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SPARK PROJECTION IGNITION DEVICE

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Fig. 1.

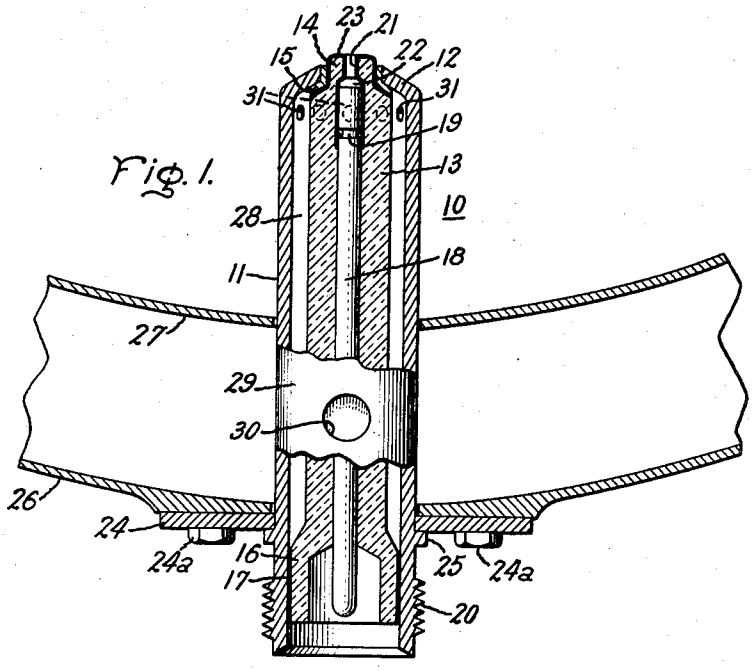
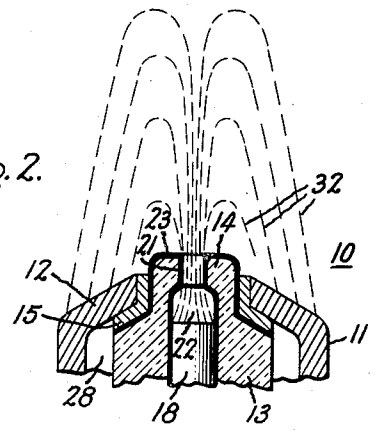


Fig. 2.



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SPARK PROJECTION IGNITION DEVICE

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11 Claims. (Cl. 313—131)

This invention relates to fuel combustion ignition devices of the electrical spark discharge type and more particularly to such devices which are especially adapted for the ignition of combustible gases which are continuously flowing at a high rate of speed with respect to the ignition device.

In certain types of fuel combustion apparatus such as in fuel burning gas turbines, for instance, there is a continuous flow of combustible materials at a relatively high velocity. It is therefore difficult to provide an ignition apparatus which is capable of heating individual portions of the combustible materials to a temperature sufficiently high to initiate combustion during the necessarily brief interval during which the combustible materials are in proximity to the ignition device.

In a prior copending patent application S. N. 382,269 for a "Fuel Combustion Ignition Device," filed by Donald C. Peroutky on September 25, 1953, and assigned to the same assignee as the present invention, it is pointed out that one approach to this problem is by the employment of an igniter device having a center electrode recessed within an opening in the igniter insulating member to obtain a projection of the spark discharge. The present invention constitutes an improvement over that prior invention.

One object of the present invention is to provide an ignition device having a greatly improved efficiency of operation.

Another object of the present invention is to obtain an ignition device which provides a substantially greater outward projection of the spark away from the device and into the stream of combustible materials than has been previously obtainable.

Another object of the invention is to provide the removal of a major effective portion of the spark discharge from the heat conductive components of the ignition device to avoid heat quenching of the spark.

Another object of the invention is to provide an improved spark projection ignition device in which a relatively long spark gap is provided between the recessed electrode and the other electrode but in which a lower voltage is required to initiate the spark discharge.

Further objects and advantages of the invention will be apparent from the following specification and the accompanying drawing.

In carrying out the objects of this invention in one preferred embodiment thereof an igniter or "spark plug" structure may be employed having an insulating member with one end enclosing a chamber and adapted for projection into a fuel combustion space. Within the chamber there is an electrode. The insulator end is provided with a restricted opening communicating with the chamber. A second electrode is positioned in mechanical engagement with the exterior of the insulating member and the surface of the insulating member from the electrode within the chamber to the second electrode is comprised of a semi-conductive material.

For a more complete understanding of the invention reference should be made to the following specification and the accompanying drawing in which:

Fig. 1 is a side view, partly in section, of a preferred embodiment of the ignition device of this invention, and

Fig. 2 is an enlarged sectional detail view of the ignition tip portion of the device of Fig. 1 showing the electrical spark discharge path and illustrating one of the principles of this invention.

