April 23, 1957 W. B. SMITS 2,790,104

SURFACE DISCHARGE SPARK PLUG AND METHOD FOR MAKING SUCH A SPARK PLUG

Filed Jan. 18, 1952

Fig. 1.

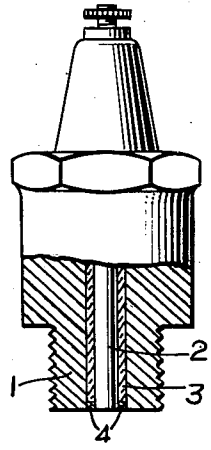
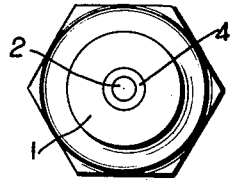


Fig. 2.



INVENTOR

WYTZE BEYE SMITS,

BY Robert B Pearson

ATTORNEY

United States Patent Office 2,790,104 Patented Apr. 23, 1957

2,790,104

SURFACE DISCHARGE SPARK PLUG AND METHOD FOR MAKING SUCH A SPARK PLUG

Wytze Beye Smits, Voorburg, Netherlands, assignor to Smitsvonk N. V. Research Laboratory Comp. (Individual Company as Corporation), Rijswijk (S. H.), Netherlands

Application January 18, 1952, Serial No. 267,077

7 Claims. (Cl. 313—131)

Surface discharge spark plugs consist of two or more electrodes, between which there is an intermediate mass, on the surface of which the ignition spark slides.

This intermediate mass naturally has other material properties than the electrodes, and in particular its coefficient of expansion is usually smaller than that of the electrodes. This may result in an air gap being formed during operation between the electrodes and the intermediate mass, which is highly undesirable for the proper functioning of the spark plug. The Netherlands patent specification No. 62,643 describes how this drawback can be obviated: according to this patent specification an organic substance is introduced separately into the seams between the electrodes and the intermediate mass, which substance absorbs the above mentioned expansion differences, thus preventing the formation of an air gap.

For the generation of a surface discharge spark it is necessary that the intermediate mass should have a given surface conductivity and should also preserve this after continued burning off. The Netherlands patent specification No. 54,723 describes a number of measures to achieve this.

It is thus an object of the present application to disclose a surface discharge spark plug utilizing an intermediate mass which both avoids the need of an organic fillter for resulting air gaps and achieves continued conductivity for the discharge spark. It is further a purpose of the present application to disclose various materials and their characteristics to accomplish the above-mentioned objects.

According to the present invention one proceeds as follows. As basic material for the intermediate mass use is made of asbestos, glass fibres or a similar material. This forms a continuous mass, which is sufficiently elastic to prevent the formation of air gaps as described above. This mass, which is preferably fibrous, is then impregnated with a substance or substances which on the one hand fill up the pores or cause the formation in situ of such a filling substance, and on the other hand subsequently produce the desired surface conductivity. Through the impregnation, the basic material may also be chemically modified until it has obtained more favourable properties.

The impregnating agents be gaseous or liquid. In the latter case they may be either molten substances or colloidal or true solutions.

These and other features of the invention will become apparent from the following specification, taken in conjunction with the accompanying drawings, in which:

Fig. 1 is a side elevational view, partly in section, of a plug manufactured in accordance with the invention; and

Fig. 2 is a bottom plan view of the plug shown in Fig. 1.

In the drawings, the numeral 1 indicates the metallic body of the spark plug which acts as an outer electrode. Numeral 2 indicates the central electrode. A porcelain insulation 3 separates the inner and outer electrodes. The insulation 3 connects the two electrodes mechanically and no intervening air spaces are left between the parts. The insulator has on its end surface between the electrodes, a special layer 4 of the type referred to above, and which will be discussed in greater detail below. As

shown, the layer 4 does not extend beyond the front surfaces of the electrodes.

As indicated above, a fibrous mass sufficiently elastic to prevent the formation of air gaps is pressed into the area 4. This mass then is impregnated with substances to fill up the pores and to give the surface the desired conductivity.

