

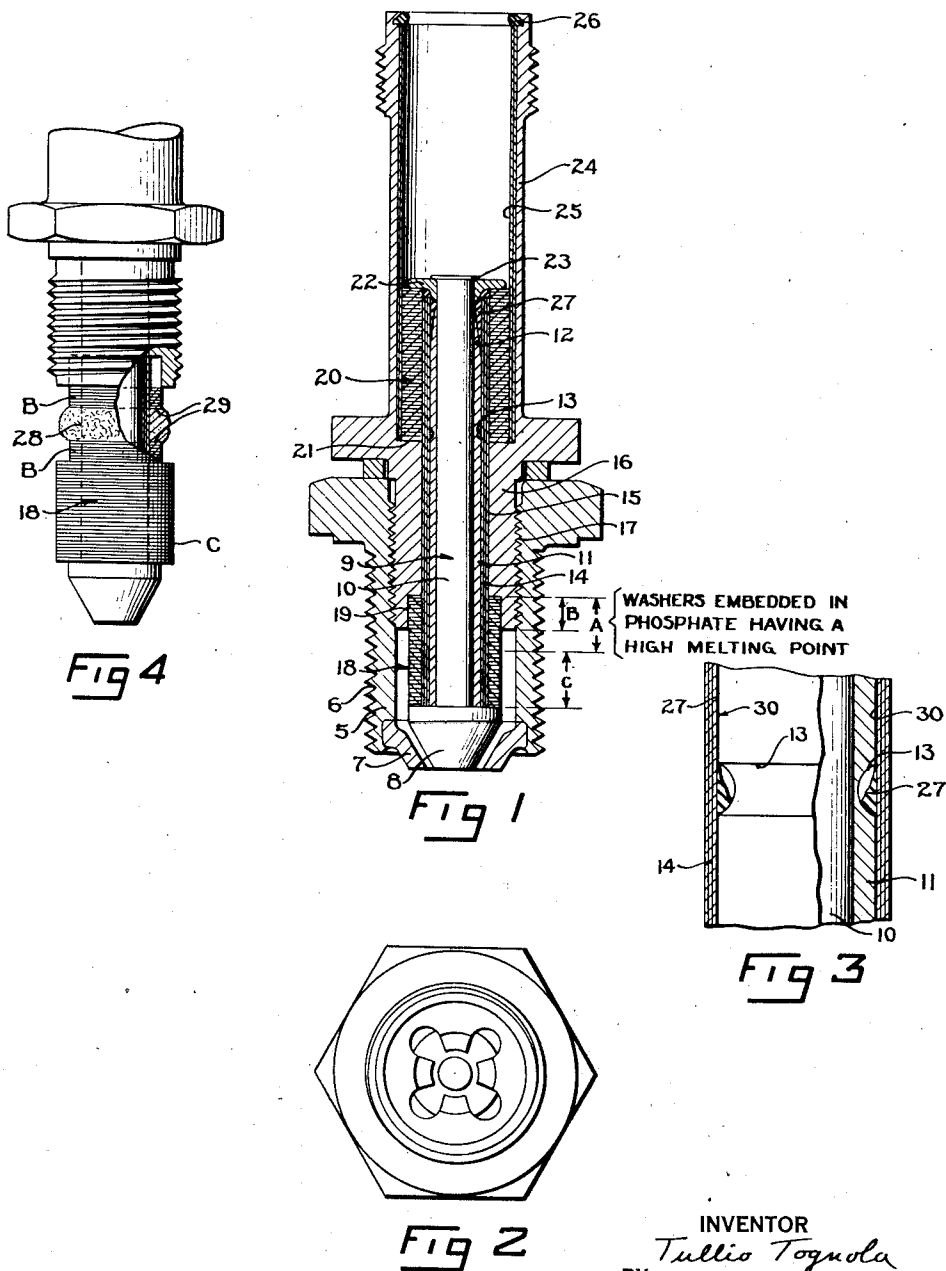
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SPARK PLUG AND METHOD OF MAKING THE SAME

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SPARK PLUG AND METHOD OF MAKING
THE SAME

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This invention relates to ignition apparatus, and more particularly to spark plugs for use in internal combustion engines or the like and to the art of making said spark plugs.

