Oct. 17, 1950 D. J. STEEG 2,526,169

AIR-COOLED IGNITER PLUG

Filed Sept. 4, 1948

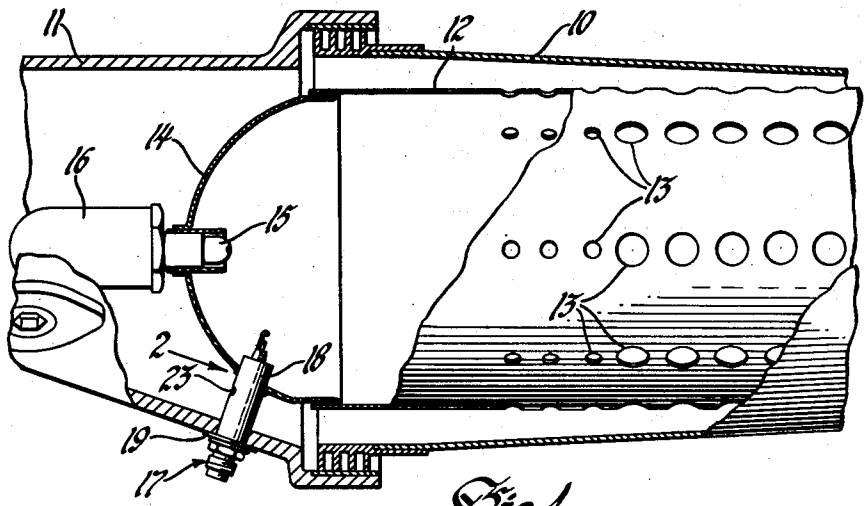


Fig. 1

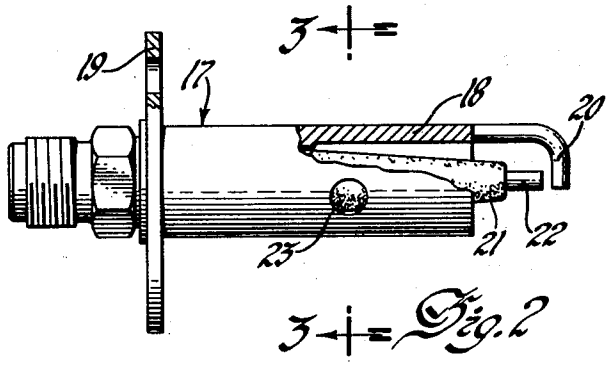


Fig. 2

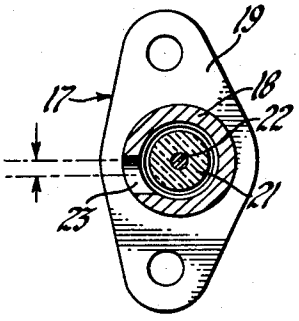


Fig. 3

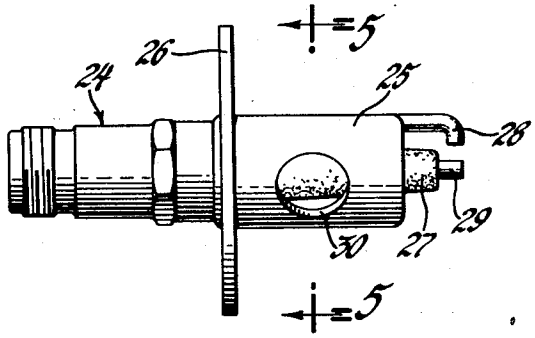


Fig. 4

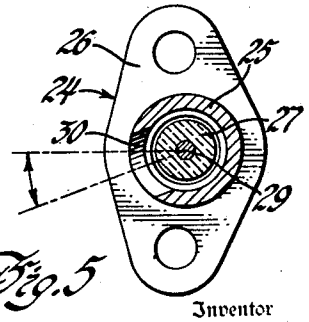


Fig. 5

Inventor

Donald J. Steeg

By

Spencer, Willets, Helwig & Bailey

Attorneys

Patented Oct. 17, 1950 2,526,169

UNITED STATES PATENT OFFICE

2,526,169

AIR-COOLED IGNITER PLUG

Donald J. Steeg, Washington, D. C., assignor to General Motors Corporation, Detroit, Mich., a corporation of Delaware

Application September 4, 1948, Serial No. 47,858

16 Claims. (Cl. 60—44)

1

This invention has to do with igniters for fuel burners and more particularly with igniters generally similar to internal combustion engine spark plugs which are employed to ignite the fuel supplied to the combustion chambers of combustion gas turbines.

