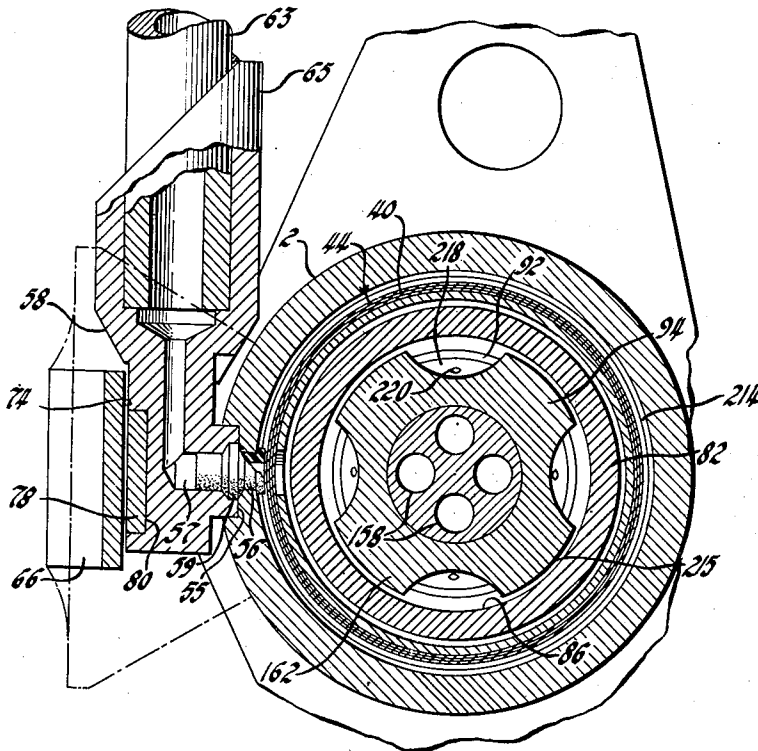


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INJECTOR IGNITER PLUG

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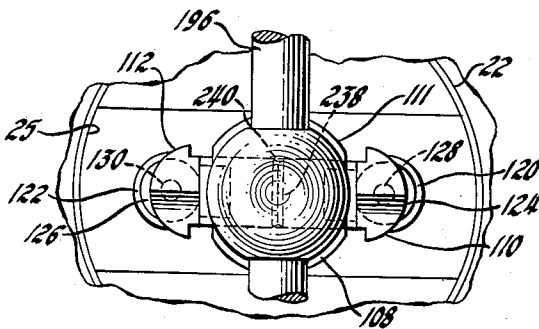


Fig. 6

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INJECTOR IGNITER PLUG

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8 Claims. (Cl. 60—39.82)

This invention relates to fuel injector igniter plugs and more particularly to igniting devices for gas turbine engines.

Although not exclusively, the invention is applicable to aircraft turbines which occasionally require reignition of the burner in flight due to unusual or adverse atmospheric conditions in the burner chamber. In such gas turbines an air compressor is usually coupled to or mounted on the same shaft as the turbine and the air output from the compressor is delivered to the burner chamber into which fuel is injected through suitable fuel nozzles and the air together with the fuel is brought to combustion by means of an electrical ignition from a spark plug. Hot gases thus formed, pass through the turbine and drive it and the compressor with part of their energy while the remaining hot gases are ejected to the atmosphere to produce a propulsive jet.

It is well known that the use of a pilot flame instead of an electrical spark will provide a more satisfactory form of ignition, and will allow the power required for motorizing the engine for starting to be reduced substantially.

Preferably, such a device is mounted in a well formed in the air space between the outer engine casing and the concentrically inwardly disposed burner casing.

The present invention is directed particularly to an improved injector igniter plug and has as one object the provision of a compact means for supplying a pilot flame to positively ignite the engine fuel.

Another object is to provide an injector igniter plug which is adapted to inject a fully atomized, readily ignitable, air fuel mixture.

A further object is to provide a device of the type described which may be completely assembled and disassembled without the application of heat during such process, thereby retaining the original finish and plating of the individual parts thereof.

Still another object is to provide an injector igniter plug which is continuously operative and is thereby available for re-igniting the propellant mixture in the main burner when combustion fails due to atmospheric variations encountered in flight.

Yet another object of the invention is to provide such a device wherein a portion of the igniter absorbs and stores sufficient heat to induce continuous combustion of the atomized mixture thereby eliminating the need for a continuous or intermittent spark.