Referring more particularly to Fig. 1, there is shown a preferred embodiment of an igniter structure for carrying out the objects of this invention. The igniter is designated as a whole by reference numeral **10**, and comprises an outer cylindrical metallic casing or shell **11**, the upper end of which serves as the outer electrode of the ignitor. At the upper end of the casing **11**, there is a radially inwardly extending flange **12** which defines a reduced central opening. In this opening there is supported and positioned one end of an insulating member **13** which may be comprised for instance of a suitable ceramic insulating material. The upper end of the insulating member **13** includes a portion **14** of reduced diameter which extends through the opening defined by the flange **12**, and this reduced diameter portion at its lower end forms a shoulder portion on the insulating member **13**.

Positioned between this shoulder portion of the insulating member **13** and the central opening of the flange **12** there is a bushing member **15** which is preferably composed of a spark erosion resisting material such as nickel. Since bushing **15** is of conductive metal and in electrical contact with flange **12**, it serves as a portion of the outer electrode formed by the shell **11**.

The lower end of the insulating member **13** includes a pin connector portion **16** having an enlarged outer diameter sufficient to provide a sliding fit within the casing **11**. The insulating member **13** includes a central bore in which there is positioned a center electrode member **18**. This center electrode **18** protrudes into an enlarged center cavity or terminal well within the lower portion **16** of the insulating member **13** to serve as a pin to which a suitable electrical socket connector may be attached for connection of the igniter to a suitable source of electrical spark energy (not shown). A second electrical connection to the igniter may be provided by engagement of such a socket connector with the exterior of the casing **11** and screw threads are provided at **20** for this purpose.

The upper end of the central electrode **18** terminates somewhat below the upper end of the central opening within the insulating member **13**. Above this termination of electrode **18**, the central opening is reduced or constricted in diameter and cross-sectional area as indicated at **21**. This reduced cross-sectional area is preferably in the order of from one-half to three-quarters of the area of the upper exposed surface of electrode **18** and the cross-sectional area of the associated portions of the central opening. It may therefore be said that this restriction partially encloses a small chamber at **22** immediately above the upper end of the electrode **18** and below the constricted opening at **21**.

The surface of the insulating member **13** is preferably coated with a semi-conductive material at the upper end thereof as indicated at **23**, and extending into the central bore and over the shoulder in engagement with bushing **15**.

This semi-conductive coating or surface is sealed and electrically connected to the upper portion of the electrode **18** at a groove in the outer surface thereof indicated at **19** for means of a high temperature brazing material such as silver solder which is fusible to both the electrode **18** and the semi-conductive insulator surface. The bush-

ing member 15 is preferably similarly sealed and electrically connected to the semi-conductive surface of the insulating member 13 by means of a similar high temperature brazing material so that a good electrical contact is established between the semi-conductive insulator surface and each of the electrodes. The purpose of this semi-conductive surface, as well as the significance of other structural features thus far described will be explained more fully below in connection with Fig. 2.

The bushing 15 may also be silver soldered to the flange 12 of the shell 11 in order to complete a permanent mechanical connection between the shell 11 and the insulating member 13. Alternatively, however, a positive mechanical connection may be established at the lower end of the igniter structure by means of a silver soldered connection indicated at 17 between the exterior of the enlarged diameter portion 16 of the insulating member 13 and the adjacent inner surface of the shell 11. When this alternative connection 17 is employed, there is sufficient electrical connection between the bushing 15 and the flange 12 by the interfitting mechanical engagement between these members.

On the exterior of the casing 11 there is provided a mounting flange 24 which may be welded to the casing against a shoulder such as indicated at 25. By means of the flange 24 the ignition device may be mounted, as by mounting bolts 24*a*, on the outer shell 26 of a combustion chamber of the apparatus which the ignition device is to serve; and which is only partially shown. The ignition device also extends through another suitable opening in an inner shell 27 of the fuel combustion apparatus and which immediately surrounds and encloses the combustion space in which combustion takes place.

It will be seen from the above description that between the inner surface of the casing 11 and the portion of the outer surface of the insulating member 13 which is enclosed therein, there is an annular space as indicated at 28. This space 28 may be employed to cool the ignition device in order to prevent premature deterioration of the parts thereof due to the continuously maintained high temperatures encountered in operation. Circulation of cooling air through the space 28 within the ignition device is accomplished by means of the following structure. In the central portion of the ignition device at 29, which is shown in elevation in Figure 1, an air inlet opening 30 is provided through the outer casing 11. Inlet 30 communicates with the annular space 28 and provides a path for the entrance of cooling air. The cooling air travels upwardly in the ignition device to a series of air discharge openings 31 in casing 11. The hottest portion of the ignitor which extends into the combustion space is thereby adequately cooled.