One of the objects of the present invention is to provide a novel constructed spark plug for use in the ignition system of an internal combustion engine.

Another object of the invention is to provide a spark plug embodying novel sealing means for preventing the leakage of gases between the various parts thereof.

A further and important object of the invention is to provide a novel method of constructing a spark plug of the above character.

A still further object is to provide a novel spark plug wherein the deleterious effects of high temperatures and gas leakage are reduced to a minimum.

Another object is to provide a spark plug incorporating a novel sealing substance that will not carbonize or deteriorate at the high temperatures to which the plug is subjected during use.

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 drawing. It is to be expressly understood, however, that the drawing is for the purpose of illustration only and is 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 drawing, 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 made in accordance with the present invention;

Fig. 2 is a bottom view of the spark plug of Fig. 1;

Fig. 3 is a detail sectional view, with parts broken away and on an enlarged scale, showing a central portion of the spark plug of Fig. 1; and,

Fig. 4 is a detail view, with parts broken away, showing loosely assembled parts of the center electrode or core assembly during one phase of the fabrication of the spark plug of Fig. 1.

The single embodiment of the invention illustrated in the drawing, by way of example, comprises a tubular body 5 which is externally threaded at 6 for cooperation with a threaded opening in an engine cylinder (not shown). Mounted in the lower end of body 5 is a ground electrode

7, which may be of any suitable type known in the art, and is secured in place in any well-known manner, such as by silver solder.

In spark gap relation with ground electrode 7 for cooperation therewith in a manner well understood in the art is the head portion 8 of a center electrode 9. The elongated stem 10 of said center electrode is surrounded by a metallic sleeve 11 of copper or like material, said stem preferably having a drive fit therein. For a novel purpose to hereinafter appear, the upper end of sleeve or tube 11 is externally reduced as by tapering at 12, and an annular external groove 13 is provided therein at a short distance below the end of the taper.

Surrounding tube 11 is a sleeve 14 of high heat resisting electrical insulation, such as mica. As shown, said insulating sleeve consists of a plurality of layers of sheet mica and has a close sliding fit in the central bore 15 of a nut or body member 16 which has threaded engagement at 17 with body member 5. Head portion 8 of the center electrode may be held in spaced relation to nut 16 by suitable insulating means, such as a stack of mica washers 18, some of which are located in a recessed portion or enlarged bore 19 in the lower face of nut 16.

Above nut 16, insulating sleeve 14 is surrounded by additional insulating means, such as a stack of mica washers 20, said washers extending from a shoulder 21 to a plane adjacent the upper end of stem 10. The entire center electrode or core assembly is clamped together to form a unitary structure with washers 18 and 20 under compression by means of a metallic washer 22. The latter surrounds the upper end of stem 10 in engagement with the upper surface of stack 20 and is secured in position by rolling or riveting the upper recessed end of said stem outwardly into engagement with the outer face thereof as indicated at 23.

If a radio-shielded spark plug is desired, a shielding barrel 24 may be secured to or formed integrally with nut 16 and extend upwardly therefrom beyond the outer end of center electrode 9 for connection in any well-known manner to the shielding for a high tension supply cable. Barrel 24 is preferably lined with an insulating sleeve 25 which may be of sheet mica and has a close sliding fit with the outer surface of mica stack 20. Liner 25 is protected at its upper end by a metallic ring 26 secured in the upper end of barrel 24. Ring 26 may have a press fit in barrel 24 or may be secured in position by silver soldering, by rolling the upper edge of barrel 24

into contact therewith, or by any other suitable means. It will be understood, of course, that the invention is not limited to a radio-shielded plug but may be incorporated in non-shielded plugs as well.

