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IGNITER PLUG

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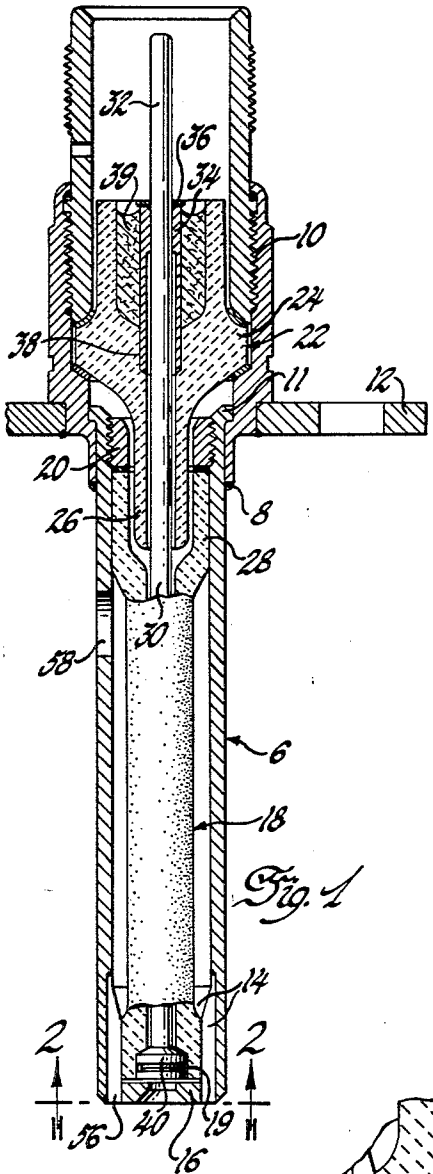


Fig. 1

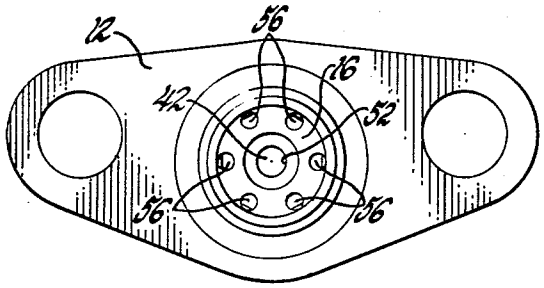


Fig. 2

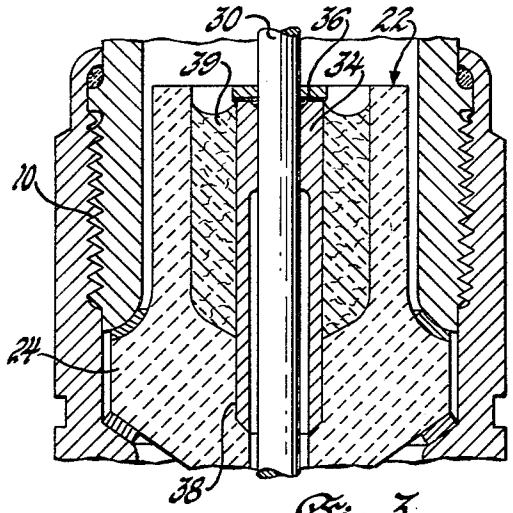


Fig. 3

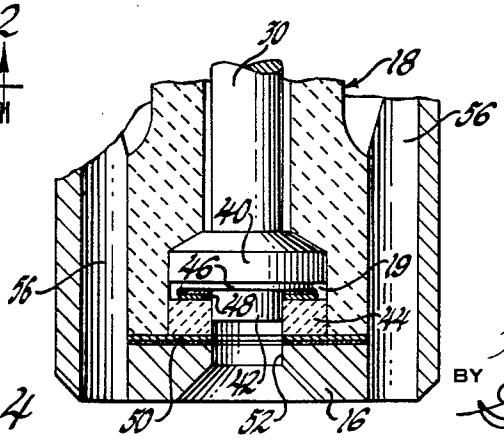


Fig. 4

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IGNITER PLUG

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10 Claims. (Cl. 313—131)

This invention relates to an igniter plug for use in internal combustion engines, particularly of the gas turbine type. It has as one of its objects the provision of an improved igniter plug which is adapted to project an intense, large spark such as is essential or at least highly desirable to assure initiation of combustion in gas turbine engines. Another object of the invention is to provide an igniter plug of the low tension type which is adapted to project an intense, large spark and which has a long useful life. Another object is the provision of an improved igniter plug of the type described having improved means for sealing the centerwire within the insulator assembly.

