SEALING CEMENT FOR SPARK PLUG

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This invention relates to a sealing cement for spark plugs and the like. The cement has particular advantages for securing and sealing the metal centerwire elements into the centerbore of a ceramic insulator. Thus, the invention will be described and explained with reference to this type structure; however, it is to be understood that the invention in its broadest scope is not limited to this particular embodiment.

For use in spark plugs, a cement should be capable of withstanding relatively high temperatures, up to 600°F, or even higher, since the spark plug is subjected to such heat conditions both during assembly and later in service. For example, one of the steps in the assembly of aircraft type spark plugs consists of brazing the shielding barrel to the shell, thereby subjecting the insulator centerbore elements to temperatures in the neighborhood of about 600°F. Similar high temperatures are encountered in service.

An object of the present invention is to provide an improved heat resistant cement composition particularly advantageous for use in spark plugs.

Another object of the invention is an improved, more durable and more reliable spark plug structure.

In the drawing there is shown a representative spark plug structure including a metal shell 2 having concentrically enwrapped therewithin a tubular-shaped ceramic insulator 4. Within the insulator centerbore is the centerwire assembly 6, including as elements, a center electrode spindle 8, a conductive glass seal 10, metal contact 12 which is imbedded in the glass seal, a cartridge element 14, contact spring 18 and a threaded contact cap 20. The threaded contact cap 20 is sealed within the insulator centerbore by means of cement 22 which is the subject of the present invention. Thus, in the particular spark plug shown, which is of the resisor type and designed for aircraft use, the cement is used to anchor and prevent loosening by vibration of the resistor contact cap and also to prevent extraneous materials from entering the resistor well which is formed by the center portion of the insulator centerbore. In other types of spark plugs, the cement may be used to seal and secure other centerwire elements within the centerbore, i.e., the resistor's cartridge, other contact elements, electrode spindle or the like.

In accordance with the invention, the spark plug centerwire element is secured and sealed within the insulator centerbore by a cement which consists of the reaction product of calcium aluminate with an aqueous solution of phosphoric acid, all as described with more particulars in the following detailed description.

As the raw materials for the cement, solid technical grade calcium aluminate, which may contain calcium oxide as an impurity, and reagent grade phosphoric acid containing about 96% by weight H₃PO₄ may be used. It is preferable to further dilute the acid with water before mixing with the calcium aluminate. The following method for manufacturing a preferred cement illustrates the proper mixing procedure: 3 parts by volume reagent grade phosphoric acid are diluted with 4 parts by volume water, thus resulting in a solution of about 48% by weight phosphoric acid. About 395 grams (350 cc.) of this dilute acid are added with rapid stirring and with cooling to 600 grams of solid calcium aluminate. An exothermic reaction results. For small batches, cooling by running tap water is sufficient to adequately control the reaction; however, in the preparation of larger batches it is preferable to cool by the addition of crushed Dry Ice to the reaction mix. At no time during the preparation of the cement should the temperature of the mix be allowed to go appreciably above 70°F. The point at which the exothermic reaction ceases and at which the artificial cooling can be terminated is indicated by a change in color from gray to marshmallow white. After addition of all of the acid and preferably a few minutes of additional stirring, the mix is ready for immediate use as a cement, or for storage.

To store the cement, we prefer to place it in lead tubes which may be kept in a refrigerator at about 40°F until needed. If the storage period is to be longer than two or three hours, it is preferable to place the tube in a deep freeze at about 10°F. Cement stored in this latter manner may be kept for an indefinite period.

