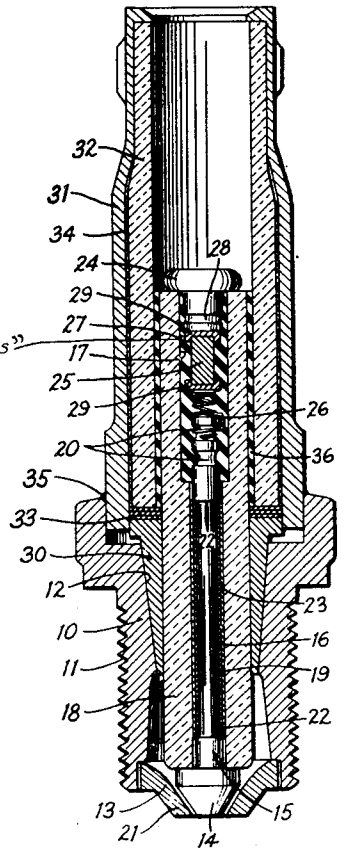
May 23, 1950 H. A. BRINSON 2,508,354

SPARK PLUG OR THE LIKE

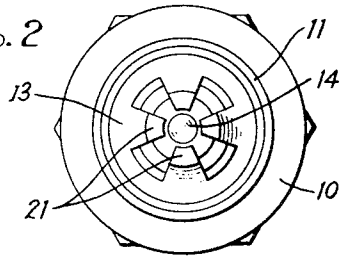
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Fig. 1



"Lead boro-silicate glass"

Fig. 2



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SPARK PLUG OR THE LIKE

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4 Claims. (Cl. 123—169)

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This invention relates to sealing means and more particularly to means for sealing the bore of an insulator in a spark plug of the type used for igniting the combustible charges in the cylinders of internal combustion engines and the like.

One of the objects of the present invention is to provide a novel spark plug structure which is so constructed that leakage of gases between the center electrode and the insulation therefore is wholly or substantially eliminated at substantially all operating temperatures.

Another object of the invention is to provide novel sealing means adapted for use in the bore of an insulator or the like, particularly around a core such as an electrical conductor.

A further object is to provide novel means for sealing the bore of an insulator in the center electrode assembly of a spark plug which will also function as means for securing an electrode or a terminal or both in said bore.

Still another object is to provide novel sealing means for the bore of spark plug insulating means or the like which may be readily and efficiently installed therein and which will withstand high operating temperatures and wide or sudden changes in temperature.

The above and further objects and novel features of the invention will more fully appear from the following detailed description when the same is read in connection with the accompanying drawings. It is to be expressly understood, however, that the drawings are for the purpose of illustration only and are not intended to define the limits of the invention, reference for this latter purpose being had primarily to the appended claims.

In the drawings, wherein like reference characters refer to like parts throughout the several views,

Fig. 1 is a half sectional elevation view of one form of radio shielded spark plug embodying the present invention; and

Fig. 2 is a bottom end view of said spark plug.

The single embodiment of the invention illustrated in the drawings, by way of example, is shown in the form of a radio shielded spark plug of the general type universally used in present-day aircraft engines, but it will be understood that the features of the invention are equally applicable to other types of shielded spark plugs as well as to spark plugs which are not of the shielded type. In the form shown, the spark plug comprises a tubular metallic shell 10 which is externally threaded at 11 for cooperation with a

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threaded opening in an engine cylinder (not shown) in a manner well understood in the art. The bore through shell 10 is provided with a tapered wall portion 12 for a purpose which will more fully appear hereafter. A ground electrode 13 having bendable prongs 21 or of any other suitable known construction is secured in the lower end of shell 10 by means of silver solder or other suitable means.

Ground electrode 13 is in cooperative spark gap relation with the enlarged head portion 14 of a center electrode 15 which constitutes a part of the conducting means mounted in the differential bore 16, 17 of a ceramic or like insulator 18 for conducting high tension electrical current therethrough. In the illustrated embodiment, the head 14 of the center electrode engages the lower end of insulator 18 and the elongated spindle 19 thereof extends through the small or reduced portion 16 of bore 16, 17 and terminates in the larger portion 17 thereof. The upper end of spindle 19 is provided with one or more annular grooves 20, or other suitable deformations, for a purpose to appear hereafter.

Means are preferably provided for mounting center electrode 15 in the bore of insulator 18 in a manner whereby accurate centering of the electrode in the insulator bore 16 and good heat conduction from the electrode to the insulator are insured without subjecting the insulator to the danger of being cracked by expansion of the electrode. As shown, spindle 19 of the center electrode has the diameter thereof slightly reduced for a major portion of its length in bore 16 to form shoulders 22, 22. The diameter of the parts of spindle 19 adjacent the ends of said reduced portion, i. e., the diameter of said shoulders, is slightly less than the diameter of bore 16, the exact clearance of these parts in the bore being determined by the accuracy with which the insulator 18 is constructed. The surface of the central reduced portion of spindle 19 is preferably roughened somewhat, such as by sand blasting, and several layers 23 of thin metallic foil, or the like, such as nickel or silver foil, are wrapped around the same, the number of layers or turns being just sufficient to provide a relatively tight sliding fit in bore 16.