These and other objects and advantages of the invention will appear more clearly from the following description of a preferred embodiment and from the drawings in which:

Figure 1 is a side view in partial section of the preferred embodiment of the invention;

Figure 2 is a bottom view of the igniter plug shown in Figure 1;

Figure 3 is an enlarged view in section of the centerwire seal portion of the igniter plug shown in Figure 1; and

Figure 4 is an enlarged view in section of the firing end of the igniter plug shown in Figure 1.

Referring now to the drawings, the igniter plug includes a metal shell 6 which is constructed in three sections suitably joined together as by the brazed joint shown at 8 and by the threaded joint shown at 10. Cooperating flanges as shown at 11 assure that the lower section of the shell will not become disassembled in the event the brazed joint should fail. A suitable mounting pad 12 is brazed to the shell so that the igniter plug can be secured to the combustion chamber wall of a gas turbine engine. The lower end of the tubular metal shell 6 is formed with a thickened portion 14 to provide a reduced internal diameter and terminates with an inwardly extending annular flange 16 which serves as the ground electrode for the igniter.

Secured within the lower end of the shell is a lower, generally tubular-shaped alumina-base ceramic insulator 18 having a lower end of enlarged internal diameter to form a recess 19, and also of enlarged external diameter to fit snugly within the lower portion 14 of the shell. This insulator is secured within the shell by means of a metal nut 20 which threadedly engages the shell, the insulator thereby being pressed between said nut and the flange 16 at the lower end of the shell which serves as the ground electrode of the igniter. An upper through-bored alumina-base insulator 22 is secured within the upper end of the shell by means of conventional shoulder 24, this upper insulator having a lower end portion 26 fitting concentrically into upper enlarged end 28 of the lower insulator.

Extending through the aligned bores of insulators 18 and 22 is a metal centerwire 30 having an upper end 32 which extends above the insulators and serves as the

connecting terminal for the igniter. The centerwire is hermetically sealed to the upper insulator by means of a metal sleeve 34, the upper end of which fits snugly around and is brazed to the center wire as shown at 36 and the lower end of which has an enlarged internal diameter such that it is of reduced wall thickness and thereby spaced from the centerwire. The bottom of the sleeve 34 is positioned in a counterbore 38 in the upper insulator and a sealed joint between the sleeve and the insulator is formed by a mass of fused glass 39 having substantially the same coefficient of expansion as that of the sleeve. Where the sleeve is made of Kovar (typical analysis: iron 54%, nickel 28%, cobalt 18%) the glass 39 may consist of 2% B_2O_3 and 98% alkali borosilicate glass (typical analysis: SiO_2 64.8%, Al_2O_3 10.2%, B_2O_3 16.5%, Na_2O 3.4%, K_2O 3%, MgO .3%, CaO .3%). The important advantage of this seal structure is its high resistance to cracking or other failure from rapid temperature changes.

The centerwire 30 is formed with a cylindrical head portion 40 adjacent its lower end which is positioned within recess 19 formed at the end of insulator 18. The centerwire terminates with a projection 42 extending below head portion 40, this projection fitting snugly into and extending partially through a flat-sided ring 44 of insulator or semi-conductor material. The centerwire projection 42 serves as the center electrode of the igniter, its base surface being spaced from and cooperating with flange 16 of the shell to form the spark gap. The ring 44 may be made of any suitable material which will electrically insulate the centerwire from the ground electrode. Preferably it should be a semi-conductor such, for example, as silicon carbide, or of an insulator material provided with a semi-conductive coating such as copper oxide. Various other semi-conductive materials for low tension spark plugs are well known in the art. If desired, an insulator ring may be used in place of a semi-conductor ring but not to the same advantage since with a semi-conductor high energy low voltage operation can be used to produce an especially hot spark.

Between head portion 40 and projection 42, the centerwire is formed with an annular shoulder 46 having a diameter intermediate those of the head and projection portions. A nickel or other heat and corrosion resistant metal washer 48 having a diameter about the same as that of shoulder 46 is brazed to the shoulder and is pressed tightly between the shoulder and semi-conductor ring 44 as shown. Another washer 50 of the same or similar material but of larger size is brazed to the inner surface of flange 16, thereby forming part of the ground electrode, and is pressed tightly between the flange and the base surfaces of insulator 18 and semi-conductor ring 44. Shoulder 46 serves the important function of increasing the distance from the centerwire to the shell by the route between ring 44 and insulator 18, and thus insures against internal flash-over which might otherwise occur. The heat and corrosion resistant washers 48 and 50 function to prevent the formation of an oxide film between the semi-conductor ring 44 and the metal surfaces the ring would otherwise contact. Thus, intimate electrical contact between the semi-conductor ring and each of the electrodes is assured throughout the life of the plug.