Still another object is to provide a device of the class described which may be readily disassembled for cleaning or replacements of component parts.

A still further object is to provide a device incorporating novel and improved means for assuring complete removal of foreign matter from the fuel supply therefor.

Other objects and advantages will hereinafter be more fully described and for a complete understanding of the nature, scope and characteristics of this invention reference may be had to the following description and the accompanying drawings in which:

Fig. 1 is a side elevation in section of the injector igniter

plug showing the details of construction and arrangement of the component parts thereof.

Fig. 2 is an enlarged fragmentary sectional elevational view showing details of the lower portion of the center electrode of the injector igniter plug.

Fig. 3 is a sectional plan view taken substantially along line 3—3 of Fig. 1.

Fig. 4 is a fragmentary sectional plan view taken substantially along the line 4—4 of Fig. 1.

Fig. 5 is a fragmentary side elevation of the lower portion of the plug with parts broken away to show certain features thereof, said view being taken substantially along line 5—5, and

Fig. 6 is a fragmentary plan view of the lower end of the igniter plug, taken along line 6—6 of Fig. 1.

Referring now to the drawings, and particularly Fig. 1, there is shown an injector igniter plug having a generally cylindrical shell member 2, comprising a straight upper body portion 4, and a reduced inwardly stepped lower body portion 6. An annular outwardly flared flange 8 is press fitted on the inwardly stepped lower edge 3 of the upper body portion 4 and is secured thereto by brazing or welding. Flange 8 is intended to abut the outer surface 10 of the burner chamber envelope for axially positioning the lower edge of lower body portion 6 in the igniter well 12 in slightly recessed relation to the inner wall 14 of the burner chamber. At its lower extremity, lower body portion 6 is provided with an outwardly extending enlarged portion 20 having a shallow annular groove 16 formed therein adapted to receive a circular pressure ring 18 for sealing the gap 19 between the said enlarged end and the inner wall 11 of igniter well 12. A venturi sleeve 22 is pressed in to the interior of the lower body portion 6, and is staked in position at three points by indenting the wall of the lower body portion 6 adjacent the shoulder 23 of said venturi sleeve, as shown at 24. At its lower extremity venturi sleeve 22 extends downwardly beyond the lower end of body portion 6 and is flared outwardly to form frusto-conical tip 26.

On its inner surface, upper body portion 4 of shell 2 is provided with an annular inwardly stepped portion forming a shoulder 28 in substantially the same transverse plane as flared flange 8. A circular spring washer 32 is positioned within the upper body portion 4 and seated on the shoulder 28 against metal washer 34. Spring washer 32 aligns and supports electrode tip insulator 36, to be described later, and is provided with an upper metallic washer 37 for sealing when the complete unit is assembled. A cylindrical filter frame unit 40 of C-shape cross-section is adapted to be press fitted into the interior of the upper body portion 4 in tight engagement with the upper surface of spring washer 32. The central core section 42 of filter frame 40 is tightly wound with a long strip of fine mesh stainless steel screen cloth 44. Screen cloth 44 is held in place by upper and lower springs 46 and 48 which in turn are held in place by crimping over the flanges 50 and 52 of filter frame 40. At one side of the upper body portion 4 and in substantial alignment with the filter frame 40 there is provided an aperture 54 and an adjoining recess 55 for positioning an elbow fuel line connector 58. A synthetic rubber nipple 56 carried by elbow fitting 58 extends through aperture 54 and forms a seal between said fitting and body portion 4. Synthetic nipple 56 is inserted in the radial bore 57 of the fuel connector 58 and is provided with an annular rib 59 which is compressed between the face of fuel line connector 58 and the wall of upper body portion 4, to provide a leak proof juncture therebetween. As best seen in Fig. 3, a fuel line 63, from an external fuel pump, not shown, extends into the enlarged bore provided in the outer end 65 of elbow connector 58 and is secured

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thereto by brazing. Slightly above fuel line connector 58, upper body portion 4 has secured thereto an outwardly extending stud 60 having external threads 62 formed thereon which are adapted for threadable engagement with the internal threads 64 of a hollow lock screw 66. A metal spring clip 68 having a longitudinal slot 69 formed centrally thereof, is provided to resiliently urge connector 58 into engagement with body portion 4. As shown in Fig. 1, the upper end of clip 68 extends into a slot 72 formed in the wall of the upper body portion 4 slightly above the outwardly extending stud 60 and extends outwardly from said recess and downwardly, straddling lock screw 66 and bearing outwardly against the inner face 74 of the hexagonal head 76 of lock screw 66. The lower portion of clip 68 is formed with an inwardly bent up loop 78 which extends into a recess provided in fitting 58 and bears against the milled slot 80 of said connector. It will be seen that as the hollow screw 66 is turned in one direction on the stud 60 clip 68 will be deformed and brought into tension causing the lower bent up loop 78 to bear firmly against the milled slot 80 of connector 58, and thereby urge the latter into sealing relation with nipple 56 and body 4.

