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HIGH VOLTAGE IGNITER WITH FLUID FEED THROUGH THE INSULATOR CORE CENTER

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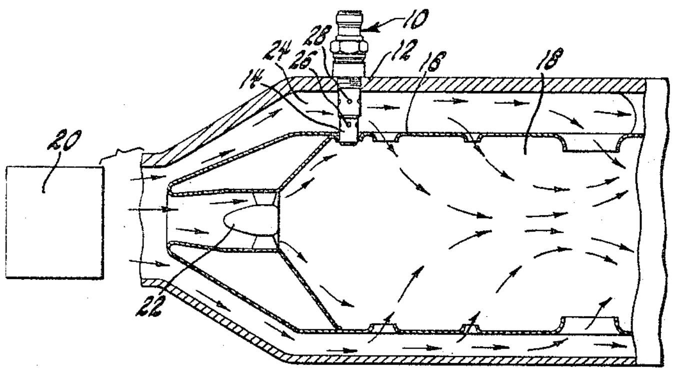

Fig.1

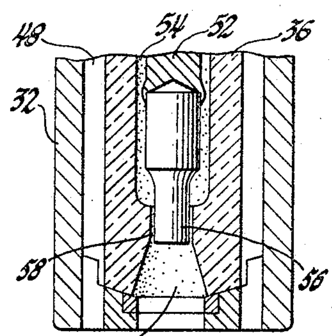

Fig.3

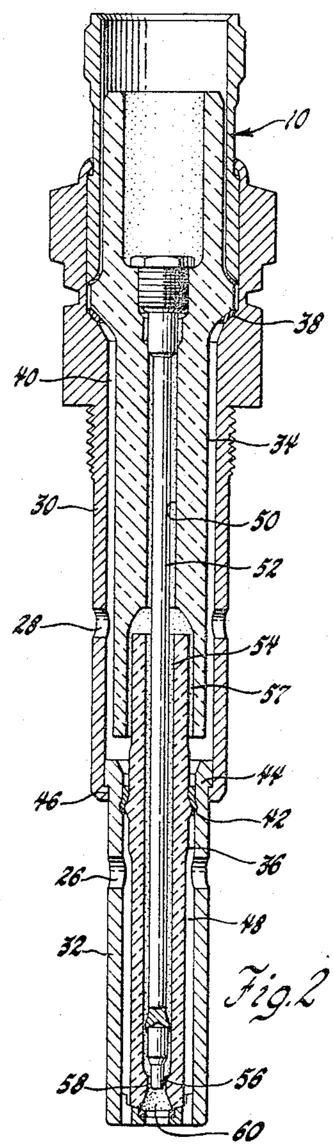

Fig.2

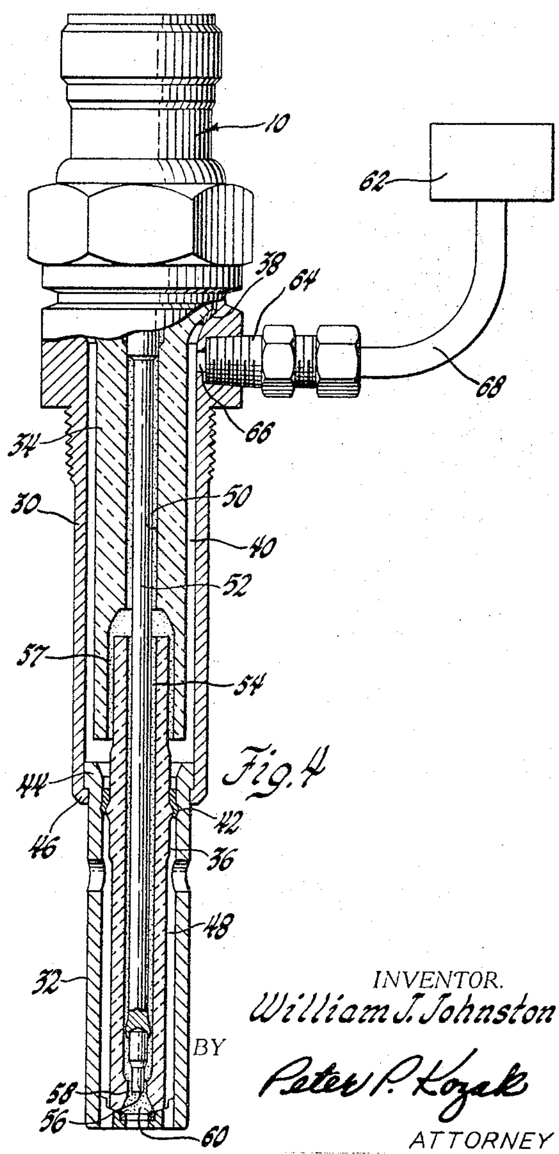

Fig.4

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HIGH VOLTAGE IGNITER WITH FLUID FEED THROUGH THE INSULATOR CORE CENTER