During the operation of combustion gas turbines and other apparatus which include fuel burners, the igniter plugs are exposed to the highly heated products of combustion and, consequently, are maintained at high temperatures which tends to deteriorate them. Moreover, during the operation of the apparatus carbon from the fuel is deposited and builds up in the spaces between the insulators and the shells of the plugs and in and around the spark gaps of the plugs. The build-up of carbon in and around the spark gaps of the plugs renders the plugs unreliable, if not inoperative, after the apparatus in which they are installed have been in use for a short while. Frequent removal of the plugs for inspection and/or cleaning not only means that the apparatus (and the airplanes in which they are installed in the cases of apparatus installed in airplanes) must be taken out of service frequently and increases the maintenance cost of the apparatus but also shortens the lives of the plugs. Moreover, in the cases of apparatus installed in airplanes, frequent inspection and/or cleaning of the plugs does not afford adequate insurance that the plugs will be operative, as it is imperative that they be, at all times when the airplanes in which they are installed are in flight so that, in the cases of pulsating jet engines, the engines will continue to operate and, in the cases of continuous combustion turbines, the turbines may be restarted if they stall. To cool the plugs and keep them clean in order to obviate frequent inspection and/or cleaning to insure that the plugs will be serviceable at all times between inspections and/or cleanings, it has been proposed to circulate air through the spaces between the insulators and the shells and through and around the spark gaps of the plugs. But insofar as I know, none of the expedients which have been employed have satisfactorily done what they were intended to do.

The object of this invention is to provide an igniter plug especially for combustion gas turbines which is so constructed and/or arranged that movement of air incident to the operation of the turbine will keep it cool and clean so that frequent inspection and/or cleaning will not be necessary to insure that the plug will remain serviceable at all times between inspections and/or cleanings.

2

For a better understanding of the nature and objects of this invention, reference is made to the following specification and the accompanying drawing in which embodiments of my invention are described and illustrated.

In the accompanying drawing:

Figure 1 is a longitudinal section through a portion of one of the combustion chambers and associated parts of a continuous combustion gas turbine with an igniter plug constructed and arranged in accordance with my invention.

Figure 2 is an enlarged side elevation, with parts broken away and in section, of the igniter plug shown in Figure 1 viewed as indicated by the arrow 2 in Figure 1.

Figure 3 is a section taken on line 3—3 of Figure 2.

Figure 4 is a side elevation of a modification of the igniter plug shown in the preceding figures.

Figure 5 is a section taken on line 5—5 of Figure 4.

In the drawing, the reference character 10 indicates the generally cylindrical outer shell of one of the combustion chambers of a continuous combustion gas turbine. Over the inner end of the outer shell 10, there is telescoped the outer end of an adapter 11 through which air is conducted from the compressor of the turbine into the outer shell. Within the outer shell 10, there is disposed the generally cylindrical liner 12 of the combustion chamber which is of smaller diameter than and coaxial with the outer shell so that it is radially spaced therefrom throughout its circumference and through whose wall extend openings 13 through which air may enter into it from the space between it and the outer shell. Over the inner end of the liner, there is secured a dome-like head 14 which extends into the adapter 11. Into the center of the head 14 coaxial with the liner, there extends a fuel nozzle 15 to which fuel is conducted from without the adapter through a fitting 16 which extends through the space between the adapter and the head.

The reference character 17 indicates an igniter plug which includes a shell 18 with a mounting flange 19 on it near what will be referred to as its outer end and an electrode 20 on what will be referred to as its inner end. Within the shell 18 there is disposed an insulator 21 which is coaxial with the shell and at a distance from its inner end is seated on the shell so that gas cannot pass between it and the shell but between this zone and the inner end of the shell is

spaced radially from the shell throughout its circumference. The insulator 21 extends somewhat beyond the inner end of the shell 18 and in it there is embedded an electrode 22 which extends beyond the inner end of the insulator but is spaced from the electrode 20 to leave therebetween a spark gap.

