Nov. 2, 1954

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2,693,082

GAS TURBINE FUEL IGNITER

Filed April 4, 1951

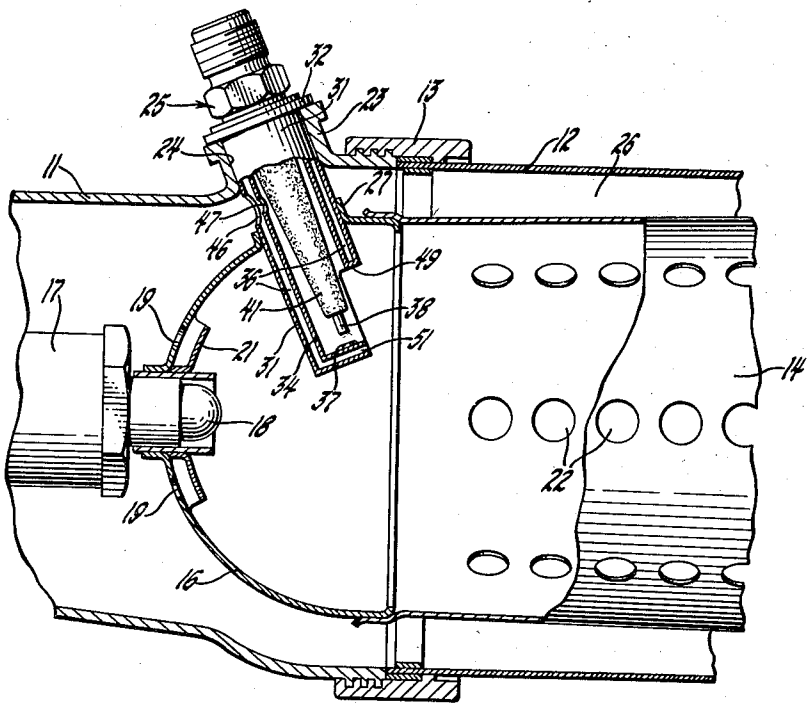


Fig. 1

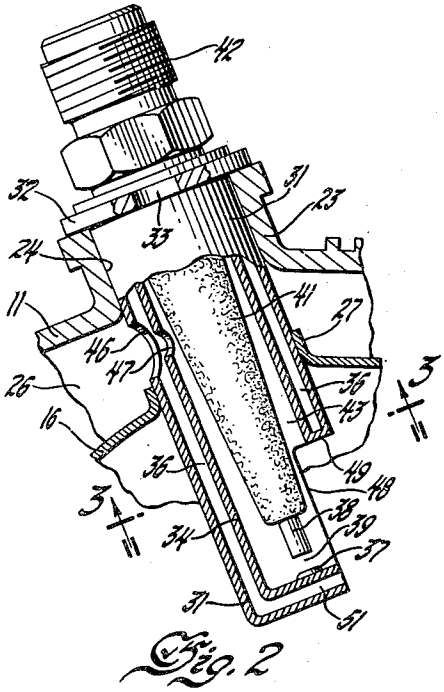


Fig. 2

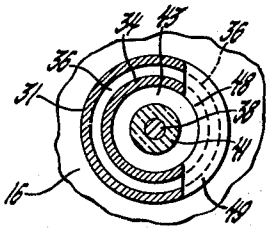


Fig. 3

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United States Patent Office 2,693,082 Patented Nov. 2, 1954

2,693,082

GAS TURBINE FUEL IGNITER

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Application April 4, 1951, Serial No. 219,229

6 Claims. (Cl. 60—39.67)

My invention relates to fuel igniters which, while they may have other fields of use, are particularly intended for application to gas turbine engines, and are so disclosed herein.

Typical gas turbine engines include one or more combustion chambers through which air is circulated and into which fuel is sprayed. Ordinarily, one or more of the combustion chambers of an engine are provided with means for igniting the fuel, in most cases, an electric spark gap device commonly known as an igniter plug.

While it would seem that the provision of a satisfactory igniter for this purpose would involve few problems, experience has shown that it presents many difficulties.

If the igniter is so located that it is too heavily affected by the heat generated in the combustion chamber, it may be damaged. This problem may be solved rather satisfactorily by judicious location of the plug and suitable provisions for cooling the same. This invention relates in part to improving the cooling of the igniter.

Another problem which often affects the reliable operation of igniters is deposition of carbon from the fuel. This problem is aggravated by the fact that it has been considered necessary to locate the igniter plug so that the electrodes are directly exposed to the spray of fuel injected into the combustion chamber.

The nature of this invention may be outlined, in general, by stating that it involves the provision of a plug of such structure and location that the electrodes are shielded from the direct spray, the structure of the plug is such that it forms a flame holder or the equivalent around the electrodes adapted to provide a turbulent circulation of the air-fuel mixture about the electrodes, and that improved provision is made for cooling the igniter plug.