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ABSTRACT OF THE DISCLOSURE

This invention relates to a high voltage igniter for gas turbine engines in which the construction provides for a stream of gas to pass between the walls of the insulator centerbore and the firing tip portion of the center electrode during sparking thereby increasing the projections and the energy release of the spark arc.

This invention relates to a high voltage igniter for gas turbine engines and more particularly to increasing the energy release of the spark from the igniter.

A high voltage igniter is required to deliver high quantities of electrical energy into the combustion chamber of the jet engine. This high energy is required to ignite air-fuel mixtures under conditions adverse to ignition of the engine, such as low temperatures, high air velocities, poorly atomized fuel droplets, etc. Although energies of 1 to 20 joules are stored in the power source, only 15 to 25% of this stored energy is actually delivered to the spark arc due to the low efficiency of the ignition system.

It is a basic object of this invention to increase the projection of the spark arc of the igniter and thereby increase the energy release of the spark arc and increase the life of the igniter.

These and other objects are accomplished by passing an oxidizing gas through an annular space between the center electrode and the insulator during the ignition cycle. In general, the high voltage igniter has a passageway through the metal shell and the insulator which connects the annular space separating the center electrode from the insulator to an oxidizing gas source. Gas from the gas source passes through the passageway in the shell and the insulator to the annular space separating the center electrode from the insulator and then out of the end of the insulator and past the sparking tip portion of the center electrode. When the high voltage igniter is energized, the gas flow increases the projection of the spark arc. The gas flow about the electrodes also removes the incandescent gas plasma from the gap region thereby increasing the energy release of the spark arc.

Other objects and advantages of this invention will be apparent from the following detailed description, reference being made to the accompanying drawings wherein several preferred embodiments of this invention are shown.

In the drawings:

FIGURE 1 is a side view in elevation of a high voltage igniter positioned in the gas turbine engine;

FIGURE 2 is a side view of an improved high voltage igniter having a passageway to receive air from the turbine secondary air chamber in cross section;

FIGURE 3 is an enlarged view of the firing tip portion of the improved high voltage igniter; and

FIGURE 4 is a side view of an improved high voltage igniter having an air passageway to receive air from a separate source.

Referring to the drawings, FIGURE 1 shows the igniter **10** installed in the engine case **12** of the gas turbine so that the ground electrode portion **14** projects through the com-

bustion liner **16** to the combustion chamber **18**. Air from the compressor **20** at a pressure of 102 to 106 p.s.i. flows through a fuel nozzle **22**, the fuel is vaporized into droplets on its way to the combustion chamber **18**. The air pressure in the combustion chamber **18** is 100 p.s.i. Air from the compressor **20** also flows through the secondary chamber **24** at a pressure of 102 to 106 p.s.i. Air passing through the secondary chamber **24** also flows through the igniter openings **26** and **28**. Igniter openings **26** are vent holes which are widely used in igniters for cooling purposes. Opening **28** in the shell of the igniter **10** provides the opening through which the air required for this invention enters the igniter **10** as will be more fully discussed hereinafter.

FIGURE 2 is an enlarged view of the high voltage igniter **10** showing a conventional outer tubular metal shell **30** having the lower end portion thereof constituting an annular ground electrode **32**. The ground electrode **32** may be made of any suitable high temperature erosion resistant metal or metal alloy. Inconel containing approximately 76% by weight nickel, 16% by weight chromium, and 6% by weight iron is used in the preferred embodiment.