Calculated out, the preferred cement, made as outlined above, contains the following proportions by weight: 60% calcium aluminate, 19% phosphoric acid and 21% water. Other proportions may, however, be used sometimes to advantage depending on the precise application to be made of the cement. For example, cement made by using 75% by weight phosphoric acid in the above procedure is excellent but somewhat more difficult to control during the very exothermic reaction during mixing. More concentrated acid than this renders the reaction too difficult to control to be useful in production operations. A relatively dilute acid containing as low as 25% by weight H₃PO₄ may be added to solid calcium aluminate to produce a cement somewhat lower in strength but having the advantage of more easily controlled preparation due to the lesser amounts of heat given off. In practice we have found that all cements made by mixing from 20 to 60 parts by weight aqueous phosphoric acid having a concentration of from 25 to 75% by weight H₃PO₄ with from 30 to 90 parts by weight calcium aluminate are advantageous. On an ingredient-proportioned basis, the cement, prior to drying should preferably contain about 50 to 90 parts by weight calcium aluminate, about 10 to 30 parts by weight phosphoric acid and about 10 to 30 parts by weight water. With lesser amounts of water or greater amounts of acid, the reaction is more difficult to control, while with greater amounts of water and lesser amounts of acid there is a loss in strength in the finished cement. The preferred range is from 57 to 62 parts by weight calcium aluminate, from 15 to 28 parts by weight H₃PO₄ and from 15 to 24 parts by weight water. If desired, inert filler materials such as fibrous mullite, fiberglas, asbestos, alumina or the like may be mixed with the cement to provide additional strength and adjust the consistency to that desired. Thus, the appended claims are intended to comprehend the inclusion in the cement of such inert fillers.

To manufacture spark plugs of the type shown in the accompanying drawing, the cement is used in the following manner. A small portion of the cement is squeezed from the lead storage tube into the threads of the contact cap 20, after which the cap is screwed into
the insulator. Excess cement is washed away from the top of the contact cap with water and any excess water may be removed by blow drying. Then the structure is air dried for about two hours and subsequently baked in an oven at about 300°F. for about two hours to thoroughly dry and set the cement. The most preferable drying and baking temperatures and times will, of course, depend upon the precise composition of the cement, the above procedure being that found most suitable for the preferred embodiment of the cement containing about 60% calcium aluminate, about 19% phosphoric acid and about 21% water before drying.

Tests have shown that the cements herein disclosed are far superior to the sodium silicate type cements conventionally used in the manufacture of spark plugs and in other devices requiring a ceramic-to-metal seal. The chief advantages are increased heat resistance and increased strength. The cement also facilitates processing since, unlike previous cements, it does not tend to boil out during curing and eliminates the necessity for lengthy drying periods.

While the invention has been described with reference to preferred and particular embodiments thereof, it is to be understood that various modifications may be made, all within the full and intended scope of the claims. For example, if desired, cement may be made with a high water content and subsequently partially dried before use to remove part of the water and thereby adjust the viscosity. Alternatively, additional water may be added to the cement in order to reduce viscosity.

We claim:

1. A cement for spark plugs and the like consisting essentially of the reaction product resulting from mixing from 50 to 90 parts by weight in place thereof aluminate with about 20 to 60 parts by weight of an aqueous solution of phosphoric acid, said solution having a concentration of from 25% to 75% by weight phosphoric acid.

2. A cement consisting essentially of the reaction product resulting from mixing together at a temperature of not over 70°F. from 57 to 62 parts by weight calcium aluminate, from 15 to 28 parts by weight phosphoric acid and from 15 to 24 parts by weight water.

3. A cement consisting essentially of the reaction product resulting from mixing about 50 to 90 parts by weight calcium aluminate with about 10 to 30 parts by weight phosphoric acid and sufficient water to provide said cement with a thick viscous texture.

4. A cement consisting essentially of the reaction product resulting from mixing about 60 parts by weight calcium aluminate with about 39.5 parts by weight of an aqueous solution of phosphoric acid, said phosphoric acid solution having a concentration of from 25% to 75% by weight phosphoric acid.

5. A cement for spark plugs and the like consisting essentially of the reaction product resulting from mixing about 60 parts by weight calcium aluminate with about 39.5 parts by weight of an aqueous solution of phosphoric acid, said solution having a concentration of about 48% by weight phosphoric acid.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 2,829,063

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It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 2, line 70, for "tube into" read -- tube onto --; column 3, line 35, strike out "in place thereof" and insert instead -- calcium --.

Signed and sealed this 27th day of May 1958.

(SEAL)
Attest:
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