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SPARK PLUG ASSEMBLY

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Fig. 1

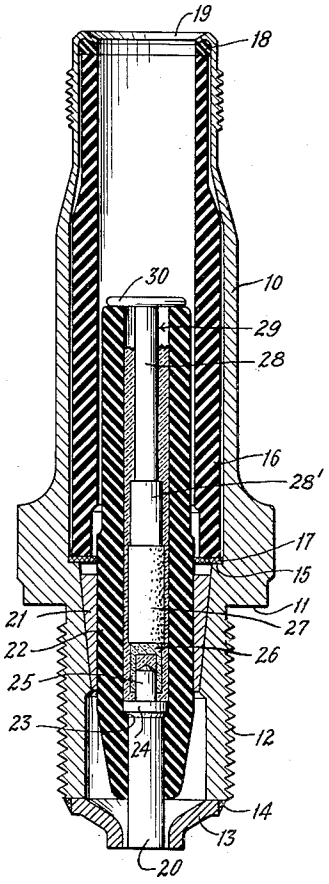


Fig. 2

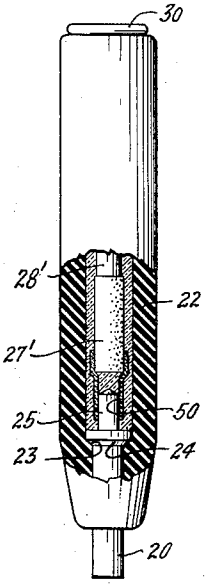
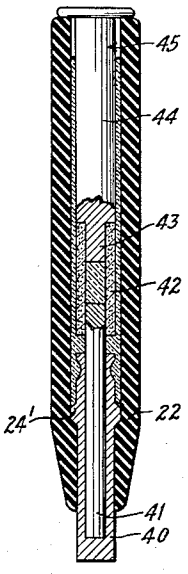


Fig. 3



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SPARK PLUG ASSEMBLY

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12 Claims. (Cl. 123—169)

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This invention relates to ignition apparatus and more particularly to spark plugs and parts therefor for use in the ignition system of an internal combustion engine or the like.

One of the objects of the invention is to provide a novelly constructed center electrode assembly for a spark plug.

Another object of the invention is to provide an electrical assembly having a tubular bore that is sealed against the leakage of gases therethrough.

Another object of the invention is to provide novelly fabricated conducting means for connecting the center electrode and high tension terminal of the center electrode assembly.

A further object is to provide a novel process for constructing spark plugs.

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 as a definition of 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 vertical sectional view through a spark plug constructed in accordance with the principles of this invention;

Fig. 2 is an elevational view partly in section of a center assembly of a spark plug having novel constructional features; and

Fig. 3 is a vertical sectional view through a spark plug center assembly of further modified construction.

In the preferred construction shown in Fig. 1, the numeral 10 refers to the outer casing of a spark plug having a shoulder 11 adapted to seat upon the top of an engine, a screw threaded portion 12 adapted to fit a screw threaded opening in a cylinder block, and a ground electrode 13 that is connected to the shell 10 by means of welding 14 or the like. The interior of the spark plug shell or casing 10 is provided with a shoulder 15 upon which rests a tubular insulator 16, between which an asbestos washer 17 may be employed or not, according to the needs of a particular service. A resilient dielectric washer 18 of asbestos, Neoprene, or the like, rests upon the upper end of the insulator 16, and the upper edge 19 of the shell 10 is peened over upon the washer to maintain the assembly.

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The center electrode 20 of the spark plug may conveniently be mounted in its assembly before the assembly is mounted in the casing of the plug. The assembly is emplaced in the casing by means of a conical sleeve 21, before the insulator 16 is mounted.

In certain types of spark plugs, it is advantageous to employ a resistor in the core, despite the disadvantages resulting from a core composed of several pieces. In order to obtain satisfactory contact between such separate elements, it has usually been deemed necessary to employ a spring connection somewhere in the assembly. By means of this invention, I have overcome the need for a spring and have assembled the separated parts of a core in firm electrical contact without the use of a spring.

The insulator 22 is interiorly provided with a shoulder 23. The electrode 20 has a cooperating shoulder 24 and a snug fit within the lower end of the insulator. The electrode is thrust through the insulator from the top until the shoulder 24 engages the shoulder 23, both of which may conveniently be conical. The end of the electrode 20 is provided with a stud 25 of less diameter than the shoulder 24. The stud is shown in the drawings to be cylindrical, but it could be conical with equal or improved results. Carbon cap 26 fits snugly over the stud 25. The fit is sufficiently close to provide broad contact areas between the stud and the sleeve or side wall of the cap, thus furnishing an excellent electrical connection. A resistor 27 is emplaced above the carbon cap, and in electrical contact therewith. The spindle 28 of a terminal 29 makes contact with the resistor, and a head 30 engages the upper end of the insulator.