Electrode tip insulator 36, previously mentioned, is a stepped hollow annular ceramic body having a straight upper body portion 82 tapering inwardly into a progressively downwardly tapering lower body portion 84. The interior portion of the electrode insulator 36 is provided with an enlarged smooth bore 86 which terminates at its lower end in a progressively stepped inwardly extending portion as shown at 88 which terminates in turn in a reduced annular bore 90.

A center electrode 92 of substantially cylindrical construction is provided with an enlarged outwardly flaring upper end 94 adapted for seating on the shoulder 88 of electrode tip insulator 36. The upper enlarged end 94 is provided with two sealing faces at 96 and 98 and a short threaded internal bore 100. Threaded bore 100 terminates in an annular beveled shoulder portion 102 which in turn terminates in an elongated reduced annular bore 104. Bore 104 terminates in an annular shoulder 106 and communicates with still further reduced bores 107, 109 and 111. As seen in Fig. 2, the upper end 113 of an electrode holder element 108 is integral with and forms the base of the lower central electrode 92. Holder element 108 is provided with a pair of diametrically opposed radially extending target pins 110 and 112 formed in the mid section thereof and a depending bored shank 114 provided with a radially extending locking pin aperture 116 for attaching electrode stub 118 in position therein. Two off-center diametrically opposed longitudinal holes 120 and 122 are bored and counterbored in the lower end of the center electrode 92 into which are press fitted bushings 124 and 126. As shown in Figs. 1 and 2, bushings 124 and 126 are disposed adjacent holder 108 and have press fitted therein injector nozzles 128 and 130 a distance sufficient to bring their upper end portions above the upper surfaces of said bushings. A centering core 132 is mounted within a core guide 133 which in turn is disposed in the lower annular bore 109 of center electrode 92 in axial abutment with the holder element 108. The upper enlarged end of core guide 133 seats on an annular shoulder 135 disposed between bores 107 and 109. A coil spring 134 surrounds the centering core 132 and presses upwardly on a valve plunger 136 which is slidably disposed in the bore 107 and surrounds the upper end of centering core 132. Valve plunger 136 is provided with six longitudinally extending flat surfaces 137, equally spaced about its periphery, and carries a synthetic rubber disc 138 at its upper end to form a seat for the lower edge portion of a filter core 140. Filter core 140 is seated on the annular shoulder 106 at the lower end of bore 104, a synthetic rubber gasket 142 being disposed therebetween. On the

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reduced main body portion 144 of the filter core 140, between a pair of spaced synthetic rubber discs 146 and 148, a fine screen cloth 150 is tightly wound and held in place by helical spring 152. At its upper end, adjacent gasket 146, filter core 140 is provided with a steel washer 153. An indented centering washer 154 is positioned directly above steel washer 153 and surrounds the reduced tip 141 of the body portion 144 of core 140. A coil spring 156 is disposed directly above centering washer 154 and is compressed by a dome shaped disc spring 158 which is seated against a gasket 160 provided on the beveled shoulder 102 in the upper end of the bore of the center electrode 92. A threaded plug 162 is mounted in the internally threaded upper bore 100 of the center electrode 92 and holds the entire assembly in compressed relation. The sealing gaskets prevent leakage between the associated parts.