Through the wall of the shell 18 near the outer end of the zone in which the insulator is spaced radially from the shell, a bore 23 extends into the interior of the shell. The bore 23 is disposed at a right angle to but, as is indicated in Figure 3, its axis is offset laterally from the axis of shell and the insulator such a distance that while the major portion of the bore is to one side of the axis of the shell and the insulator a very minor portion (approximately 2½%) of it is to the other side of the axis of the shell and the insulator.

The plug 17 is installed in the turbine with the flange 19 seated on and secured to the outer surface of the adapter 11 and the portion of its shell between the flange and its inner end extending through openings in the adapter and the head 14 of the liner 12 and the space between the adapter and the head into the interior of the liner. The bore 23 is so located lengthwise of the shell that it opens into the space between the adapter and the head at distances from the walls of the adapter and the head and is so oriented that it faces upstream with its axis approximately parallel to the direction of flow of air through the space between the adapter and the head at the point at which it opens into it.

When the plug is thus installed and the turbine is operating, relatively cool air from the compressor will enter into the interior of the shell of the plug 17 through the bore 23 and pass through the space between the shell and the insulator and over the electrodes 20 and 22 into the interior of the liner 12. This passage of air through the space between the shell and the insulator and over the electrodes of the plug cools the plug and prevents or, at least, inhibits the deposition or accumulation of carbon from the fuel in the space between the shell and the insulator and in and around the spark gap.

Experience has shown that a bore formed and disposed as shown in Figures 1, 2 and 3 and hereinbefore described, is much more effective in cooling the plug and keeping it free of carbon deposits than a radial hole which faces upstream with its axis parallel to the direction of flow of air by the plug. The reason for this is that with the radial hole air which enters the shell of the plug is split by the insulator into two streams of approximately equal volume and force which collide and produce on the side of the insulator opposite that on which the air enters the shell eddies which impede the flow of air through the space between the insulator and the shell. With a bore formed and disposed as shown in Figures 1, 2 and 3 and hereinbefore described, more of the air which enters the shell passes to one than the other side of the insulator and the air within the shell, consequently, eddies less. Moreover, the smaller stream of air deflects the larger stream toward the inner end of the plug and the air which enters the shell, consequently, tends to follow a helical path through the space between the insulator and the shell and over the electrodes. Because of this change in the pattern of flow of the air, the air flows more freely through the plug and its rate of flow therethrough and over the electrodes is, consequently, increased. I consider that both the increase in the rate and the change in the pattern of the flow of the air through the plug and over the electrodes contribute to the increase in the effectiveness of a bore formed and disposed as shown in Figures 1, 2 and 3 and hereinbefore described in cooling the plug and keeping it free of carbon deposits. The pattern of flow of the air through the plug and over the electrodes especially in the matter of the pitch of the helical path of the air, is affected by the proportion of the volume of the air which enters the shell that passes to one and the other side of the insulator and, consequently, by the extent to which the bore is offset laterally of the axis of the shell and the insulator. The rate of flow of air through the plug and over the electrodes is affected by this factor and by the size of the bore. The pattern and rate of flow of air through the plug and over the electrodes, consequently, can be changed by changing the extent to which the bore is offset laterally of the axis of the shell and the insulator and/or the size of the bore and should be adjusted to secure the optimum cooling and cleaning effect that can be obtained without establishing a pattern or rate of flow of air over the electrodes which will interfere with the maintenance of a combustible mixture at this point. The importance in the matter of increasing the rate of flow of air through the plug of eliminating even slight impediments to the flow of air therethrough becomes apparent when the relatively large area offered by the openings 13 in the liner as alternative paths for the passage of air from the space between the outer shell and the liner into the liner of the combustion chamber and the small differential between the pressure of the air in the space between the outer shell and the liner and the pressure of the gases in the liner of the combustion chamber are considered.