In making the center electrode assembly, the center electrode is put in position against the shoulder 23, and the components of a glassy insulation, finely divided, are poured into the bore of the insulator above the shoulder. The insulator is then heated by the application of direct flame, for instance by the play of flame from three gas burners spaced 120° about the periphery thereof, until a temperature of 1200 to 2000° F. is reached, in which range the finely divided components of the glassy insulation become molten. While the said components are in this molten state, the cap 26, resistor 27, and terminal 29 are forced through and into firm engagement with each other and with the stud 25. The sleeve of the cap 26 may fit closely over the stud 25, but with enough clearance to permit escape of melted glass from inside the cap. If desired, a closer fit can be employed

and a small vent in the side of the cap may be made to release confined molten material. By this means, a considerable pressure may be required to force the head 30 of the terminal 29 into engagement with the insulator 22. This pressure is found at each contact in the core. When satisfactory engagement has been made, the heat is removed from the insulator and the molten material inside is allowed to cool, preferably while maintaining the pressure. As the material cools, it solidifies and holds the several sections of the core in firm electrical contact with each other.

The diameter of the resistor, the cap, and the enlarged portion 28' of spindle 28 are such that they form abutments about which the glass solidifies to hold the spindle, the resistor, and the cap in firm conductive contact.

The electrode 20 may be of Nichrome or of any other suitable conductive material depending upon the use to which the plug is to be subjected and if desired, the stud 25 may be of silver or similar material and may extend downwardly into the body of electrode 20 in the manner illustrated at 41 in Fig. 3. The precise material employed will depend to some extent upon the temperature reached during use. If the temperature at the lower end of the plug becomes so great that silver would soften or melt, it may be advisable to employ a material of higher melting point.

The carbon sleeve is satisfactory because carbon is a good conductor and has other advantageous properties for use as a cap. However, other materials could be employed provided they withstand the temperature required to melt the glassy insulation and have the requisite conductivity. Carbon remains hard and set at the temperatures attained and is otherwise satisfactory.

The resistor may be of various sizes and constructions or it may be eliminated when its use is undesirable.

The glassy insulation is made by melting lead oxide and boro-silicate glass, preferably in situ, but it may be melted and poured into the tube if desired. If the latter method is used, the tube should be maintained at such temperature that the glass melt will not solidify in contact with the tube before the core is emplaced. The temperature of the lower end of the spark plug in use varies considerably according to surrounding circumstances, but on some occasions rises so high that there is a tendency for the glassy insulation to become fluid at the lower end. This is generally undesirable and is overcome by the following novel conception. The melting point of the lead-oxide-boro-silicate glass can be varied by varying the relative percentages of lead oxide or boro-silicate in the whole. By including a larger percentage of the higher melting constituent in the mixture at the lower end of the insulator, the melting point of the glassy insulation at the lower end of the tubular insulator can be raised. Thus the completed glassy insulation will have a higher melting point in the area exposed to the greatest heat and lower melting point in other areas. This is a considerable advantage both in the operation of the spark plug and in the making of the spark plug.

The novel glassy sealing material 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 the bore 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 22 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 1000° C., and that of lead oxide is 888° C. The glass component will generally begin to soften at approximately 800° C., 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., it 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 acid, .2 per cent potassium oxide, 1.9 per cent sodium oxide, 1.1 per cent aluminum oxide and 49.9 per cent lead oxide.

In Fig. 2 is shown a modification of the invention in which a tubular metallic sleeve 50 is employed to join the respective parts of the core. This sleeve can be mounted upon the stud in advance of the emplacement of the glassy insulation if desired. The resistances 27' and 27 may be of carborundum, for example, and of 50 to 2,000 ohms, for example. Frequently, a resistance of 1,000 ohms is employed. The structures of Fig. 2 and Fig. 1 are otherwise alike.

The modification shown in Fig. 3 has a number of elements of novelty. The electrode has a nickel alloy surface 40 and a silver core 41. It is made in a novel manner by annealing the core until it is soft, emplacing it in the nickel alloy, placing a sleeve around the upper end of the core and against the top of the nickel alloy tip, insert-

ing a plunger in the sleeve, and forcing the silver into firm and permanent contact with the nickel alloy tip. This assembly may then be mounted in the insulator 22 and the remaining elements may be assembled as hereinabove described in connection with Figs. 1 and 2. However, a further modification may be made. A sleeve 42 of conducting material such as carbon or a suitable metal engages the projecting end of the silver core 41 and a stud 43 on the spindle 44 of the terminal 45. The same principles of assembly may be employed with respect to the glassy insulation that have hereinabove been disclosed. Sleeve 42 may be a resistor.

In all three modifications it is deemed to be undesirable to allow the glassy insulation to pass the shoulder 24, or 24' and enter between the insulator and the center electrode.