Novel means are provided for filling the minute spaces between various parts of the central electrode assembly to thereby minimize gas leakage through the spark plug from the engine cylinder and, hence, substantially eliminate flashovers between the center electrode and core nut 16. At the lower or inner end of the spark plug, which portion is subjected to the highest temperatures during use, the minute spaces which necessarily occur between washers A in the upper portion of stack 18 and between said washers, sleeve 14 and nut 16 are filled with a novel sealing material in accordance with a novel method to be hereinafter described. Said material consists of a metaphosphate, such as may be derived by dehydrating sodium phosphate, calcium phosphate or barium phosphate. Because of the small scale employed in the drawing, this filling material cannot with any degree of accuracy be indicated in Fig. 1, but attention is invited thereto by a suitable legend on the drawing. Filling or sealing materials of the above character have melting points ranging approximately from 1140° F. to 1780° F. and accordingly adequately resist the high temperatures to which the lower portion of the spark plug is subjected during use in present day engines. Additionally, said filling materials form solids upon cooling from melted form and constitute an excellent seal against gas leakage and the accumulation, in the spaces between the mica insulation, of gases which may become ionized and form a conductive path for electrical current between electrode head 8 and nut 16. By thus preventing flashovers and gas leakage, any carbonization of the mica insulation which results in an electrically conductive path is substantially prevented. Since the dehydrated or metaphosphate filler may at a temperature near its fusing point become a conductor of electricity, although an extremely poor one, only the upper portion A of the washer stack 18 is treated therewith. In addition to the above-mentioned filling materials, potassium metaphosphate, strontium metaphosphate, and possibly others might also be used.

Although the washers 20 may also be treated with the above materials, particularly when the plug is not of the shielded type, the upper portion of the center electrode assembly is not subject to as high temperatures as the lower portion thereof which has direct contact with the gases of combustion in the engine cylinder. Gas leakage and flashovers may accordingly be prevented through this portion of the plug by means of a filler 27, the heat resisting abilities of which may be somewhat less than the phosphate filler above described. Filling material 27 is preferably placed in the plug in a manner to be hereinafter described so that it will fill substantially all the spaces between parts 11, 14, 20 and 25 above shoulder 21, thereby preventing leakage of gases from the engine cylinder and eliminating air pockets in the insulating material which might enhance the possibility of flashovers. One material which has been found suitable for use as filler 27 is made from cashew nut-shell oil in accordance with the teachings of U. S. patents issued to Mortimer T. Harvey. One preferred material of this character is obtained by taking the undistillable part of raw cashew nut-shell

oil, such as the residue obtained in following the teachings of U. S. Patent No. 2,157,126, and polymerizing the same under acid conditions, such as with sulphuric acid, in the manner disclosed in U. S. Patent No. 2,128,247. A small percentage of xylol or other suitable solvent or thinning agent may be added to the resin thus obtained to produce the desired viscosity. The resin or compound may be placed in the plug in liquid form, a viscosity comparable to that of 250 S. A. E. oil being suitable. If linseed oil is used as a thinner, the desired viscosity and properties may be obtained by adding about 45% to 55% linseed oil to the resin. This liquid compound may be set by proper baking after it is incorporated in the spark plug without appreciable shrinkage to form a relatively hard, yet pliable and yieldable substance, which is an excellent insulator and capable of resisting the high temperatures to which the upper portion of the spark plug is subjected.

In the novel method of fabricating the above-described spark plug, copper tube 11 is first pressed onto spindle or stem 10, a good press fit being required in order to prevent gas leakage. Said tube is then provided with taper 12 and groove 13. Sufficient sheet mica is then wrapped tightly around tube 11 to provide a close sliding fit through the central bore of nut 16. If desired, a small amount of filler 27 in a viscous liquid form may be placed between the layers of sleeve 14 adjacent the upper end thereof. Mica washers 18 are then placed on sleeve 11, the washers in portion B of the stack being of the exact diameter and thickness for filling recess 19, and the washers in portion C of the stack having a somewhat greater diameter, as indicated in Fig. 4, to permit subsequent machining thereof.

The above sub-assembly is inserted part way into nut 16, as seen in Fig. 4, and filling material 28 in the form of powdered sodium metaphosphate, for example, mixed with sufficient monobasic sodium phosphate in liquid form to make a thick paste, is placed in a groove 29 formed by dividing and separating recess washers B. Filling compound 28 is then melted by applying a flame directly thereto, preferably while the electrode sub-assembly is rotated in a suitable fixture at approximately 90 R. P. M. The melted filling material flows along mica sleeve 14 and between the mica washers 18 adjacent groove 29. The time required for the melting operation varies with the heating means employed and the particular type of metaphosphate used as the filling material. During the melting operation, when sodium phosphate is employed, it is desirable that the washers B be heated to a temperature of approximately 1300° F. and that the lower portion of nut 16 reach a temperature of around 600° F. In some instances phosphoric acid may be used as one of the paste making ingredients.