A hollow annular shield insulator 164 of ceramic material, is disposed centrally within the upper body portion 4 of the sleeve 2 and has its lower end extending downwardly into the upper annular bore 86 of the insulator 36. The lower edge 166 of the shield insulator 164 engages a gasket 168, which is disposed on upper edge shoulder 96 of the enlarged upper end 94 of the center electrode 92. Shield insulator 164 is held in position and is centered by a tubular shield 170 which surrounds the shield insulator 164 and is slidably fitted within the upper body portion 4 of shell 2. Shield 170 is formed with outwardly stepped annular portions having an inclined annular groove 172 formed near the lower edge thereof and adapted to receive and hold an O sealing ring 174. The upper end 169 of shield 170 is provided with external threads 171 for securing thereto an ignition cable cap, not shown, which in turn retains one end of an ignition cable not shown, within the internal bore of the shield insulator 164 to provide electrical contact with the threaded plug 162. It will be seen, therefore, that current passes from the ignition cable through the body of center electrode 92 and is discharged across the gaps between electrode prongs 196 and the ground provided by venturi tip 26. Shield 170 is provided with a reduced annular portion 176 near the upper end of shell 2 which terminates in an inclined shoulder 178 at the lower end thereof thus providing an annular space for an externally threaded ring nut 180 which threadably engages the internal threads 182 on the upper end of said shell. Ring nut 180 is formed with a knurled upper edge 181 to provide a grip to facilitate turning thereof on threads 182. On its lower edge nut ring 180 is provided with a beveled edge 183 which bears against the plurality of gaskets 184, positioned on the inclined shoulder 178 of the shield 170. Shield insulator 164 is centered within shield 170 by a sleeve type centering spring 186 as shown in Fig. 1. A sealing gasket 188 is disposed between an inclined shoulder 190 on shield insulator 164 and an inclined shoulder 192 on shield 170 to provide a tight seal therebetween.

To assemble the injector igniter plug, insulator tip 36 is inserted into the shell 2 so that its outer shoulder portion 37 is in contact with the gasket 38 resting on the circular spring 32. Center electrode 92 is first completely assembled and then inserted axially of the insulator 36 to the position shown in Fig. 1. Shield insulator 164 is then inserted in the upper end portion 86 of the insulator 36 and thereafter shield 170 is slidably fitted into the upper end portion 4 of the shell 2 in such a manner as to surround and center shield 164 by means of sleeve spring 186. The entire assembly is then placed in a press and the shoulder 194 of the shield 170 is subjected to 3,000 lbs. pressure. While the shield 170 is under pressure, nut ring 180 is threaded into the shell 2 against the plurality of washers 184 disposed on the shoulder portion 178 of said shield until metal to metal contact is assured, whereupon the pressure on the shoulder 194 of the shield

170 is relieved, producing very slight spring-back in the shield 170 thereby locking the nut ring 180 against any possibility of backing off. The entire unit is thereby rendered, for all practical purposes, a unitary device which cannot be disassembled except by reversing the above described process.

In the past, injector igniter plugs have required brazing in final assembly, making it necessary to perform several cleaning and refinishing steps prior to final packaging. Since no heat is required in the process of assembling the present device, all the parts retain their original finish and cleanliness, thereby considerably decreasing the time and labor involved in producing a finished unit.

Center electrode stub 118 and the electrode prong 196 is assembled last. Electrode prong 196 is of double curved construction and is centered in a bore 198 in the electrode stub 118 and extends radially outwardly toward the venturi tip 26. Center electrode stub 118, with the prong member 196 previously assembled thereon, is pressed upwardly into a longitudinal bore 200 in holder element 108 and is locked therein by short stub pin 202 which is pressed into the radial bore 116 of said holder element. This portion of the igniter plug must be assembled after the completion of the major portion of the assembly since the span of the electrode prong 196 is such that it cannot be withdrawn upwardly when the central electrode 92 is removed as a unit.

When the device is installed in a jet engine, the lower body portion 6 of the shell 2 extends downwardly into the igniter well 12 formed between the outer wall 10 and the burner wall 14 of the engine casing. Auxiliary air flows in the envelope between the outer wall 10 and the burner wall 14 and passes through a plurality of apertures 204 formed in the wall of the well 12. From the igniter well 12, air passes through circumferential ports 206 and 208 formed in the lower body portion of the sleeve 6 and through the upper end portion of the venturi 22. From the upper end portion of the venturi, air passes through the venturi throat 25 and mixes with atomized fuel which is generated at the target pins 110 and 112 in a manner to be described.

The fuel supply enters the fuel line connector 58 from an independent fuel supply pump, not shown, and passes into an annular chamber 210, through the synthetic rubber nipple 56 and then into filter chamber 39. The fuel then passes through the mesh screen 40 of the filter 44 and enters annular chambers 212, 214 and 216, and continues through four radial inwardly inclined holes 218 formed in the center electrode 92 and then passes through narrow annular spaces 220 into the narrow annular space 222 surrounding the filter 150. The fuel then flows through the filter 150 into radial holes 224 and longitudinal bore 226 in the filter core 144 and into valve chamber 228. When the valve opens, fuel flows past the seat 138 and into the annular space 230, thence through spaces 232 formed by the bore of the center electrode and the hexagonal valve plunger 136 and thence into the bottom slot 234 of the plunger 136. The fuel then enters radial bore 236 and longitudinal bore 238 in centering core 132, then passes through radial bore 240 in the lower end of the centering core 132 and into the conical chamber 242 and thence into chambers 244 and 246, from which it is discharged at high velocity through the discharge nozzles 128 and 130. The fuel so discharged strikes the inclined surfaces 115 and 117 (Fig. 2) of the target pins 110 and 112, thereby producing a finely atomized mixture in the venturi throat 25.