Positioned within the metal shell **30** and the ground electrode **32** is a tubular two-piece alumina base ceramic insulator having an upper portion **34** and a lower portion **36**. The upper portion **34** is in contact with an upper annular gasket **38** which presses against the shell **30**. Below the upper gasket **38** is an upper annular space **40** which separates the lower end of the upper insulator portion **34** from the shell **30** and provides a passageway for the flow of air. The lower insulator portion **36** fits snugly against the lower annular gasket **42** which rests against the upper end **44** of the ground electrode **32**, the upper end **44** being held in locking relationship by the lower end **46** of the shell **30**. Below the lower gasket **42** is an outer annular space **48** which separates the ground electrode **32** from the lower insulator portion **36** and provides a passageway for the flow of air. The insulator portions **34** and **36** have a centerbore **50** therethrough. Positioned within the insulator centerbore **50** is a center electrode **52**. The center electrode **52** is separated from the upper insulator portion **34** and the lower insulator portion **36** by an inner annular space **54**. The inner annular space **54** provides a passageway for the flow of air. The lower end of the center electrode **52** is the firing tip portion **56**. The inner annular space **54** separating the center electrode **52** from the insulator lower portion **36** becomes very narrow about the firing tip portion **56** of the center electrode **52**. The annular space **54** at the end of the lower insulator portion **36** becomes the opening **58** having a width of approximately 0.001 to 0.010 inch which is shown more clearly in FIGURE 3. The width of the opening **58** is not critical. The opening **58** is smaller, that is, in the range of .001 inch when the pressure is higher and larger, say in the range of 0.010 inch when the pressure is smaller. The pressure of the gas and the opening **58** must be such so as to project the gas about the space immediately surrounding the end of the firing tip portion **56**. One of the primary purposes of this gas is to remove the incandescent gases which are present in the electrode region. The incandescent gases present in the electrode region lower the arc resistance between the firing tip portion **56** and the ground electrode **32**. By lowering the arc resistance between the two electrodes, the incandescent gases allow the current to flow more easily thereby causing a reduction in the energy of the spark arc. By removing the incandescent gases the voltage drop is not lowered and the corresponding reduction of energy brought about by the lowering of the arc resistance is eliminated. The gas coming out of the opening **58** causes an increase in the projection of the arc thereby effecting an increase in the energy of the spark arc. The gas flow between the center electrode **52** and the insulator cools the electrodes thereby increasing the life of the electrodes. This gas also increases the length of the center electrode **52** life by causing the arc to wander over the entire surface of the firing tip portion **56** of the center electrode **52**.

The ground electrode **32** has openings **26** which permit air to flow through the outer annular space **48** between the ground electrode **32** and the lower insulator portion **36** to cool these two pieces respectively. These vents, as indicated earlier, are well known in the art and their primary purpose is to cool the lower end of the igniter. The opening **28** in the shell **30** permits the air to enter the shell **30** and flow through the upper annular space **40** and from there through the space **57** separating the upper insulator portion **34** from the lower insulator portion **36**, and from there into the inner annular space **54** separating the center electrode **52** from the lower insulator portion **36**. The gas proceeds to flow down the inner annular space **54** until it reaches the opening **58**. The gas flows out of the opening **58** around the end of the firing tip portion **56** and carries away any incandescent gases in the spark gap region **60** which have been ionized by previous spark arcs.

FIGURE 4 shows the preferred embodiment of this invention wherein gas from a separate source **62** is introduced into igniter **10** by means of a standard tubing fitting **64** attached to the shell **30** at opening **66**. The pressure of the gas from the separate source must be greater than the 100 p.s.i. pressure in the combustion chamber. It has been observed that beneficial results have been obtained by passing air from the separate source having a pressure as low as 102 p.s.i. However, better results are obtained with much higher pressures, for example in the range of 100 p.s.i. greater than the combustion chamber pressure. For example, a pressure of 200 p.s.i. increased the energy of the spark an appreciable amount. Pressures greater than 200 p.s.i. did not yield energy gains much different than with 200 p.s.i. The pressure of the gas from the separate source can range from 2 to 250 p.s.i. greater than the combustion chamber pressure with 75 to 125 p.s.i. being preferred. Air is the preferred gas, however other oxidizing gases can be used; for example, oxygen, fluorine, and the like. In this embodiment gas from the separate source **62** passes through the tube **68** through the standard fitting **64** through the opening **66**. The air then passes down the upper annular space **40** through the insulator opening **57** to the inner annular space **54**. The gas then goes through the opening **58** adjacent to the center electrode firing tip **56** to increase the energy of the spark arc by removing the incandescent gas plasma and by increasing the projection of the arc, as well as increasing the life of the center electrode by cooling the electrodes and by causing the arc to wander over the firing tip portion of the center electrode.