The effect obtained by forming and disposing the bore in the wall of the shell of the plug as shown in Figures 1, 2 and 3 and hereinbefore described can be obtained with a radial bore in the wall of the shell if the bore is oriented so that it faces upstream with its axis at such an angle to the direction of flow of the air through the space between the shell and the liner of the combustion chamber at the point at which the bore is located that more of the air which enters the shell through the bore passes to one than to the other side of the insulator.

In Figures 4 and 5 there is shown an igniter plug 24 in which my invention in the modified form suggested in the next preceding paragraph is incorporated. The plug 24 includes a shell 25, a mounting flange 26, an insulator 27 and electrodes 28 and 29 arranged in the same general manner as the corresponding parts of the plug 17 shown in Figures 1, 2 and 3 and was designed for installation in a continuous combustion gas turbine with a combustion chamber generally like that shown in Figure 1 in a manner similar to that in which the plug 17 is installed. However, the ratio of the diameter of the bore 30 to the diameter of the shell of the plug 24 is somewhat greater than the ratio of the diameter of the bore 23 to the diameter of the shell of the plug 17 and the axis of the bore 30, instead of nonradial, is radial to the axis of the shell and, when the plug 24 is installed in the turbine, the bore 30 is oriented so that its axis is at such an angle, which is indicated by the double-headed arrow in Figure 5, instead of parallel, to the direction of flow of air at the point at which the bore is located that more (approximately 78%)

of the open area presented by the bore at a right angle to the direction of flow of the air at the point at which the bore is located lies to one than to the other side of the axis of the shell and the insulator but a smaller proportion (approximately 22%) lies to the other side of the axis of the shell and the insulator.

Although I have described and illustrated my invention as it has been applied to continuous combustion gas turbines, it is to be understood that the invention is also applicable to other types of combustion gas turbines and to other apparatus in which igniters are or may be similarly installed.

I claim:

1. In a continuous combustion gas turbine combustion chamber, a shell through which air travels, a shell-like liner within and spaced from the wall of the shell so that air can pass between it and the shell with openings in its wall through which air may pass into the liner from the space between it and the shell, a head over the end of the liner which is upstream of the flow of air through the shell, and an electric igniter which includes a shell which extends from without the shell of the combustion chamber, through the space between the shell of the combustion chamber and the liner and terminates within the liner, an insulator in which is embedded an electrode which is disposed within and extends lengthwise of and is spaced from the wall of the shell of the igniter, and an opening in the wall of the shell of the igniter which opens into the space between the shell of the combustion chamber and the liner upstream of the flow of air therethrough and is offset laterally of the direction of flow of air through the space between the shell of the combustion chamber and the liner from the axis of the insulator such a distance that the major portion of the opening is to one side of the axis of the insulator and a minor portion of the opening is to the other side of the axis of the insulator.

2. The continuous combustion gas turbine combustion chamber claimed in claim 1 in which the axis of the opening in the shell of the igniter is approximately parallel to the direction of flow of air through the space between the shell of the combustion chamber and the liner.

3. The continuous combustion gas turbine combustion chamber claimed in claim 1 in which the axis of the opening in the shell of the igniter is disposed at an angle to the direction of flow of air through the space between the shell of the combustion chamber and the liner.

4. In a continuous combustion gas turbine combustion chamber, a shell through which air travels, a shell-like liner within and spaced from the wall of the shell so that air can pass between it and the shell with openings in its wall through which air may pass into the liner from the space between it and the shell, a head over the end of the liner which is upstream of the flow of air through the shell, and an electric igniter which includes a shell which extends from without the shell of the combustion chamber, through the space between the shell of the combustion chamber and the liner and terminates within the liner, an insulator in which is embedded an electrode which is disposed within and extends lengthwise of and is spaced from the wall of the shell of the igniter, and an opening in the wall of the shell of the igniter which opens into the space between the shell of the combustion chamber and the liner upstream of the flow of air therethrough and is offset laterally of the direction of flow of air through the space between the shell of the combustion chamber and the liner from the axis of the insulator.

5. The continuous combustion gas turbine combustion chamber claimed in claim 4 in which the axis of the opening in the shell of the igniter is approximately parallel to the direction of flow of air through the space between the shell of the combustion chamber and the liner.