Valve 136 is adjusted to open at a pressure of 30 pounds per square inch but it not intended as a check valve but rather is utilized to keep the fuel line under light pressure and to reduce the pressure at the injector nozzles 128 and 130 to minimize dripping.

It will be noted that the injector nozzles 128 and 130 extend beyond the upper ends of the bushings 120 and

122 and thereby provide a velocity trap to prevent any residual impurities from by-passing the filter and entering and obstructing the injector nozzles 128 and 130. In this type of trap the fuel enters the off-set bored out holes 244 and 246 and is required to execute a severe change of direction in order to exit through the discharge nozzles 128 and 130. This rapid change in direction tends to remove foreign particles by centrifugal force, depositing them at the base of the bushings 124 and 126.

Injector nozzles 128 and 130 function as metering orifices as well as discharge nozzles and cause the fuel to strike the target pins 110 and 112 at high velocity thereby atomizing the fuel into a finely separated mist which mixes with the auxiliary air which is flowing through the venturi throat 25 past the electrode 196 and the venturi tip 26. At this point application of high tension sparks from electrode prongs 196 to the venturi tip 26 causes the fuel air mixture to ignite and produce a long shaft of flame extending downwardly into the burner chamber of the engine at substantially right angles to the axis of engine.

An outer envelope of flame forms in the tip 26, which is made of metal such as Inconel and has the property of storing and diffusing heat along the conical wall. The mixture is therefore gradually brought to flashing point as it approaches the tip 26 of the venturi. At the venturi tip 26 the fuel flashes due to the temperature at the tip. Therefore, except for the initial starting of the injector igniter plug, a spark is not thereafter required since the heat absorbing characteristics of the venturi tip 26 causes the flame to be self-propagating.

To prevent high velocity cold air and liquid jet mixture in the main burner from cooling the venturi tip, the injector plug is recessed in the igniter well 12 sufficiently to withdraw venturi tip 26 slightly from the burner chamber. The sealing ring 18 protects the venturi tip 26 from the cooling effect of the auxiliary air stream in the envelope between the outer wall 10 and the burner wall 14 of the engine casing.

The high velocity of air flow through the envelope between the outer wall 10 and the burner wall 14 is broken by radial ports 204, 206 and 208 in the lower body portion 6 of the shell 2. It will therefore be seen that the velocity of the air flow through the injector igniter plug is controlled mainly by the differential pressure between the auxiliary air in the envelope and the air in the burner chamber.

From the foregoing it is seen that there has been devised a novel and highly improved injector ignited plug which is capable of operating under extreme conditions and in which the effect of atmospheric conditions in the burner chamber only slightly, if at all, adversely affect the operating efficiency of the igniter. With this type of igniter it will be apparent that starting may be accomplished in flight when the jet, for any reason, has gone out and the burner chamber is filled with liquid spray and cold air passing through at high velocity, a condition which has rendered restarting of jets in the past a very difficult task.

While only a single embodiment of the invention has been illustrated and described, it will be apparent to those skilled in the art that various changes and modifications may be made therein without departing from the scope of the invention. It is to be understood, therefore, that it is not intended to limit the invention to the single embodiment disclosed but only by the scope of the claims which follow.

I claim:

1. 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 mounted in a well between said outer casing and said burner wall, air admitting ports formed in the wall of said lower body portion, a venturi member disposed within said lower

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body portion, a plurality of passages formed in said lower body portion for admitting air to said venturi, a fuel supply connector mounted on said upper body portion, a spark plug tightly secured in said shell, electrode means secured in said spark plug, said electrode means having an annular bore formed longitudinally therein, a plurality of gaskets forming a sealed circuit between said fuel connector and said annular bore, a pair of fuel discharge nozzles disposed adjacent one end of said annular bore, fuel atomizing means secured in said annular bore below said discharge nozzles, and a plurality of filters interposed between said fuel connector and said discharge nozzles.