The increase in the spark arc energy of the igniter was observed by two methods. The first method involved measuring the voltage and current discharge of the spark arc during the 4 or 5 half-cycle loop life of the spark arc. The instantaneous values of the voltage and current referred to above were multiplied together to give the power at each interval. The energy was determined by integrating the power over the discharge time. It was observed that the power increase of the spark arc obtained by the igniter in the preferred embodiment was in the range of 50%. Another indication of the energy release is the projection of the spark arc from the electrode end of the igniter. Pictures were taken during the ignition of an igniter operating in accordance with this invention and a standard igniter. It was observed that the projection of the flame increased between 80 and 100% when using the igniter disclosed in this invention.

While the invention has been described in terms of certain specific examples, it is to be understood that the scope of the invention is not limited thereby except as defined in the following claims.

I claim:

1. A high voltage igniter plug comprising an alumina base ceramic insulator having a centerbore therethrough, a stationary center electrode positioned longitudinally within said insulator centerbore and having a firing tip portion, said center electrode being separated over a substantial length from said insulator by an annular space, and means communicating said annular space with an oxidizing gas source, said annular space providing a passageway for the flow of said oxidizing gas about said firing tip portion during sparking to increase the energy release of the spark arc from said plug.

2. A high voltage igniter plug comprising an outer annular shell having an annular ground electrode connected to the lower end thereof, said shell having an opening therein to permit the flow of gas therethrough,

a two-piece tubular ceramic insulator positioned longitudinally within said shell and having a centerbore therethrough, said two-piece ceramic insulator having an upper portion and a lower portion, said upper portion being separated over a substantial length from said shell by an outer annular space, said outer annular space being connected to said opening in said shell, said upper portion having an opening therein to permit the flow of gas therethrough,

a center electrode positioned longitudinally within said insulator centerbore and having a firing tip portion at the lower end thereof, said center electrode being separated from said insulator over a substantial length by an inner annular space, said firing tip portion of said electrode being separated from the lower end of said insulator by a narrow opening, said inner annular space being connected to said outer annular space by said insulator opening,

said openings combining with said inner annular space and said outer annular space to provide a passageway for the flow of gas about said firing tip portion to increase the energy release of the spark arc from said plug.

3. An igniter plug as defined in claim **2** wherein said narrow opening ranges in width from 0.001 to 0.010 inch.

4. The combination of a separate source of oxidizing gas and a high voltage igniter plug comprising an alumina base ceramic insulator having a centerbore therethrough, a stationary center electrode positioned longitudinally within said insulator centerbore and having a firing tip portion, said center electrode being separated over a substantial length from said insulator by an annular space, and means communicating said annular space with said oxidizing gas source, said annular space providing a passageway for the flow of said oxidizing gas about said firing tip portion during sparking to increase the energy release of the spark arc from said plug.

5. The combination as defined in claim **4** wherein the pressure from said separate gas source ranges from 2 to 250 p.s.i. greater than the pressure in the turbine combustion chamber.

6. The combination as defined in claim **4** wherein said separate gas source is air.

7. The combination as defined in claim **4** wherein said separate gas source is oxygen.

8. The combination of a separate source of oxidizing gas and a high voltage igniter plug comprising an outer annular shell having an annular ground electrode connected to the lower end thereof, said shell having an opening therein to permit the flow of gas therethrough, said opening connected to said separate source of oxidizing gas,

a two-piece tubular ceramic insulator positioned longitudinally within said shell and having a centerbore therethrough, said two-piece ceramic insulator having an upper portion and a lower portion, said upper portion being separated over a substantial length from said shell by an outer annular space, said outer annular space being connected to said opening in said shell, said upper portion having an opening therein to permit the flow of gas therethrough,

a center electrode positioned longitudinally within said insulator centerbore and having a firing tip portion at the lower end thereof, said center electrode being separated from said insulator over a substantial length by an inner annular space, said firing tip portion of said electrode being separated from the lower end of said insulator by a narrow opening, said inner annular space being connected to said outer annular space by said insulator opening,

said openings combining with said inner annular space

and said outer annular space to provide a passageway for the flow of said oxidizing gas about said firing tip portion to increase the energy release of the spark arc from said plug.

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