The principal objects of the invention are to improve the reliability of starting of gas turbine engines, to reduce substantially the maintenance requirements of such engines due to the igniters, and to provide an improved fuel igniter for combustion apparatus, particularly such as is employed in gas turbine engines.

The preferred manner in which these principal objects of the invention are achieved, as well as other objects and advantages of the invention, will be apparent to those skilled in the art from the succeeding detailed description of the preferred embodiment of the invention.

Referring to the drawing, Figure 1 is a partial longitudinal sectional view of a gas turbine combustion apparatus with the igniter of the invention installed therein; Figure 2 is an enlarged view of the igniter with certain parts in section; and Figure 3 is a cross section of the igniter taken on the plane indicated in Figure 2.

Since the nature of gas turbine engines of the sort to which this invention may be applied and, more particularly, the structure of representative combustion apparatus therefor is well known; and since the igniter plug of the invention is suitable for use with combustion apparatus of various configurations, the drawing illustrates only so much of an exemplary combustion chamber arrangement as will suffice for an understanding of the installation and operation of the igniter plug therein.

Referring to Figure 1, the combustion apparatus therein illustrated comprises a diffuser **11** defining a duct through which air is discharged from the compressor of the gas turbine engine. The outlet of the diffuser **11** is coupled to a generally cylindrical outer combustion chamber **12** by a ring nut **13**. The diffuser **11** and shell **12** define

a duct through which air flows from left to right in the figure.

Mounted within this duct is an inner combustion chamber, combustion liner, or flame tube, which will be referred to herein as a combustion chamber. The combustion chamber comprises a generally cylindrical perforated shell or casing **14** partially closed at the upstream end by a dome or cap **16**, these parts being supported in the duct in any suitable manner. A fuel nozzle assembly **17** mounted in the duct comprises a spray tip **18** extending into the dome on the axis thereof. The dome is formed with openings **19** for admission of primary combustion air and a deflector **21** which tends to deflect the primary air along the inner surface of the dome. Secondary combustion air and dilution air are admitted through the perforations **22** in the combustion chamber section **14**. It will be understood that this specific combustion chamber structure is merely illustrative.

The diffuser is formed with a boss **23** in which is a cylindrical opening **24** through which the igniter plug **25** of the invention extends into the combustion apparatus. As will be apparent, the igniter plug extends through the air passage **26** between the wall of the air duct and the combustion chamber and into the combustion chamber through an opening defined by a flange **27** on the dome **16**.

Referring now to Figure 2, in which the igniter is shown on a larger scale, the plug comprises a generally cylindrical or elongated cup-shaped outer shell **31** which fits in the cylindrical opening **24** of the boss **23** and is integral with a flange **32** formed with holes **33** for mounting studs by which the plug may be held in place. This flange may be, for example, of the form of the equivalent flange **26** of Steeg Patent No. 2,526,169.

Fixed within the outer shell and spaced therefrom is an inner shell **34** similar in form to the shell **31** and spaced therefrom to define a cooling air passage **36** between the shells.

The lower ends of the shells are partially closed, and an electrode **37** is welded to or otherwise provided on the lower end of the shell **34**. The shells are fixed together so that this electrode is grounded to the diffuser **11**. A second electrode **38** extends along the axis of the igniter into proximity to the electrode **37** to define a spark gap **39**. The electrode **38** is embedded in an insulator **41** except at the tip thereof, and is insulated thereby from the shell **34** at the upper end of the plug. Electrode **38** extends to a single point electrical connector **42**, which may be of any conventional type, mounted on the upper end of the igniter. Any suitable energizing circuit may be connected to the electrode **38** by means of the connector **42**.

The insulator **41** is spaced from the shell **34** to define a cooling air passage **43**. An opening **46** is provided in the shell **31** on the upstream side of the axis of the igniter within the air duct **26** for admission of cooling air. A smaller opening **47** in the inner shell is aligned with the opening **46**. Air flows through the duct **26** at relatively high speed from left to right and is forced by dynamic pressure and by a static pressure differential between the duct **26** and the interior of the combustion chamber through the opening **46** into the air passage **36** between the two shells and through the opening **47** into the air passage **43** between the inner shell and the insulator.

The shells **31** and **34** are cut away or otherwise formed to provide an opening **48** on the downstream side of the igniter adjacent the spark gap **39** and the lower end of the insulator **41**. Preferably, the lower edges of the shells above this opening are closed by an arcuate plate **49** but below the plate **49** the space between the shells may be open to define an air outlet **51** which extends across the bottom of the igniter plug and up the wall of the plug on each side of the electrode to the top of the opening **48**. The opening **51** may be continuous as illustrated, or may be divided so as to provide a plurality of restricted air outlets.

