

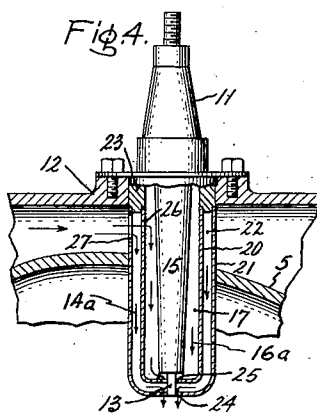
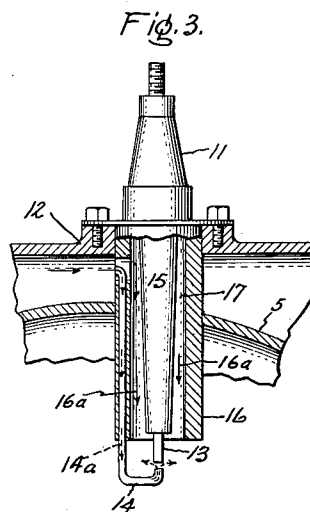
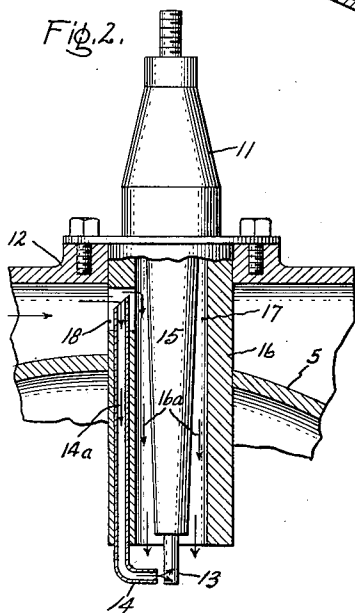
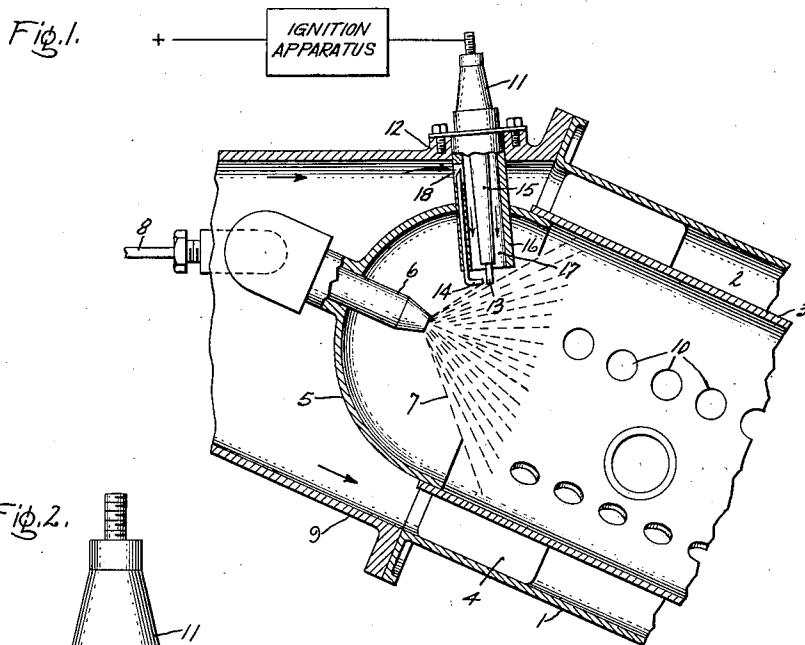
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AIR-COOLED SPARK PLUG

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AIR-COOLED SPARK PLUG

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2 Claims. (Cl. 123-169)

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This invention relates to electric igniters, and more particularly to electric spark igniters subjected to high temperatures as in internal combustion power plants.

The invention is well adapted for use in connection with spark plugs for the combustors of gas turbine powerplants, and it is this application of the invention which I have elected specifically to illustrate and describe. It is to be understood, however, that the invention is not limited thereto necessarily but may be used also in rocket or reaction type motors and other combustion apparatus.

Actual service experience has shown that thermal powerplants of the type described are subject to serious limitations with regard to permissible power rating, operating temperatures, service life of the igniting device, and the maximum interval between overhauls because of the inability of the igniting device to withstand the exceedingly high temperatures to which it is subjected during the operation of such powerplants. Furthermore, because of high operating temperatures, it has not been possible to locate the igniter in the most favorable location for optimum ignition characteristics of the combustor.

Accordingly, it is an object of this invention to provide a novel and improved arrangement for cooling the igniter.