An advantage of this invention is that a spark plug is assembled without spring connections to the center electrode.

Another advantage is in the permanent assembly of the separate parts of a spark plug core by means of a glassy insulation that may vary in composition at the points of exposure to greatest heat.

Another advantage of the invention is the use of a fluid material under pressure to maintain the parts of an assembly in firm contact.

Another advantage of the invention is in the sleeve principle of connection in combination with a setting material of glassy insulation type.

Yet another advantage is in the novel center electrode described and shown in Fig. 3.

Although only three embodiments of the invention have been illustrated and described in the accompanying drawings and specification, it is to be expressly understood that the invention is not limited to said embodiments. Various changes may be made therein, particularly in the design and arrangement of the parts illustrated and in the two materials used, without departing from the spirit and scope of the invention, as will now be apparent to those skilled in the art. For example, a core such as 41 (Fig. 3) may be employed in all three embodiments of the invention and various other features of the different embodiments are interchangeable. The elements 26, 42 and 50 of the illustrated embodiments may be formed of a highly conductive carbonaceous material, metal or an electrically resistant material. For a definition of the limits of the invention, reference is had primarily to the appended claims.

What is claimed is:

1. A spark plug assembly comprising a tubular insulator having a bore providing an internal shoulder, a snug fitting center electrode having a cooperating shoulder and an internally projecting stud, a carbon cap upon said stud having an internal content of glassy dielectric, a resistor engaged with said cap, a terminal having a spindle engaging said resistor and a head engaging the insulator, and a glassy dielectric sealing the internal spaces of the assembly and holding the parts together.

2. A spark plug assembly comprising a tubular insulator having an internal shoulder, a center electrode having a cooperating shoulder and an internally projecting stud, a non-metallic electrically conductive cap upon said stud, a resistor engaged with said cap, a terminal having a spindle engaging said resistor and a head engaging the insulator, and a glassy dielectric holding the parts together.

3. A spark plug assembly comprising a tubular insulator having an internal shoulder, a center

electrode having a cooperating shoulder, a hollow carbon cap upon said electrode, a resistor engaged with said cap, a terminal having a spindle engaging said resistor and a head engaging the insulator, and a glassy dielectric sealing the internal spaces of the assembly.

4. A spark plug assembly comprising a tubular insulator, a center electrode closing one end thereof, a non-metallic electrically conductive cap in sleeved engagement with said electrode, a resistor engaged with said cap, a terminal having a spindle engaging said resistor and a head engaging the insulator, and a heat resistant dielectric holding the parts together.

5. A spark plug assembly comprising a tubular insulator, an electrode closing one end thereof, a carbon cap in sleeved engagement with said electrode, a resistor engaged with said cap, a spindle having an intermediate shoulder and an enlarged end engaging said resistor, and a heat resistant dielectric sealing the internal spaces of the assembly and holding said parts together.

6. A spark plug assembly comprising a tubular insulator, an electrode closing one end thereof by shoulder to shoulder contact within the insulator, a terminal closing the other end thereof, conducting means in sleeved engagement with said electrode and connecting terminal, and a heat resistant dielectric sealing the internal spaces of the assembly.

7. A spark plug assembly comprising a tubular insulator, an electrode closing one end thereof by shoulder to shoulder contact within the insulator, a terminal mounted at the other end thereof, sleeve means electrically connecting terminal and electrode, said means being wholly out of contact with said insulator, and a heat resistant dielectric sealing the internal spaces of the assembly.

8. A spark plug having a center electrode assembly comprising a tubular insulator, a terminal and an electrode operatively connected by a non-metallic electrically conductive sleeve in said insulator, and dielectric means spacing said sleeve from said insulator.

9. A spark plug having a center electrode assembly comprising a tubular insulator, a terminal and an electrode operatively connected by a carbon sleeve in said insulator, and by dielectric means holding them in assembled relation and spacing the sleeve from said insulator.

10. A spark plug having a center electrode assembly comprising a tubular insulator and a terminal and an electrode operatively connected by a conductive sleeve in said insulator, said sleeve being wholly out of contact with the insulator.

11. A spark plug assembly comprising a tubular insulator, an electrode closing one end thereof, said electrode having a recess filled with a high heat conducting metal, such as silver, a terminal in the other end of said insulator, and means for electrically connecting said electrode and terminal including a sleeve-like conductor having telescopic relation with an extended portion of said metal.

12. A spark plug assembly comprising a tubular insulator having an internal shoulder, an electrode having a portion seated on said shoulder, said electrode having a recess filled with a high heat conducting metal which projects from the inner end thereof, a terminal in one end of said insulator, means for electrically connecting said electrode and terminal including a sleeve-like conductor having telescopic relation with the projecting portion of said metal, and a solidified

mass in said insulator for sealing the internal spaces of the assembly.

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