Air flowing from the opening **46** through the passage **36** may thus exhaust in a downstream direction through the opening or openings **51**, and the air flowing through the opening **47** and over the outer surface of the electrode

41 is discharged through the opening 48, also in a downstream direction.

With the plug installed as illustrated in Figure 1, air flowing through the combustion chamber tends to swirl around the plug and a turbulent flow is set up around the spark gap 39. The fuel sprayed from the nozzle tip 18 defines a conical pattern so that a part of the fuel spray flows past the lower end of the igniter and is drawn into the spark gap by this turbulent air flow. The spark gap is shielded from direct oil spray by the shell 31, and thus is protected against a heavy discharge of fuel into the electrodes. Since the plug shells are open downstream, that is, toward the flame which burns in the section 14, radiation of heat from the flame is effective, in connection with the circulation of air about the electrodes, to prevent or burn off any formation of carbon on the electrodes which might impair the effectiveness of the igniter. The circulation of cooling air through the passages 36 and 43 prevents dangerous overheating of the structure of the plug. As will be understood, the rate of flow of air through the duct 26, and therefore, of cooling air through the igniter plug, increases with increase in intensity of combustion.

It will be apparent to those skilled in the art from the foregoing description that the igniter plug of the invention is particularly adapted to secure the objects and advantages previously outlined. It will also be apparent that many modifications of form and structure may be made within the principles of the invention by the exercise of skill in the art, and that the invention is not to be considered as limited by the detailed description of the preferred embodiment thereof.

I claim:

1. A gas turbine combustion apparatus comprising, in combination, an air duct, means defining a combustion chamber therein, the combustion chamber having an air inlet at the upstream end thereof, means for injecting fuel at the upstream end of the combustion chamber, and an electric fuel igniter extending through the air duct into the combustion chamber downstream from the fuel injecting means, the igniter comprising a shell closed on the upstream side and formed with an opening on the downstream side, and electrode means shielded from the fuel injection means by the closed upstream side of the shell defining a spark gap within the shell.

2. A gas turbine combustion apparatus comprising, in combination, an air duct, means defining a combustion chamber therein, the combustion chamber having an air inlet at the upstream end thereof, means for injecting fuel at the upstream end of the combustion chamber, and an electric fuel igniter extending through the air duct into the combustion chamber downstream from the fuel injecting means, the igniter comprising a double-walled shell closed on the upstream side and formed with an opening on the downstream side, electrode means shielded from the fuel injection means by the closed upstream side of the shell including an electrode extending through the shell defining a spark gap with the shell adjacent the said opening, and means for circulating air from the said duct between the walls of the shell and over the said electrode.

3. A gas turbine combustion apparatus comprising, in combination, an air duct, means defining a combustion chamber therein, the combustion chamber having an air inlet at the upstream end thereof, means for injecting fuel at the upstream end of the combustion chamber, and an electric fuel igniter extending through the air duct into the combustion chamber downstream from the fuel injecting means, the igniter comprising a shell and electrode means defining a spark gap within the shell, the shell defining a shroud around the upstream side of the electrode means and spark gap between the electrode means and spark gap and the fuel injecting means and being open on the downstream side adjacent the spark gap.

4. An igniter plug for gas turbine engines and the like comprising, in combination, a generally cup-shaped shell, at least the major part of one end of the shell being closed, a first electrode on the inside of the end of the shell, and a second electrode extending through the shell to form a spark gap with the first electrode; the shell being open at the downstream side of the plug axis adjacent the spark gap for access of fuel mixture to the spark gap, and the shell being formed with an opening adjacent the end remote from the spark gap for admission of cooling air between the shell and second electrode.

5. An igniter plug for gas turbine engines and the like comprising, in combination, a generally cylindrical outer shell, an inner shell mounted therein and spaced therefrom to define a cooling air passage between the shells, a first electrode within the inner shell, and a second electrode extending through the inner shell to form a spark gap with the first electrode; the shells being open at the downstream side of the plug axis adjacent the spark gap for access of fuel mixture to the spark gap, the shells being formed with openings adjacent the end remote from the spark gap for admission of cooling air between the shells and between the inner shell and second electrode, and at least one opening being provided for discharge of cooling air from between the shells.

6. An igniter plug for gas turbine engines and the like comprising, in combination, a generally cup-shaped outer shell, an inner shell mounted therein and spaced therefrom to define a cooling air passage between the shells, at least the major part of one end of each shell being closed, a first electrode within the inner shell, and a second electrode extending through the inner shell to form a spark gap with the first electrode; the shells being open at the downstream side of the plug axis adjacent the spark gap for access of fuel mixture to the spark gap, the shells being formed with openings adjacent the end remote from the spark gap for admission of cooling air between the shells and between the inner shell and second electrode, and at least one opening being provided for discharge of cooling air from between the shells adjacent the partly closed end thereof.

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