2. In an injector igniter plug, the combination of a main body shell having an upper body portion and a lower body portion, said lower body portion having circumferential ports formed therein for admission of air, fuel connector means on said upper body portion for admitting fuel, a spark plug centrally disposed in said shell in gas tight relation therewith, a center electrode in said spark plug having a longitudinal fuel passage formed therein, one end of said electrode being enlarged and provided with fuel intake ports, sealing means between said shell and said spark plug providing a connecting annular chamber between said fuel connector and said fuel intake ports, filter means in said chamber, additional filter means in said longitudinal fuel passage, pressure sensitive valve means disposed in said longitudinal fuel passage, high velocity fuel discharge means mounted in the other end of said electrode adjacent said longitudinal fuel passage, means for atomizing and mixing said fuel with said air, said last mentioned means being in axial alignment with said discharge means, a venturi member sleeved in said lower body portion and surrounding said atomizing means, spark discharge means on said center electrode for initiating combustion of said fuel-air mixture, and heat absorbing means on a portion of said venturi for propagating continuous combustion when said spark discharge is discontinued.

3. In an injector igniter plug, the combination of a main body shell having means formed therein for admitting air, fuel admitting means attached to said shell, a spark plug disposed within said shell, means mounted internally of said shell for filtering said fuel, means for atomizing and mixing said fuel with said air, said last mentioned means comprising a pair of fuel injector nozzles disposed at one end of said spark plug and adapted to discharge fuel at high velocity, said nozzles having needle-like annular bores therein, and a pair of target pins secured to said spark plug below said injector nozzles, said target pins having inclined surfaces disposed in proximity to and in axial alignment with said fuel discharge nozzles for breaking up and mixing said high velocity fuel discharge with air from said air admitting means.

4. An injector igniter plug as set forth in claim 1 wherein said filter means in said chamber comprises a cylindrical core member of C-shape cross-section mounted in said shell, said cylindrical member having a slotted mid-portion, fine mesh wire screen tightly wound around said mid-portion, and spring means for retaining said screen on said cylindrical member.

5. An injector igniter plug as set forth in claim 1 wherein said additional filter means comprises a metal core having a flange at the lower end thereof, fine mesh wire screen tightly wound around said core, a helical spring for securing said wire mesh in position on said core, and said core having longitudinal and radial passages formed therein communicating with said wire screen.

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6. In an injector igniter plug, the combination of a main body shell, circumferential ports formed in the wall of said shell for admitting air, a fuel connection attached at one side of said shell, a spark plug secured in said shell, a center electrode in said spark plug having fuel passages formed therein, a plurality of seals disposed between said shell and said spark plug to form a closed circuit therebetween for guiding said fuel to said center electrode fuel passage, a plurality of discharge nozzles for said fuel disposed at one end of said center electrode, a plurality of filters interposed between said fuel connector and said discharge nozzle, and centrifugal trap means in said electrode near said discharge nozzles for further removing impurities from said fuel.

7. An injector igniter plug as set forth in claim 6 wherein said centrifugal trap means comprises a pair of laterally offset longitudinally extending wells in said electrode communicating with said fuel passage, a pair of bushings secured in lower end portion of said wells, and a pair of injector nozzles mounted in said bushings, said nozzles projecting beyond said bushings and into said wells whereby the fuel entering the said wells execute abrupt changes in direction before discharging through said discharge nozzles.

8. In an injector igniter plug, the combination of a main body shell having an upper body portion and a lower body portion, said lower body portion having circumferential ports formed therein for admitting air, fuel connector means on said upper body portion for admitting fuel, a spark plug centrally disposed in said shell in gas tight relation therewith, a center electrode in said spark plug having a longitudinal fuel passage formed therein, one end of said electrode being enlarged and provided with fuel intake ports, seal means between said shell and said spark plug providing a connecting annular chamber between said fuel connector and said fuel intake ports, filter means in said chamber, additional filter means in said longitudinal fuel passage, pressure sensitive valve means mounted in said longitudinal fuel passage, high velocity fuel discharge means mounted in the other end of said electrode adjacent said longitudinal fuel passage, means for atomizing and mixing said fuel with said air, said last mentioned means being substantially in axial alignment with said discharge nozzles, a venturi member mounted in said lower body portion and surrounding said atomizing means, spark discharge means on said center electrode for initiating combustion of said fuel-air mixture, heat absorbing means on a portion of said venturi for propagating continuous combustion, and ring means secured to said lower body portion for insulating said heat absorbing means from the air admitted by said circumferential ports.

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