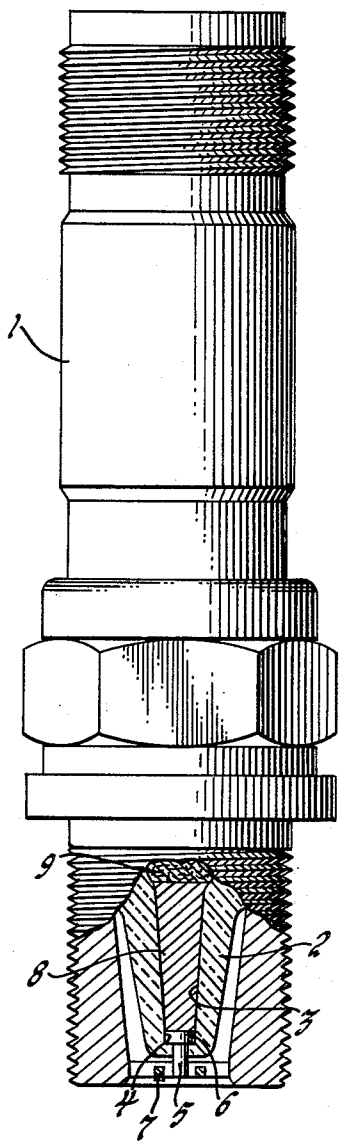
Feb. 23, 1965 K. SCHWARTZWALDER 3,171,052

CERAMIC-TO-METAL BOND FOR SPARK PLUGS AND THE LIKE

Filed Oct. 10, 1961



INVENTOR.
Karl Schwartzwalder
BY
Paul J. Leising
ATTORNEY

United States Patent Office 3,171,052
Patented Feb. 23, 1965

3,171,052

CERAMIC-TO-METAL BOND FOR SPARK PLUGS AND THE LIKE

Karl Schwartzwalder, Holly, Mich., assignor to General Motors Corporation, Detroit, Mich., a corporation of Delaware

Filed Oct. 10, 1961, Ser. No. 144,128
6 Claims. (Cl. 313—145)

This invention relates to ceramic-to-metal bonding and, more specifically, to structure and composition for spark plugs and the like wherein a good, intimate bonded contact between metal and ceramic is required.

In various types of high performance aircraft spark plugs, it has become conventional practice to employ a platinum center electrode firing tip embedded in a mass of silver cast in situ within the ceramic insulator centerbore in order to obtain maximum heat transfer away from the firing tip and hence longer electrode life. Such spark plug structure is shown in United States Patent 2,927,238, issued March 1, 1960, to Alfred Candelise, and in other patents referred to therein, all of which are assigned to the assignee of the present invention. To accomplish the maximum heat conductivity desired it is important that there be intimate contact between the silver and the ceramic. For this reason, it is the practice to cast the silver in situ within the insulator centerbore, centrifugal force often being applied in order to eliminate air voids between the silver and the ceramic while the silver is still molten. However, even where such techniques are employed there is often incomplete elimination of air voids and therefore poor contact between the silver and the ceramic. Further, even where good contact is obtained during manufacture, it often deteriorates during the life of the plug for the reason that the corrosive compounds resulting from the use of leaded gasoline tend to gradually work between the platinum electrode and the ceramic and thence between the silver and the ceramic, thereby creating a film or voids disrupting the heat path.

It is an object of the present invention to provide a composition and structure which affords excellent intimate and continuous contact between silver and ceramic. More specifically, it is an object of the invention to provide an improved aircraft spark plug of the type having a cast silver center electrode wherein intimate durable contact between the silver electrode and the ceramic insulator is assured.

Briefly, these objects are accomplished in accordance with the invention by including a small amount of tellurium in the silver. I have discovered that the presence of the tellurium greatly facilitates the elimination of all air voids between the silver and the ceramic and provides such intimate contact between the two materials as to provide a bond highly resistant to the corrosive effects of lead compounds or otherwise. While the precise reasons for the improved results attained by the tellurium addition are not yet fully known, I have theorized that the tellurium serves in the nature of a wetting agent for the silver as it is cast or otherwise applied against the ceramic, such wetting action thereby resulting in so intimate a contact between the silver and the ceramic as to accomplish a durable mechanical bond.