One may, for example, press in a solution of concentrated chromic acid. An intermediate mass impregnated in this manner always has sufficient surface conductivity at the working temperature. The same holds good for solutions of boric acid; an additional advantage is that through an appropriate temperature treatment boron silicates are formed with the asbestos, if the latter has been used as basic material. Solutions of sodium ammonium phosphate also have a similar effect. In fact, the chemical modification of the basic material also comes within the scope of the invention.

However, one may also operate in stages and cause a suitable substance to be formed in the pores. The basic material is, for example, first impregnated with a silver nitrate solution and then with hydrochloric acid. The silver chloride formed enters the pores, and a surface conductivity which is permanent, even after continued burning, is thus ensured.

It was found to be a very good method first to impregnate with a liquid low-molecular organic silicon compound. Treatment of the mass in the heat gives rise to polymerization and to the formation of silicon compounds. In the thermal decomposition during operation, surface conductivity is produced. Instead of using low-molecular organic silicon compounds ready for use, one may also impregnate with a number of basic substances in succession, from which the compounds mentioned are produced in the mass itself.

One may first impregnate the basic material in the manner described above, and then insert it between the electrodes. It is, however, advisable first to construct the spark plug, at least in part, with the basic material between the electrodes, and subsequently to press in the impregnating agent(s) under pressure. There is naturally no sense in pressing in for a longer time or applying a higher pressure than is required to impregnate the pores of that section of the basic material and/or to effect chemical modification of more than the section lying between the active parts of the electrodes. It is obvious that the last-mentioned method i. e. impregnation in the spark plug when already (partially) assembled, is possible in particular when the intermediate mass per se already possessed sufficient elasticity and plasticity to be applied properly. The impregnation then merely serves to produce the surface conductivity. Finally it is also obvious that the basic material—which is preferably fibrous—can first be partially impregnated, outside the spark plug, to ensure good elasticity and plasticity, and can then, after being fitted in the spark plug, be impregnated further to produce good surface conductivity.

A number of examples will be given to explain the invention more in detail, without, however, its being restricted thereto. To this end a spark plug element was filled with fibrous materials, such as asbestos, glass wool or heat-resistant fibrous materials which had already been partially prepared, and the impregnating agent was subsequently pressed in or inserted by the application of a vacuum.

Example I

A saturated solution of chromic acid is pressed in for 1–10 minutes under a pressure of 4 at., the superfluous chromic acid is removed, and the mass is dried for about 30 minutes at 80° C.

Example II

A saturated solution of chromic acid is pressed in for about 5 minutes under a pressure of 4 at., and immediately afterwards a solution of lead nitrate is pressed in for about 15 minutes under a pressure of 6 at.; the mass is dried for about two hours at about 90° C.

Example III

A saturated solution of boric acid is pressed in for 1–30 minutes under a pressure of 0–20 at.; the mass is dried for one hour at 140° C.

Example IV

A solution of sodium acetate is pressed in for 5 minutes under a pressure of 4 at., and the mass is dried for one hour at 140° C.

Example V

A solution of sodium acetate is pressed in for 5 minutes under a pressure of 4 at. When the mass has been dried for one hour at 140° C., it is burned off with a hydrogen flame in such a manner that the surface of the mass has a temperature of 300° C.

Example VI

An alkylphenolformaldehyde condensate is pressed in for 10 minutes at 10 at., and the mass is subsequently baked for one hour at 240° C.

Example VII

A mixture of 50% of dimethyl-silicon trichloride and 50% of methyl-silicon trichloride is pressed in for 10 minutes at 6 at. After this the element is suspended in steam for 15–60 minutes, upon which it is dried for 1–10 hours at 240° C. If desired, steam under a pressure of 4 at. can be used for this.

Example VIII

A heat-resistant varnish on a basis of silicon compounds is introduced into the element by the application of a vacuum for 30 minutes and subsequently by pressure for 30 minutes, and it is then baked for 12 hours at 240° C.