In the apparatus in which the ignition device is normally intended to operate, the space between the outer shell 26 and the inner shell 27 is provided with a continuous flow of cooling air in a direction normal to the plane of opening 30 and at a higher pressure than in the combustion space to which discharge openings 31 communicate so that such air is forced to enter the space 28 to accomplish this cooling operation. The cooling structure described, including the casing 11 having the openings 30 and 31, constitutes subject matter which is described and claimed in my copending patent application Serial No. 441,729 for "Electric Spark Igniter With Improved Cooling Structure," filed on even date herewith and assigned to the same assignee as the present application.

In Figure 2 there is shown an enlarged sectional view of the upper tip portion of the structure of Figure 1, which portion may be referred to as the "firing end." Dotted lines 32 are also included in this view to indicate the theoretical paths of the various portions of the spark discharge which occurs when this ignition device is in used. When the spark discharge voltage is applied between the central electrode 18 and the outer electrode (the upper end of the casing 11 including the flange 12 and bushing 15), a spark discharge is initiated between these electrodes.

It has been found that the presence of the semi-conductive surface 23 on the portion of the insulating member 13 between the electrodes 18 and 11 provides for initiation of the spark discharge at a lower voltage than would otherwise be possible. Stated in another manner, it has been found that with a given spark discharge initiation voltage and with the semi-conductive surface included, then, the spacing between the electrodes 18 and 11 may be subtantially increased and the amount of energy which can be expended in the spark gap between these electrodes can correspondingly be increased and the ignition device therefore can be made much more effective.

The reason for the improved performance in terms of lower initiation voltage which is possible with semi-conductive surface is not clearly and definitely known. It is thought that the small current which the semi-conductive surface permits enables the initiation of small local arc discharges along the semi-conductive surface, which soon combine to provide a full scale spark discharge between the electrodes themselves. Improved performance has been achieved when care is taken to establish a good electrical contact between the electrodes and the semi-conductive surface. Accordingly, in the present structure, the bonds provided at 15 and 19 are considered to be very important.

While use of the semi-conductive surface 23 is preferred in most applications, such semi-conductive surface may be omitted and the igniter will operate successfully if sufficient voltage is available. The bonds at 15 and 19 are then made to the non-conductive surfaces of insulating member 13.

As described in the above-mentioned copending Peroutky patent application, Serial Number 382,269, the provision of a recessed center electrode in a structure in which the other electrode is positioned adjacent to the insulating member, and wherein such other electrode has no greater projection into the combustion space than the insulating member but does have greater projection than the center electrode, produces a projection of the spark discharge and the hot gases outwardly and away from the structure of the ignition device. It has now been found that this action is greatly accentuated if a restriction or constriction is provided in the central opening of the insulating member such as shown at 21 above the center electrode 18. It is not precisely known just why this constriction accomplishes this result, but the results which have been obtained have been quite pronounced. Projections of the spark discharge have actually been obtained which are greater in respect to the dimensions of the device used than the magnitude of the projection indicated by the dotted lines 32. For instance, with a device having an outer casing diameter of nine sixteenths of an inch, projections of the spark in the order of one inch have been obtained.

It is believed the provision of a chamber 22 having larger physical dimensions than the constriction 21 contributes to the projection of the arc. This chamber provides a partial enclosure of limited volume in which the gases are heated to a very high temperature when the spark discharge is initiated, thus causing the expansion and expulsion of these gases through the constriction 21. A projection of the spark is thus obtained which might be characterized as a squirting or a semi-explosive expansion of these gases and the spark into the desired location in the combustion materials within the combustion space and away from the ignition device structure.

The size of the chamber 22 and the depth to which the electrode 18 may be recessed are obviously to be determined at least in part by the permissible length of the air gap between the two electrodes 18 and 11. Accordingly, it is thought to be desirable that the semi-conductive surface 23 should be included in this struc-

ture in order to permit a maximum inter-electrode gap dimension with a reasonably limited spark initiation voltage. The projection effect may thus be at a maximum.

In some installations the projection of the spark which is provided by this structure is such that the igniter device itself need not project very far into the combustion space. In some of these installations the igniter device may be made so short that the flange **12** of the shell **11** at the firing end of the igniter is substantially in alignment with the inner wall **27** of the combustion space. In such a structure it has been found to be unnecessary to provide the cooling structure including the space **28** between the insulating member **13** and the shell **11** and the cooling air entrance and exit openings **30** and **31**. The structure may otherwise be quite similar to that shown.

While only certain preferred embodiments of the invention have been described and illustrated by way of example in the foregoing, many modifications will occur to those skilled in the art and it therefore should be understood that the appended claims are intended to cover all such modifications as fall 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. A fuel combustion ignition device comprising a first electrode, an insulating member surrounding and supporting said electrode and forming a chamber surrounding one end thereof, said insulating member including a restricted opening in communication with said chamber, and a second electrode positioned adjacent to the portion of said insulating member enclosing said chamber, and not obstructing said restricted opening.