6. The continuous combustion gas turbine combustion chamber claimed in claim 4 in which the axis of the opening in the shell of the igniter is disposed at an angle to the direction of flow of air through the space between the shell of the combustion chamber and the liner.

7. In a fuel burner, a duct through which air travels, an electric igniter which includes a shell which extends transversely of the direction of travel of air through and terminates within the duct, an electrode which is disposed within and extends lengthwise of and is spaced from the wall of the shell, and an opening in the wall of the shell which opens into the duct upstream of the flow of air therethrough and is offset laterally of the direction of flow of air through the duct from the axis of the electrode such a distance that the major portion of the opening is to one side of the axis of the electrode and a minor portion of the opening is to the other side of the axis of the electrode.

8. The fuel burner claimed in claim 7 in which the axis of the opening in the shell is approximately parallel to the direction of flow of air through the duct.

9. The fuel burner claimed in claim 7 in which the axis of the opening in the shell is disposed at an angle to the direction of flow of air through the duct.

10. In a fuel burner, a duct through which air travels, an electric igniter which includes a shell which extends transversely of the direction of travel of air through and terminates within the duct, an electrode which is disposed within and extends lengthwise of and is spaced from the wall of the shell, and an opening in the wall of the shell which opens into the duct upstream of the flow of air therethrough and is offset laterally of the direction of flow of air through the duct from the axis of the electrode.

11. The fuel burner claimed in claim 10 in which the axis of the opening in the shell is approximately parallel to the direction of flow of air through the duct.

12. The fuel burner claimed in claim 10 in which the axis of the opening in the shell is disposed at an angle to the direction of flow of air through the duct.

13. In a fuel burner, a duct through which air travels, an electric igniter including a shell extending transversely of the direction of travel of air through the duct, means disposed lengthwise of and in the shell and spaced from its wall, and means for effecting flow of air in a helical path about the first-named means, the second-named means including an opening in the wall of the shell which opens into the duct upstream of the flow of air therethrough and is offset laterally of the direction of flow of air through said duct.

14. In an igniter, a shell, an insulator in which is embedded an electrode which is disposed within and extends lengthwise of and is spaced from the wall of the shell, and an opening in the wall of the shell whose axis is offest laterally from the axis of the insulator such a distance that the

major portion of the opening is to one side of the axis of the insulator and a minor portion of the opening is to the other side of the axis of the insulator.

15. In an igniter, a shell, an insulator in which is embedded an electrode which is disposed within and extends lengthwise of and is spaced from the wall of the shell, and an opening in the wall of the shell whose axis is offset laterally from the axis of the insulator.

16. In an improved igniter for use in combustion apparatus having spaced inner and outer walls forming a combustion chamber surrounded by a passage through which air supplied to said combustion chamber flows in a selected direction and also having nozzle means for injecting fuel into said combustion chamber, said igniter comprising a tubular body adapted to be secured to the outer wall of said combustion apparatus and to project through aligned openings in said outer and inner walls and to terminate within said combustion chamber, an insulator positioned concentrically within said tubular body, said insulator extending lengthwise of said tubular body and having adjacent the end of said tubular body within said combustion chamber a portion spaced from the inner face of said tubular member, and electrodes carried by said tubular body and by said insulator defining a spark gap located within said combustion chamber when said igniter is in position on said combustion apparatus, said tubular body having in the wall thereof an opening which communicates with the interior of said tubular body at a point where said insulator is spaced from the inner face of said tubular body, said opening in said tubular body being located so that when said igniter is in position on said combustion apparatus the opening is intermediate the inner and outer walls of said combustion apparatus and faces the direction from which air is supplied to the passage between said inner and outer walls, the opening in said tubular body also being of such size and being disposed so that when said igniter is in position on said combustion apparatus said opening is offset from the axis of said insulator laterally of the direction of flow of air through the passage between said outer and inner walls so that a major portion of the area of said opening is at one side of the axis of said insulator and so that at least a minor portion of the area of said opening is at the other side of the axis of said insulator.

DONALD J. STEEG.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,205,983	Kraber	June 25, 1940
2,465,092	Harkness et al.	Mar. 22, 1949

FOREIGN PATENTS

Number	Country	Date
587,564	Great Britain	Apr. 30, 1947