Annular flange 16 has an inner surface the upper portion of which, adjacent ring 44, is of cylindrical shape as shown at 52 and the lower end of which tapers outwardly as shown. Cylindrical surface 52 is of the same diameter and is aligned with the inner surface of washer 50 and ring 44. Thus, the combination of these surfaces forms a cylinder or "barrel" from which the electrical discharge projects when the igniter is actuated.

To provide adequate cooling, the inner wall of thick-

ened portion 14 of the shell is formed with a series of six circumferentially arranged axially-extending indentations which cooperate with the lower end of insulator 18 to form air passages 56 to the exterior of the igniter. An inlet air passage 58 allows cooling air to enter the annular space between shell 6 and lower insulator 18 from whence it exits through the passages 56 thereby cooling the entire lower end of the igniter.

To manufacture the spark plug, the two lowermost shell portions and pad 12 are joined together as by the braze and mechanical joints 8 and 11, respectively, and gasket 50 brazed to the inner surface of the ground electrode flange 16. Center electrode 30, with the gasket 48 brazed to shoulder 46, is then inserted into insulator 18 along with the semi-conductor ring 44, and this entire assembly is then positioned in the shell, as shown, and nut 20 threaded tightly into place. By threading the nut 20 tightly into the shell, pressure is exerted by insulator 18 against the upper tapered surface of the head portion 40 of the centerwire and also against gasket 50 thereby creating a good electrical contact. As a separate operation, Kovar sleeve 34 is positioned with its lower portion is counterbore 38 of the upper insulator, the glass mixture in powdered form is poured between the sleeve and the insulator, and the assembly is then heated to cause the glass to fuse and to form a bond between the sleeve and the insulator. After the heating operation the bore in the thick upper portion of the sleeve is reamed to remove any oxide film which is formed. Then this upper insulator-Kovar sleeve assembly is inserted into the shell such that centerwire 30 passes through the Kovar sleeve, as shown, after which the upper portion of the shell is threadedly engaged with the lower portions, as shown at 10, and the flange, at the upper end of the threaded joint 10, turned inwardly and shrink welded (Cico welded). The centerwire is then brazed to the Kovar sleeve by placing a ring of brazing material around the centerwire, on the top of sleeve 34, and heating to fuse the brazing material and thereby bond the parts together to thereby complete the assembly.

It is desirable that the centerwire 30 and the metal shell be made of the same metal, or at least of metals having substantially the same coefficients of expansion. By this means, pressure is maintained on head portion 40 of the electrode, and in turn on semi-conductor ring 44, throughout the operating temperature range of the igniter, the longitudinal expansion of the shell and of the centerwire being virtually the same because of their similar coefficients of expansion. This assures good electrical contact between ring 44 and electrodes 16 and 30, respectively, throughout the operating temperature range. A preferred metal for the centerwire and for the shell is Inconel (typical analysis: iron 5%, nickel 80%, chromium 15%).

It is to be understood that while the invention has been described with reference to a particular embodiment thereof, various changes and modifications may be used, all within the full and intended scope of the claims which follow.

We claim:

1. An igniter plug comprising a generally tubular shaped metal shell having an inwardly extending annular ground electrode at one end thereof, an elongated ceramic insulator secured within said shell having a recess at the end thereof adjacent said ground electrode, a ring in said recess abutting said ground electrode, the bore of said ring being aligned with the bore of said ground electrode, and a center electrode in said recess extending partially through said ring into spaced relationship with said ground electrode, said ring being of a material which electrically insulates said center electrode from said ground electrode.

2. An igniter plug comprising a generally tubular shaped metal shell having an inwardly extending annular

ground electrode at one end thereof, an elongated ceramic insulator secured within said shell having a bore extending therethrough with an enlarged portion forming a cylindrical recess at the end thereof adjacent said ground electrode, a center electrode in said insulator bore having a cylindrical head portion positioned in said recess, a ring in said recess pressed between said head portion and said ground electrode, the bore of said ring being aligned with the bore of said ground electrode, and a cylindrical extension on said head portion extending only partially through said ring into spaced relationship with said ground electrode, said ring being of a material which electrically insulates said center electrode from said ground electrode.

