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SPARK PLUG ELECTRODE SEAL

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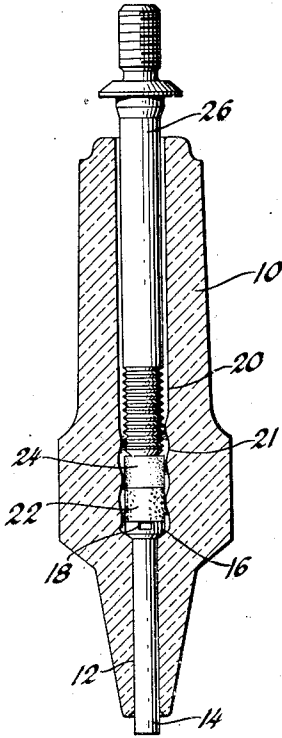


Fig. 1

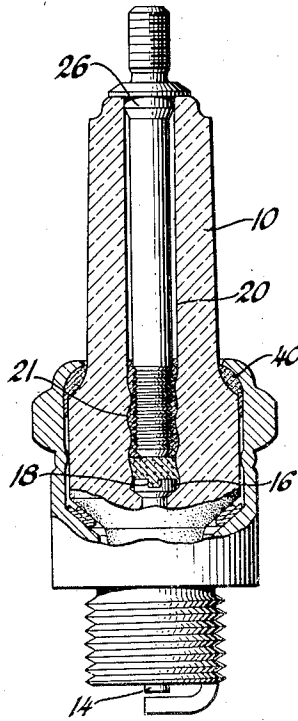


Fig. 2

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SPARK PLUG ELECTRODE SEAL

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8 Claims. (Cl. 123-169)

This is an improvement on the invention disclosed in Patent No. 2,106,578 granted to Schwartzwalder and Kirk on January 25, 1938.

In that patent there is disclosed a gas-tight, electrically conducting seal of ceramic material, preferably glass, securing the center electrodes of spark plugs in the insulators and a method of making same. In some embodiments of the invention the glass seal also constitutes part of the electrode itself forming a conducting path between axially spaced metal parts of the electrode and spark plugs having such construction are also claimed therein.

We have found that improved results may be secured by employing a seal consisting of a fused mixture of ceramic material such as glass and powdered metal. We prefer to employ glass having a relatively low coefficient of expansion such as borosilicate glass, of which Pyrex is a well known example. Various metals may be employed such as copper, cobalt, nickel, iron, molybdenum or tungsten.

We have also found that in the application of the invention to such articles as spark plugs in which one end is subjected to much higher temperatures than the other it is desirable to employ two different compositions of sealing material, one especially adapted to secure and seal the portion of the center electrode toward the firing end of the plug bore and the other to secure and seal the adjacent portion of the electrode in the bore. The first composition may be that described above while the other consists of a glass of greater plasticity, such as lead borosilicate glass, mixed with a metal such as powdered copper. The greater plasticity of the latter material enables it to flow into the space between the upper part of the electrode and the bore so that the electrode is more firmly gripped. Similar plasticity in the case of the other sealing material is not desirable because it is preferable not to have it exposed to the action of the combustion chamber gases as would happen should it seep down around the lower end of the electrode. In the production of the insulator the two sealing materials are united and at the same time form a gas-tight bond or seal with the electrode parts and with the insulator.

In the drawing:

Figure 1 is a vertical section through a spark plug insulator showing the electrode parts and the pellets of sealing material in position prior to sealing.

Figure 2 is a similar view showing the parts in final assembled position and also showing the

insulator sealed in the shell with the same material.

10 indicates a spark plug insulator which may be of any suitable material. We have successfully employed insulators made of porcelain as well as insulators made of various refractory oxides and mixtures of oxides and other ceramic materials sintered at high temperatures. The insulator compositions have varied greatly in coefficient of expansion, ranging from 4.16×10^{-6} in the case of porcelains to 8.0×10^{-6} in the case of sintered alumina.

Insulator 10 is provided with a central bore the lower small diameter portion 12 of which receives the center electrode 14 which may be made of any suitable heat resisting metal or alloy. The electrode 14 is provided with a head 16 which may be slotted as indicated at 18 so that it may interlock better with the glass seal. 20 Intersecting slots may be provided to insure better gripping of the electrode by the sealing material.

It will be noted that the head 18 rests in the bottom of the upper enlarged portion 20 of the insulator bore. The portion 20 may be threaded as indicated at 21 in order to better interlock with the seal but this is not essential. On top of head 18 are placed pellets 22 and 24 of sealing material and on top of them is placed the upper portion 26 of the electrode which may have its exterior threaded as shown. This portion of the electrode is not exposed to combustion chamber gases and may be made of any suitable material such as steel or the like. The internal diameter of the enlarged portion 20 of the bore is preferably greater than the exterior diameter of the terminal portion 26 so that the threads do not engage but serve merely as anchorages for the sealing material.

The parts, assembled as shown in Figure 1, are heated to a temperature sufficient to soften or render plastic the sealing material 22 and 24. Then the electrode portion 26 is forced down into the insulator bore causing the sealing material to be extruded into the position shown in Figure 2. At the temperatures employed the glass and metal sealing compositions unite and also bond to the insulator and the electrode portions, firmly anchoring them in the bore of the insulator, and producing a joint that is gas-tight under all of the temperature and pressure conditions encountered in service.