While the sub-assembly of the spark plug is still under the flame, or immediately after it is removed, pressure is applied to force the spindle assembly, consisting of the central electrode and sleeves 11 and 14, into nut 16 and to compress washers 18, a total pressure of about 500 lbs. being adequate in most cases. Upon the application of pressure, the excess filling compound 28 is squeezed out around the end of nut 16. Before the pressure is released, the parts should be clamped in compressed position by some suitable clamping means. When the heated sub-assembly has cooled to about 150° F., it may be

removed from the clamping fixture and then baked in an oven at about 250° F. for several hours in order to dry the same.

After the assembly is removed from the oven, the mica washers 20 of the upper stack are coated with cashew nut-shell oil compound 27 in liquid form and inserted in barrel 24. Washer 22 with the lower face thereof smeared with compound 27 is then placed in position and pressure is applied to compress stack 20. During the application of pressure, the upper end of stem 10 is pressed or riveted outwardly to secure the entire electrode assembly in compressed assembled relation. During the riveting of the upper end of stem 10, head 8 of the center electrode should rest on a solid support in order to insure against breaking of the seal provided by filling material 28 and to insure proper compression of washer stacks 18 and 20.

During the compression of washers 20, excess compound applied to the same is squeezed out, thereby completely filling the annular spaces between said washers and sleeves 14 and 25. The filling material on the lower face of washer 22 is sufficient to slightly more than fill the space created by taper 12 on tube 11, and said tapered portion is adapted to direct material 27, when pressure is applied, to the minute annular space 30 between sleeve 14 and tube 11, said space being magnified in Fig. 3 for purposes of illustration. In order to prevent filling material 27 from being pressed down into the hotter portion of the plug where it might be deteriorated by heat and, hence, become electrically conductive, groove 13 is provided in the outer surface of tube 11. This groove serves as a sort of reservoir in which excess compound may accumulate. Some of the filling compound 27 may also find its way from the upper edge of sleeve 14 to any spaces which occur between the various layers thereof. The completed sub-assembly is now placed in an oven and baked for several days from temperatures ranging from 200° F. to 500° F. to cause the filler 27 to properly set and become a solid. Thereafter, the central electrode assembly is machined to size and inserted in body 5.

There is thus provided a novel spark plug which has novel sealing means incorporated therein for preventing gas leakage and undesired flashovers or arcing, thereby enhancing the life and efficiency of the plug. Said sealing means comprises materials which have not been heretofore used in the manufacture of spark plugs and which have extremely good heat resisting qualities. A novel method for fabricating said spark plug and particularly for incorporating said sealing means therein is also provided. The spark plug thus provided has better physical and electrical characteristics than any similar plugs heretofore known, the sealing means being relatively unaffected by expansion and contraction of the parts of the plug during use thereof in an engine.

Although only a single embodiment of the invention has been illustrated and described in detail, it is to be expressly understood that the invention is not limited thereto. For example, the novel sealing means may be incorporated in spark plugs of specifically different construction and the novel method may also be practiced in connection with spark plugs which differ in some respects from the one illustrated. Various other changes may also be made in the design and arrangement of parts illustrated as well as in the specific materials mentioned by way of example without departing from the spirit and scope of the

invention as the same will now be understood by those skilled in the art. For a definition of the limits of the invention, reference is had primarily to the appended claims.

What is claimed is:

1. In a spark plug, a center electrode, electrical insulation surrounding said electrode, a metallic body member surrounding said insulation, and a quantity of dehydrated mono-basic phosphate filling spaces between said insulation and said member.

2. In a spark plug, a metallic body member having a bore therein, an electrode extending into said bore, electrical insulating means interposed between said member and said electrode, and sealing means including a quantity of solidified metaphosphate associated with said insulating means.

3. In a spark plug, a metallic body member, a center electrode in said member, electrical insulating means interposed between said member and electrode, said insulating means including a stack of washers, at least a portion of said stack of washers being embedded in a quantity of solidified metaphosphate.

4. In a spark plug, a metallic body member, a center electrode in said member, electrical insulating means interposed between said member and electrode, said insulating means including a stack of washers, and means including a solidified metaphosphate for unifying at least a portion of said stack of washers.