A metallic terminal 24 adapted for suitable connection with an incoming supply cable carrying high voltage electrical current is installed in the upper end of the bore 17 in insulator 18. The adjacent ends of terminal 24 and spindle 19 are spaced from one another and are electrically connected by means of a resistor 25 and a wire 26

of relatively small radial cross-section. Resistor 25 may be eliminated and replaced by other suitable conducting means or by an extension of wire 26. If the resistor is used for the purpose of reducing erosion of the active parts 14 and 21 of the electrodes 13 and 15, the same may have a resistance value of anywhere between approximately 75 ohms to 10,000 ohms. The preferred value of resistor 25 is approximately between 500 ohms and 1,000 ohms. Conductor 26 may be made of any suitable type of wire, such as Nichrome or molybdenum, and preferably has a diameter of only a few thousandths of an inch. One end of said conductor is secured to the upper end of spindle 19 before the latter is inserted in insulator 18 and the free end thereof is preferably coiled to form a spring adapted to yieldably and electrically engage resistor 25 or terminal 24.

Novel means are provided in bore 17 of insulator 18 for sealing said bore against leakage of gases therethrough from the engine cylinder and for securing electrode 15 and terminal 24 in the insulator. The novel sealing material 27 is preferably, though not necessarily, electrically non-conductive and completely fills the annular space around the conducting elements 19, 24, 25 and 26. The sealing material has a high melting point and in its final form is a unitary rigid mass which has interlocking relation with spindle 19 at grooves 20 and with terminal 24 at groove 28 or other similar deformations in said spindle and terminal to thereby hold the parts in assembled relation.

The novel sealing material 27 is formed by fusing a mixture of powdered boro-silicate glass or other similar material having a high melting point, such as "Pyrex" glass, and one or more other powdered substances having lower melting points, such as lead oxide, for example. One suitable mixture which has been found to be practical and useful in forming a seal in bore 17 consists of one part by weight of powdered boro-silicate glass, such as Corning "Pyrex" glass No. 774, and one part by weight of powdered lead oxide. These proportions are not critical, however. It has been found practical, for example, to employ mixtures consisting of from 20 per cent to 60 per cent lead oxide and 80 per cent to 40 per cent glass, the proportions being in terms of weight. One of the considerations, insofar as spark plugs are concerned, is to provide a sealing material which will be plastic-like or pasty only when heated to a temperature above the maximum operating temperature of the spark plug but below any temperature which might be detrimental to the spark plug parts, i. e., to the insulator 18 and the parts installed in the bore thereof. This result may be obtained by using the above mixtures since the melting point of the glass component although not definite is above 1832° F., and that of lead oxide is 1630° F. The glass component will generally begin to soften at approximately 1472° F., but a considerably higher temperature is required to melt it. The mixture of the powdered glass and lead oxide is in effect a eutectic mixture which will soften at approximately 1400° F., a temperature below the softening and melting points of the constituents thereof. Accordingly, when the mixture is heated to temperatures between approximately 1500° F. to 1800° F., the same is reduced to a pasty or plastic-like compound. Although the melting point of the glass component is higher than 1500° F., the glass particles of the mixture soften somewhat at temperatures above approximately 1400° F. in the presence of the lead oxide and a certain amount of chemical reaction is believed to take place

and unite the lead oxide particles with the Pyrex glass particles. The resulting material solidifies to a unitary homogeneous mass on cooling, said mass being a form of lead boro-silicate glass.

In forming the seal for the center electrode assembly of a spark plug it has been found suitable to make the boro-silicate glass component of the mixture by firing 80.5 parts by weight of silicon dioxide with 12.3 parts of sodium tetraborate, 7.8 parts of boric acid, 2.2 parts of aluminum oxide and .6 part of potassium carbonate. When this boro-silicate glass is mixed with equal parts of lead oxide and fused in the manner hereinafter pointed out, the resulting product has a chemical analysis of 40.25 per cent silicon oxide, 6.45 per cent boric oxide, .2 per cent potassium oxide, 1.9 per cent sodium oxide, 1.1 per cent aluminum oxide and 49.9 per cent lead oxide.