3. A spark plug as set forth in claim 2 and wherein the shell and center electrode are of the same metal.

4. An igniter plug comprising a generally tubular shaped metal shell having an inwardly extending annular ground electrode at one end thereof, an elongated ceramic insulator secured within said shell having a bore extending therethrough with an enlarged portion forming a cylindrical recess at the end thereof adjacent said ground electrode, a center electrode in said insulator bore having a cylindrical head portion positioned in said recess, an annular shoulder formed on said head portion having a diameter smaller than said head portion, a semiconductor ring in said recess pressed between said shoulder and said ground electrode, the bore of said ring being of substantially the same diameter and aligned with the bore of said ground electrode, and a cylindrical extension on said head portion extending only partially through said ring into spaced relationship with said ground electrode.

5. An igniter plug comprising a generally tubular shaped metal shell having an inwardly extending annular ground electrode at one end thereof, an elongated ceramic insulator secured within said shell having a bore extending therethrough with an enlarged portion forming a cylindrical recess at the end thereof adjacent said ground electrode, a center electrode in said insulator bore having a cylindrical head portion positioned in said recess, an annular shoulder formed on said head portion having a diameter smaller than said head portion, a ring in said recess pressed between said shoulder and said ground electrode, the bore of said ring being of substantially the same diameter and aligned with the bore of said ground electrode, and a cylindrical extension on said head portion extending only partially through said ring into spaced relationship with said ground electrode, said ring being of a material which electrically insulates said center electrode from said ground electrode.

6. An igniter plug comprising a generally tubular shaped metal shell having an inwardly extending annular ground electrode at one end thereof, a nickel gasket brazed to the inner surface of said ground electrode, an elongated ceramic insulator secured within said shell having a bore extending therethrough with an enlarged portion forming a cylindrical recess at the end thereof adjacent said ground electrode, a center electrode in said insulator bore having a cylindrical head portion positioned in said recess, an annular shoulder formed on said head portion having a diameter smaller than said head portion, a nickel gasket brazed to said shoulder, a semi-conductor ring in said recess pressed between the gasket on said shoulder and the gasket on said ground electrode, the bore of said ring being of substantially the same diameter and aligned with the bore of said ground electrode, and a cylindrical extension on said head portion extending only partially through said ring into spaced relationship with said ground electrode.

7. An igniter plug comprising a generally tubular shaped metal shell, a ceramic insulator secured within said shell having a bore extending therethrough, a center electrode extending through said insulator bore, a thin-walled metal tube having a diameter greater than that of said center electrode positioned concentrically around and

having an upper end bonded to said center electrode, and a glass seal between and bonded to said tube and said insulator, said glass seal and said tube having approximately the same coefficients of expansion.

8. An igniter plug comprising a generally tubular shaped metal shell, a ceramic insulator secured within said shell having a bore extending therethrough, an upper portion of said bore being of large diameter, a middle portion of said bore being of intermediate diameter and a lower portion of said bore being of small diameter, a center electrode extending through said insulator bore, a thin-walled metal tube having a diameter greater than that of said center electrode positioned concentrically around and having an upper end bonded to said center electrode, the lower end of said tube being of about the same diameter and positioned in the middle portion of said bore, and a glass seal in the upper portion of said bore bonded to said tube and said insulator, said glass seal and said tube having approximately the same coefficients of expansion.

9. An igniter plug comprising a generally tubular shaped metal shell having an inwardly extending annular ground electrode at one end thereof, aligned upper and lower elongated ceramic insulators secured within said shell each having a bore extending therethrough, the bore of lower insulator having an enlarged portion forming a cylindrical recess at the end thereof adjacent said ground electrode, a center electrode extending through said insulator bores having a cylindrical head portion positioned in said recess, a ring in said recess between said head portion and said ground electrode, the bore

of said ring being of substantially the same diameter and aligned with the bore of said ground electrode, a cylindrical extension on said head portion extending only partially through said ring into spaced relationship with said ground electrode, said ring being of a material which electrically insulates said center electrode from said ground electrode, a thin-walled metal tube having a diameter greater than that of said center electrode positioned concentrically around and having an upper end brazed to the portion of said center electrode within said upper insulator, and a glass seal between and bonded to said tube and said upper insulator, said glass seal and said tube having approximately the same coefficients of expansion.

10. An igniter plug comprising a generally tubular shaped metal shell having an inwardly extending annular ground electrode at one end thereof, an elongated ceramic insulator secured within said shell having a centerbore therethrough, a ring of semi-conductor material positioned at the end of said insulator and abutting said ground electrode, the bore of said ring being aligned with the centerbore of said insulator and with the bore of said ground electrode, and a center electrode in said insulator centerbore extending partially through said ring into spaced relationship with said ground electrode.

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