Pellet 22 consists of a finely pulverized ceramic material mixed with powdered metal or a combination of powdered metals held together by a

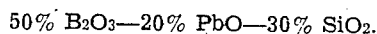
small amount of any suitable binder which is driven off in the sealing operation.

The ceramic material is preferably glass such as borosilicate glass known as Pyrex. We have found it convenient to employ Pyrex cullet crushed to pass 150 mesh screen.

We have had best success employing one or more of the following metals in powdered form: copper, iron, cobalt, nickel, tungsten and molybdenum.

We have used as binders, among other materials, dextrin and Dritex,—a hydrogenated cottonseed oil. The pellets are formed under pressure from an intimate mixture of the finely pulverized ceramic material, metal or metals and binder. In some cases it may prove desirable to dispense with a binder and simply sinter the material into pellet form.

Pellet 24 is of substantially the same composition as pellet 22 except that it contains glass of greater plasticity, for example, lead borosilicate glass having the composition



For this pellet we prefer to employ electrolytic copper, the copper and glass preferably being used in equal proportions by weight.

We have found temperatures on the order of 1500° F. or higher to be sufficient to cause the glass to become plastic, and the heat, together with the pressure used in assembly, causes the sealing material to bond to the insulator and to the electrode parts so that, upon cooling, a strong, gas-tight seal is produced. It will be noted that the sealing material 24, because of its greater plasticity when heated, readily flows into the space between the electrode 26 and the upper part of the insulator bore, thereby firmly gripping this part of the electrode and holding it in place.

We have had success with compositions of sealing material having quite different proportions of ingredients. Thus with electrolytic copper powder excellent seals have been obtained with copper contents varying from 50 to 70% with the balance Pyrex. As the Pyrex content is decreased we have found it preferable to increase the temperature used in assembly in order to increase the plasticity of the glass and reduce the pressure required. Thus with a mixture of 55% electrolytic copper and 45% Pyrex, 1650° F. is necessary, while with a mixture of 70% copper and 30% Pyrex, 1770° F. is necessary. Increasing the metal content increases the heat as well as electrical conductivity.

We have successfully used the following compositions among others: 70% tungsten—30% Pyrex; 55% molybdenum—45% Pyrex; 60% iron—40% Pyrex; 55% cobalt—45% Pyrex; 55% nickel—45% Pyrex.

The described sealing means may also be used to secure spark plug insulators in the shell as indicated at 40 in Figure 2. Obviously it may also be used in the manufacture of many other particles in which ceramic parts are secured to each other or to metal parts. It will be found particularly useful where ceramic material characterized by good heat and electrical conductivity is needed.

While the invention has been illustrated as applied to securing two piece electrodes in insulators it will obviously be equally useful in securing one piece electrodes in place just as in the

case of the invention disclosed in Patent No. 2,106,578.

The term "fused" is used herein to cover any softening up to and including liquefaction and the phrase "fused material" is used to cover any material which has been so treated but has since hardened.

We claim:

1. A spark plug comprising a ceramic insulator and an electrode secured thereto by an intermediate bond consisting of ceramic material having metal interspersed therein.
2. A spark plug comprising a ceramic insulator and an electrode secured thereto by an intermediate bond consisting of glass having metal interspersed therein.
3. A spark plug comprising a ceramic insulator and an electrode secured thereto by an intermediate bond consisting of borosilicate glass with metal interspersed therein.
4. A spark plug comprising a ceramic insulator having a bore therein, an electrode in said bore, and means for sealing the electrode in the bore comprising a fused mixture of glass interspersed with metal bonded to the electrode and to the insulator, the portion of the seal in the end of the bore away from the firing end of the plug consisting of glass of greater plasticity than the remainder so as to better seal the space about the electrode.
5. A spark plug comprising a ceramic insulator having a bore therein, an electrode in said bore having the portion toward the firing end of the plug closely fitting the bore and the upper portion loosely fitting the bore, and means for sealing the electrode in the bore comprising a fused mixture of glass interspersed with metal bonded to the electrode and to the insulator, the portion of the seal in the end of the bore away from the firing end of the plug consisting of glass of greater plasticity than the remainder so as to better seal the space about the electrode.
6. In a spark plug the combination of an insulator having a bore therein comprising a portion of reduced diameter adjacent the firing end of the plug and a portion of larger diameter at the other end of the plug and a shoulder between them, a lower electrode portion snugly fitting the portion of the bore of reduced diameter and having a head resting on said shoulder, an upper electrode portion loosely fitting the enlarged portion of the bore, and a seal consisting of a fused intimate mixture of ceramic material and metal bonded to said electrode portions and to said insulator, forming an electrically conductive path between the electrode portions and sealing the bore against the passage of gas.
7. The combination of an insulator having a passage therethrough and an electrode in the passage comprising spaced metal portions connected by an electrically conducting sealing material consisting of ceramic material having metal interspersed therein, said material being bonded to the insulator and to the metal portions of the electrode and forming a gas-tight seal for said passage.
8. A spark plug comprising a ceramic insulator and an electrode secured thereto by a bond consisting of ceramic material containing pores filled with metal.

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