The amount of tellurium alloyed with the silver need not be great to accomplish the desired results; about .3% by weight tellurium is generally ample and in no instance is it required to use more than about 1% by weight.

The invention will be more fully understood by reference to the following detailed description made with reference to the appended drawing which shows a side view in partial section of an aircraft spark plug embodying the invention.

Referring now to the drawing, the spark plug comprises a steel outer shell 1 having concentrically secured therein a ceramic insulator 2 with a centerbore 3 therein which tapers gradually inwardly toward the lower or firing end of the plug and terminates in a portion 4 of reduced diameter. The ceramic insulator should preferably be of a high alumina composition containing upwards of 85% alumina such for example as covered by United States Patent 2,760,875, issued August 28, 1956, to Karl Schwartzwalder and Helen Barlett. A platinum firing tip 5 is secured within the lower end of the centerbore by a head portion 6 and extends out from the insulator into spark gap relationship with ground electrodes 7 which are welded to the base of the shell. In accordance with the invention, the tapered portion of the centerbore is filled with an alloy 8 of about .3% by weight tellurium and the remainder substantially all silver except for the usual impurities. A conductive layer 9 consisting of a fused mixture of glass and metal powder abuts the top surface of the silver alloy to establish electrical connection therewith. This layer and other elements of the conductive path within the centerbore leading to the top of the spark plug can be of well-known construction such, for example, as shown in the aforementioned Candelise Patent 2,927,238. Also, it should be understood that the firing tip and the silver alloy mass can be formed to different shapes such, for example, as those shown in the Candelise patent wherein an extension to the firing tip extends upwardly through the silver mass.

In manufacturing the spark plug, the silver mass is formed by first positioning the firing tip as shown and then casting the silver alloy in situ within the centerbore preferably while spinning the assembly, as in a centrifuge, to create centrifugal force. As alluded to above, the presence of the tellurium in the silver facilitates the elimination of all air voids during the casting operation and results in an exceptionally good surface contact between the silver, the ceramic and the head portion of the platinum firing tip. This intimate surface contact resists the erosive effects of lead salts and the like which otherwise tend to cause a separation of the silver from the ceramic, and hence increases the durability and useful life of the spark plug.

While the invention serves to particular advantage in spark plugs for the reasons outlined above, it will also serve to advantage in other embodiments. For example, it may be used to form an excellent metal-to-ceramic connection. This can be accomplished by applying a thin layer of silver-tellurium alloy to a ceramic part and then subsequently silver brazing or soldering the steel or other metal part to the silver-tellurium alloy surface. Hence it will be understood that while the invention has been described in detail with reference to a particular embodiment thereof, it may take such other forms as are within the scope of any of the claims which follow.

I claim:

1. A metal-to-ceramic connection comprising a ceramic body having in contact with the surface thereof an alloy consisting essentially of silver and a small but effective amount of tellurium to provide improved more intimate contact with said ceramic.

2. Structure as set forth in claim 1 wherein said ceramic body contains at least 85% by weight alumina.

3. A spark plug comprising a ceramic insulator having a centerbore therethrough and a body of silver alloy within said centerbore in intimate contact with the side walls thereof, said silver alloy containing a small but effective amount of tellurium to improve the surface contact between said silver alloy and said insulator.

4. A spark plug comprising a ceramic insulator having a centerbore therethrough, a metal firing tip secured in

one end of said centerbore and a body of silver alloy within said centerbore in contact with the surface of said firing tip and said insulator, said silver alloy consisting essentially of silver and a small but effective amount of tellurium to improve the surface contact between said silver alloy and said insulator and firing tip.

5. A spark plug as set forth in claim 4 wherein said insulator contains at least 85% by weight alumina.

6. A silver alloy for use in a metal-to-ceramic connection of a spark plug body or the like consisting essentially of silver and tellurium, said tellurium being present in an amount up to about 1% by weight.

References Cited in the file of this patent

UNITED STATES PATENTS

2,602,095	Faus	July 1, 1952
2,604,087	Gregory et al.	July 22, 1952
2,760,875	Schwartzwalder et al.	Aug. 28, 1956
2,837,679	Schwartzwalder et al.	June 3, 1958