It is also an object of the invention to prevent fouling of the igniter which may result from the deposition of unburned fuel or carbonized particles on the electrodes, insulator or other exposed parts of the igniting device, which might provide a current leakage path or otherwise adversely effect ignition of the fuel by the spark.

Other objects and advantages will be apparent from the following description taken in connection with the accompanying drawings, in which Fig. 1 is a view, partly in section, illustrating one embodiment of the invention as applied to a gas turbine powerplant; Fig. 2 is an enlarged sectional view of the arrangement shown in Fig. 1; Fig. 3 is an enlarged sectional view illustrating a modified arrangement of the electrodes; and Fig. 4 is another enlarged sectional view illustrating a further modification.

Referring now to Figs. 1-3, an outer casing 1 defines an air supply space 2, in which a cylindrical inner wall or "liner" 3 is co-axially supported, as for example, by a plurality of radially extending fins or baffles 4. These baffles may be welded to the outer surface of liner 3 and arranged to slide freely into the outer housing or casing 1. The liner 3 defines an elongated com-

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bustion space which is closed at one end by an end dome 5. The opposite end of the combustion space is open to permit the discharge of the combustion products to a suitable turbine (not shown). For the purpose of illustration, the combustion shown is similar to that disclosed in the copending application of Anthony J. Nerad, Serial No. 750,015, filed May 23, 1947, and assigned to the same assignee as the present application; but it should be noted that the invention may be applied to other combustion devices of the general type described.

The end dome 5 supports a fuel nozzle 6, which is preferably of a type which produces a conical spray of fuel particles, as indicated by the spray pattern 7. A conduit 8 serves to conduct fuel to the nozzle from a suitable fuel supply means (not shown). As is more particularly described in the above-mentioned application of Anthony J. Nerad, combustion air under pressure is conveyed by means of a duct or "air adapter" 9 from a suitable compressor (not shown) to the air supply space 2. This combustion air is admitted from the air supply space to the combustion or reaction space within liner 3 through a plurality of spaced holes 10.

In order to initiate combustion in the chamber, an igniting device in the form of an electrically-energized spark plug, is provided. Spark plug 11 may be supported on air adapter 9 by a mounting boss 12 in such a manner that an end portion of the spark plug projects through the end dome and into the combustion chamber. The arrangement and proportions of this end portion of the spark plug is such that electrodes 13, 14 which define the spark gap are located substantially in the normal path of the conical spray pattern 7 of fuel particles issuing from the fuel nozzle 6. Surrounding an insulator 15 and the central electrode 13 of the spark plug is a cylindrical co-axially spaced metal sleeve 16 forming an annular cooling air passage 17. An opening 18, Figures 1 and 2, is provided in sleeve 16 in cooperative relation with the air supply space 2 and the cooling passage 17 to form a complete flow path for the cooling air around the insulator and the central electrode.

Still referring to Figures 1-3, the second igniter electrode 14 may comprise a hollow tubular member bent or formed to any suitable configuration as illustrated in the drawings. One end of electrode 14 is maintained in spaced relation with the central electrode 13 to define a spark gap of any desired value. Electrode 14 may be secured to the shroud or sleeve 16 by welding or

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any other convenient securing means. The other end of electrode 14 may be beveled as illustrated in Fig. 2, or it may be directed so as to receive substantially the full dynamic pressure from the air supply space 2 in any convenient manner, as for example by bending the hollow tubular member 14 to face in the proper direction as indicated in Fig. 3.

Cooling and insulating air under pressure may be supplied from the same compressor which serves as the source of supply of the combustion air. It will be apparent that such an arrangement is feasible because in the ordinary operation of a combustor of the type described there is a definite pressure drop from the supply space 2 to the reaction space within the liner 3. This pressure drop is therefore available to effect a flow of cooling air through opening 18 and cooling passage 17. Of course, a separate auxiliary source of cooling air at any desired pressure may be employed if desired. It will also be obvious to those skilled in the art that since the total or the dynamic pressure of the air flowing in the air supply space 2 and against the open end of member 14 will always be greater than the static pressure of the same air stream in the absence of any pressure conversion or diffusion process, there is a decrease in pressure from one end of member 14 to the other in such a direction as to cause a flow of air through this member from the air supply space 2 to the interior of the combustion chamber.

An important feature of the arrangement is that this flow of relatively cool air from hollow electrode 14 is discharged directly against the exposed end portion of the solid central electrode 13. Thus the air issuing from electrode 14 as indicated by arrow 14a serves to effectively cool the solid electrode 13 as well as to insulate the latter so as to prevent the deposit of carbonized fuel particles thereon. Obviously electrode 14 is cooled by virtue of the air flowing through it as indicated by arrow 14a. In addition, the air issuing from the open end of shroud 16, as indicated by arrows 16a, also tends to blow fuel particles away from both electrodes to prevent the deposit of carbonized fuel particles thereon.