When the foil wrapped center electrode with conductor 26 secured thereto has been inserted into insulator 18, a predetermined quantity of the sealing material 27 in finely divided powder form is placed in bore 17 of the insulator. The components of the sealing mixture should be thoroughly and intimately mixed and it is desirable that the same be sufficiently fine to pass a 150 mesh screen. In order to insure good electrical contact between resistor 25 or terminal 24 and conductor 26, the latter should extend to or slightly beyond the upper surface of the powdered mixture at this stage of the assembly. After the powdered sealing material has been settled, such as by vibration of the assembly, tamping, or the like, the assembly is placed in a chuck on a press and resistor 25 is set on the surface of the powder in contact with the coiled end of conductor 26. Terminal 24 may be magnetically or otherwise suitably supported by the plunger of the press and lowered into engagement with the resistor 25. While a longitudinal compression pressure of approximately 50 pounds is being applied to the parts by the press, one or more flames are applied to the outer surface of insulator 18, or other suitable means are employed to raise the temperature of the powdered mixture to the approximate temperatures heretofore mentioned for melting the lead oxide or other equivalent component of the mixture and bringing about the chemical reaction between the lead oxide and the Pyrex glass. The mixture is thus rendered pasty or plastic while resistor 25 and terminal 24 are forced into final position by the pressure applied by the press. When the parts reach the positions illustrated in the drawings, the source of heat is removed and as soon as the parts have cooled somewhat at normal room temperature the center electrode assembly, completed except for minor machining operations, is removed from the press for mounting in shell 10.

The novel center electrode assembly when thus sealed against the leakage of gases is preferably mounted in shell 10 in such a manner as to prevent any leakage of gases between insulator 18 and the shell. This mounting may be effected, for example, by wedging a sleeve 30 of relatively soft metal such as copper between the surface of insulator 18 and tapered wall 12 in shell 10, said sleeve being held within the shell by a shielding barrel assembly consisting of a metallic barrel 31 surrounding a rigid sleeve 32. Barrel 31 may be silver soldered, as at 35, or otherwise suitably secured in shell 10 or the same way may be formed integrally with the shell. Annular shims 33 made of mica, asbestos, or the like, may be interposed between insulating sleeve 32 and metallic sleeve 30 to insure proper longitudinal dimensions

on the spark plug. For the purpose of centering sleeve 32 in barrel 31, the annular space between these parts is preferably substantially filled by one or more layers 34 of sheet asbestos, or the like, wrapped around said insulating sleeve. If desired, the annular space between insulator 18 and insulating space 32 may be filled with a suitable insulating compound 36.

There is thus provided a novel spark plug wherein the bore of the insulator is sealed against the leakage of gases therethrough by means of a novel sealing material which may be readily installed and which will be effective at all temperatures to which the spark plug is subjected during engine operation. Also, the novel sealing means comprehended by the invention will withstand rough handling and may be installed readily and inexpensively in mass production by relatively unskilled workmen. Additionally, the novel sealing material has an affinity for and, hence, adheres well to the insulator 18, spindle 19, and terminal 24.

Although only a single embodiment of the invention is illustrated and described, it is to be expressly understood that the same is not limited thereto. For example, it will now be apparent to those skilled in the art that the invention may be practiced with other than ceramic insulators. Accordingly, the term ceramic, as used in the foregoing specification and the claims, is to be interpreted to include other similar insulators such as aluminum oxide or the like. It will also be apparent to those skilled in the art that the invention is equally as applicable to unshielded spark plugs and other types of shielded spark plugs as it is to the specific type shown. The invention is also applicable to structures other than spark plugs when it is desired to seal a passage in materials having melting points below the assembly temperatures employed. The external contour of insulator 18 may be greatly varied and the manner of mounting the same in the spark plug shell may be materially changed. It will also be apparent that materials other than those specifically mentioned as being suitable for the various elements of the spark plug may be used without departing from the invention. Various changes may also be made in the design and arrangement of the parts illustrated without departing from the spirit and scope of the invention. For a definition of the limits of the invention, reference is had primarily to the appended claims.

What is claimed is:

1. In the center electrode assembly of a spark plug, an insulator having a bore therein, an electrical conductor in said bore, and sealing means filling a portion of said bore around said conductor consisting of a fused mixture of boro-silicate glass and lead oxide.

2. A center electrode assembly for a spark plug comprising an insulator having a bore therein, an electrical conductor in said bore, said conductor being smaller in transverse cross section than the part of the bore in which it is situated, and means sealing the space in said bore around said conductor and consisting essentially of glass and a fused metal oxide of the type useful in glass making having a melting point lower than the melting point of the glass.

3. The method of sealing the bore of a ceramic spark plug insulator that includes the steps of inserting in the bore a powdered mixture of borosilicate glass constituting about 80 to 40% of the mixture, and of lead oxide constituting about 20 to 60% of the mixture, and heating the mixture to a temperature at which the lead oxide is molten and the glass is softened.

4. A spark plug having a conductor sealed within a ceramic insulator by a composition analyzing 40.25% SiO_2, 6.45% B_2O_3, 0.2% K_2O, 1.9% Na_2O, 1.1% Al_2O_3, and 49.9% PbO.

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