Example IX

First a lead nitrate solution is introduced into the mass for 5 minutes under a pressure of 4 at., and subsequently 10–20% sulphuric acid for 15 minutes under a pressure of 6 at., upon which the mass is dried for one hour at 140° C.

Example X

A lead nitrate solution is introduced into the element for 5 minutes under a pressure of 4 at., and subsequently a solution of 10–20% hydrochloric acid for 15 minutes under a pressure of 10 at., upon which the mass is dried for one hour at 140° C.

The hydrochloric acid may also be introduced into the mass under a pressure of 6 at.

Example XI

A solution of fairly concentrated silver nitrate is introduced for 5 minutes at 4 at., and the mass is subsequently dried for one hour at 140° C.

Example XII

A solution of sodium acetate is pressed in for 5 minutes at 4 at. and subsequently a solution of 10–20% hydrochloric acid for 15 minutes at 6 at., upon which the mass is dried for one hour at 140° C.

Example XIII

A solution of silver nitrate is pressed in for 5 minutes at 4 at. and subsequently a solution of 10–20% hydrochloric acid for 15 minutes at 6 at., upon which the mass is dried for one hour at 140° C.

Example XIV

A mixture of 80–20% of silver nitrate solution and 20–80% of lead nitrate solution is pressed in for 5 minutes at 4 at., and after this, 10–20% hydrochloric acid is pressed in for 15 minutes at 10 at. into the element, upon which the mass is dried for one hour at 140° C.

The fibrous materials, such as asbestos, glass wool, and the like may also be replaced by other insulating material, for example, mica. A few more examples of this are given below.

Example XV

An alkylphenolformaldehyde condensate is pressed in for 10 minutes at 10 at., and the mass is then baked for one hour at 200° C.

Example XVI

An alkylphenolformaldehyde condensate is introduced into the mass, first under vacuum and then by the application of pressure; this double treatment is repeated once more, and the mass is then baked for one hour at 240° C.

Example XVII

The treatment was the same as in Example VII, but in this case, as has been stated, the mass consisted of mica.

Example XVIII

The element is introduced for 45 minutes into a separate space under a vacuum of about 0.1 mm. mercury, and subsequently a heat-resistant varnish on a basis of silicon compounds is admitted into the space, pumping is continued for another 5 minutes, the mass is then brought under a pressure of 2–4 at., which is maintained for one hour, it is dried for one hour at 120° C., and then baked for 10 hours at 250° C.

I claim:

1. A spark plug of the surface discharge type comprising a pair of spaced electrodes, semi-conductive means disposed between said spaced electrodes, said semi-conductive means forming a discharge surface for the passage of a spark between the electrodes, said semi-conductive means comprising an elastic fibrous material, the pores of the fibrous material being filled with a substance which has no detrimental effect on the elasticity and plasticity of the intermediate mass and which maintains the conductivity of the mass.

2. A spark plug according to claim 1 wherein the substance filling the pores is chromic acid.

3. A spark plug according to claim 1 wherein the substance filling the pores is boric acid.

4. A spark plug according to claim 1 wherein the substance filling the pores is sodium acetate.

5. A spark plug according to claim 1 wherein the substances filling the pores are lead nitrate followed by a strong acid of the class comprising sulfuric acid and hydrochloric acid.

6. A spark plug according to claim 1 wherein the substance filling the pores is silver nitrate.

7. A spark plug according to claim 1 wherein the substance filling the pores is an alkyl phenol formaldehyde condensate.

References Cited in the file of this patent

UNITED STATES PATENTS

1,390,014	Brewster	Sept. 6, 1921
1,958,580	Kasarjian	May 15, 1934
2,176,858	Koehler et al.	Oct. 17, 1939
2,333,749	Tognola	Nov. 9, 1943
2,356,053	Hastings et al.	Aug. 15, 1944
2,503,194	Cipriani et al.	Apr. 4, 1950
2,527,489	Smits	Oct. 24, 1950
2,578,754	Smits	Dec. 18, 1951
2,608,186	Hudson	Aug. 26, 1952

FOREIGN PATENTS

536,460	Great Britain	May 15, 1941