2. A fuel combustion igniter device comprising an insulating member for projection into a combustion space and having a chamber enclosed therein, a first electrode having a surface defining one wall of said chamber, said insulating member including a restricted opening communicating from the exterior of the maximum projecting portion thereof to said chamber, and a second electrode positioned exterior to said chamber, and not obstructing said restricted opening.

3. A fuel combustion ignition device comprising a first electrode and an insulating member surrounding and supporting said electrode for projection into a combustion space, said insulating member projecting farther than said electrode and including an opening therein for exposure of the projecting end of said electrode, the outer end of said opening having a smaller cross-sectional area than the inner end thereof adjacent the exposed end of said electrode, and a second electrode exterior to said opening and having a projection no greater than said insulating member.

4. A combustion igniter device comprising an insulating member for projection into a combustion space, said insulating member including an opening therein, a first electrode recessed within said opening and having an exposed area in communication therewith, at least the outer end portion of said opening having a restricted cross-sectional area less than said exposed area of said electrode, and a second electrode positioned adjacent said insulating member and having a projection no greater than said insulating member but greater than said first electrode.

5. A fuel combustion igniter device comprising a first electrode for projection into a combustion space, an insulating member surrounding and supporting the sides of said electrode and having a greater projection into said combustion space, an open chamber formed between said first electrode and said insulating member, said chamber having a restricted portion at the open end thereof, a second electrode in physical engagement with the exterior of said insulator and projecting into said combustion space less than said insulator but more than said first electrode, at least a continuous portion of the surface of said insulator between said electrodes being comprised of a semi-conductive material.

6. A fuel combustion igniter device comprising a first electrode, an insulating member surrounding and supporting said electrode and forming a chamber adjacent and open to one end thereof, said insulating member including a restricted opening in communication with said chamber, a second electrode positioned in engagement with the portion of said insulating member enclosing said chamber, said insulating member including a surface layer of semi-conductive material in electrical contact with both of said electrodes and extending therebetween.

7. A fuel combustion ignition device comprising an insulating member for projection into a combustion space, said insulating member having an opening within the projecting portion thereof, a first electrode recessed within said opening and in mechanical engagement with the side walls thereof, an open chamber formed between said first electrode and said insulating member, said chamber having a restricted portion at the open end thereof, a second electrode positioned adjacent to said insulating member in mechanical engagement with the surface thereof and having a projection into said combustion space greater than said first electrode but smaller than said insulating member, at least a portion of the surface of said insulating member between the respective mechanical engagements of said electrodes being comprised of a semi-conductive material.

8. A fuel combustion ignition device comprising an insulating member for projection into a combustion space, a first electrode having an end portion enclosed within said insulating member, said insulating member and first electrode together defining a chamber disposed interiorly of said insulating member, said insulating member including a restricted opening communicating with said chamber, and a second electrode engaged with the exterior surface of said insulating member, at least a continuous portion of the surface of said insulating member between the engagements of said electrodes being comprised of a semi-conductive material.

9. A fuel combustion ignition device comprising an insulating member for projection into a combustion space, said insulating member having an opening within the projecting portion thereof, an electrode recessed within said opening and in mechanical engagement with the side walls thereof, the outer terminal portion of said opening being constricted in area with respect to inner portions thereof, a second electrode positioned adjacent to said insulating member in mechanical engagement with the surface thereof and having a lesser projection into said combustion space, at least a portion of the surface of said insulating member between the respective mechanical engagements of said electrodes being comprised of a semi-conductive material.

10. A device for receiving ignition spark energy and for projecting a spark discharge into a combustible mixture comprising a tubular casing serving as one electrode and having a radially inwardly extending flange at the spark end thereof, a tubular insulating member having the spark end thereof supported in the central opening of said flange, said insulating member including an axial opening extending therethrough, a second electrode positioned within said axial opening and terminating short of the spark end of said insulating member, said axial opening at the spark end of said insulating member having a cross-sectional area smaller than its cross-sectional area at the terminal end of said second electrode.

11. A device for receiving ignition spark energy and for projecting a spark discharge into a combustible mixture comprising a generally tubular casing member comprising one electrode and having a radially inwardly extending flange at one end thereof, a tubular insulating member having one end supported in the central opening of said flange and including a reduced diameter portion projecting therethrough, said insulating member includ-

ing a central opening extending through said reduced diameter portion, a second electrode positioned within said insulating member opening and recessed within said reduced diameter portion, said central opening at the terminal end of said reduced diameter portion having a restricted cross-sectional area approximately one-half to three-fourths that of the portion thereof between said terminal end and the recessed end of said second electrode.

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