A modified embodiment of the invention is illustrated in Fig. 3. This arrangement is similar to Fig. 2, but differs in that the discharge from electrode 14 is substantially coaxial with the axis of solid electrode 13 and that the opposite end is arranged to face in the proper direction to receive substantially the full dynamic pressure from the air supply space as will be apparent from the drawing.

A further modification is illustrated in Fig. 4. The sleeve or shroud 16 may be replaced by concentric spaced walls 20, 21 surrounding the insulator 15 and the central electrode 13 and defining cylindrical co-axially spaced shroud means and forming annular cooling passages 17 and 22. Walls 20, 21 may be welded to a supporting member 23 which also forms a closure for the upper portion of passage 22. The other end of walls 20, 21 are bent or formed to close the lower end of the cylindrical shrouds except for circular openings 24, 25 of equal diameter which are provided in each of the walls 20, 21 concentric with central electrode 13. The diameter of openings 24, 25 is of such value as to define annular spark gaps between the central electrode 13 and walls 20, 21 of any desired value.

Openings 26, 27 are provided in walls 20, 21, respectively, to admit cooling and insulating air

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to passages 17 and 22. Ordinarily opening 27 will be made of greater diameter than that of opening 26 to insure that some of the air from the air supply space 2 will be caused to flow in each of passages 17, 22. It will be apparent that openings 26, 27 need not be arranged in any particular relation to each other; but it is desirable that opening 27 be adapted to receive the dynamic pressure of the air flowing in the air supply space 2. In addition, it is desirable that opening 26 be located as near the upper end of passage 17 as is feasible in order to cause the air to flow across the surfaces of the insulator 15.

It will be seen that, since pressure relationships similar to those described above in connection with the arrangements illustrated in Figures 1-3 will also apply with respect to the arrangement illustrated in Fig. 4, cooling air is caused to flow through passage 17 across the surfaces of insulating bushing 15 and the exposed end of electrode 13; and that cooling air is also caused to flow through passage 22 and from an annular jet which is discharged against the exposed end portion of the solid electrode 13. In this manner both the vulnerable electrodes are cooled and insulated from partly burned fuel particles during the combustion process. The cooling air also supplies extra oxygen so as to insure complete combustion in the neighborhood of the spark plug, thereby reducing the amount of unburned fuel in this region which might otherwise carbonize and be deposited on the comparatively cool surfaces of the electrodes. I have also found that less frequent cracking of the insulator bushing 15 occurs when cooling is accomplished in accordance with the invention.

Whereas previously used spark plugs lasted only about five hours in operation with gas turbine combustors, those incorporating the invention have operated as long as 260 hours without serious deterioration. It will be seen that the invention provides a simple yet effective arrangement for cooling both electrodes of an electric igniting device as well as the insulating bushing, and also for preventing fouling by carbonized particles so that the permissible power rating, operating temperature limits, and the time interval between overhauls can be increased.

While particular embodiments of the invention have been illustrated and described, it will be apparent to those familiar with the art that various changes and modifications may be made without departing from the invention, and it is intended to cover in the appended claims all such changes and modifications as come within the true spirit and scope of the invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. For use in combustion apparatus having a combustion chamber, an igniter including an insulating bushing supporting a first electrode having an end portion adapted to project into the combustion chamber, a first wall portion defining a shroud surrounding said projecting end portion and spaced therefrom to define a first annular cooling fluid passage, a second wall portion surrounding said first wall and spaced therefrom to form a second annular cooling fluid passage, said first and second walls being secured at one end to the igniter to form a closure at one end of both of said passages, said first wall adapted to cooperate with said second wall at the opposite end to form a second electrode and a nozzle communicating with said second passage and spaced from said first electrode to define a

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spark gap, said nozzle being adapted to discharge a jet of cooling and insulating fluid across said jet and against the first electrode to cool both electrodes and to prevent the deposition of carbonized fuel particles thereon, and means for supplying cooling fluid under pressure to both of said passages.

2. Apparatus in accordance with claim 1 wherein the means for supplying cooling fluid to both passages includes an opening adjacent the closed end defined by each of shroud walls, said openings being of unequal diameter and the second wall portion defining the larger of said openings.

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REFERENCES CITED

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

UNITED STATES PATENTS

Number	Name	Date
870,369	Lamkin	Nov. 5, 1907
1,286,435	Slate	Dec. 3, 1918
1,447,278	Brewster	Mar. 6, 1923
1,521,106	Keim	Dec. 30, 1924