5. In a spark plug, a metallic body member having a differential bore therein, a center electrode extending into said bore, electrical insulating means interposed between said member and electrode, said insulating means including a stack of washers, some of which washers are positioned in said bore, and a solidified, dehydrated mono-basic phosphate filling the space between said member and the washers in said bore.

6. A spark plug comprising a plurality of assembled parts including a metallic body member having a bore therethrough, an electrode extending into said bore and electrical insulation interposed between said member and electrode, and sealing means consisting of a quantity of solidified metaphosphate filling spaces between said insulating means and another of said parts.

7. A spark plug comprising a plurality of assembled parts including a metallic body member having a bore therethrough, a center electrode extending into said bore and electrical insulation interposed between said member and electrode, and sealing means consisting of sodium metaphosphate filling spaces between said insulating means and another of said parts.

8. A spark plug comprising a plurality of assembled parts including a metallic body member having a bore therethrough, a center electrode extending into said bore and electrical insulation interposed between said member and electrode, and sealing means consisting of calcium metaphosphate filling spaces between said insulating means and another of said parts.

9. A spark plug comprising a plurality of assembled parts including a metallic body member having a bore therethrough, a center electrode extending into said bore and electrical insulation interposed between said member and electrode, and sealing means consisting of barium metaphosphate filling spaces between said insulating means and another of said parts.

10. In a spark plug, the combination of a tubular body member, an elongated electrode disposed in the bore of said member, means for in-

insulating said electrode from said member, a solidified cashew nut-shell oil product filling minute spaces in and between said insulating means and said electrode around the upper portion of the latter, and a solidified metaphosphate filling spaces between an intermediate portion of said insulating means and said body member.

11. In a spark plug, a center electrode assembly comprising a center electrode having an elongated stem, a metallic tube closely surrounding said stem, the outer surface of said tube at the upper end thereof being tapered, an electrical insulating sleeve surrounding said tube, whereby an annular tapered space is formed between said tube and sleeve, and a solidified electrical insulating material filling the space between said tube and sleeve from the upper ends thereof to a plane below the tapered portion of said tube.

12. In a spark plug, a center electrode assembly comprising a center electrode having a reduced tapered portion adjacent the upper end thereof, a cylindrical electrical insulating sleeve surrounding said electrode, whereby an annular tapered space is formed between said electrode and sleeve, and a solidified insulating material filling the space between said electrode and sleeve from the upper end of said sleeve to a plane below the tapered portion of said electrode.

13. In a spark plug, a center electrode assembly comprising a center electrode having a reduced tapered portion adjacent the upper end thereof and an annular external groove below said tapered portion, a cylindrical electrical insulating sleeve surrounding said electrode, and a filler of electrical insulating material filling the space between said sleeve and electrode above said groove.

14. The method of making a spark plug which comprises the steps of loosely assembling a body member, a center electrode, and means for electrically insulating said electrode from said body member, applying a quantity of substantially dehydrated monobasic phosphate having a consistency of paste to the aforesaid assembled parts, subjecting said phosphate to the action of a flame to melt the same, and pressing said assembled parts together while said phosphate is in melted condition.

15. The method of making a spark plug which comprises the steps of loosely assembling a body member, an electrode, and means for electrically insulating said electrode from said member, placing a mixture of metaphosphate and monobasic phosphate on the aforesaid assembled parts, applying heat locally to melt said mixture and reduce the same to metaphosphate form, pressing said assembled parts together while said metaphosphate is in a melted condition, maintaining said parts in compressed condition while permitting said metaphosphate to solidify, and baking said assembled parts to dry said metaphosphate.

16. The method of making a spark plug which comprises the steps of assembling a body member, a center electrode, and means for electrically insulating said electrode from said body member including a stack of insulating washers interposed loosely between said body member and an enlarged portion of said electrode, applying a quantity of metaphosphate intermediate the ends of said stack, melting said metaphosphate by applying a flame directly thereto, compressing said stack while said metaphosphate is in melted condition, and maintaining the compression pressure while said metaphosphate solidifies.

17. In a spark plug, a center electrode, a body member, and electrical insulation interposed between said electrode and said member, said insulation including a quantity of phosphate in its meta form.

18. The method of making a spark plug which comprises the steps of loosely assembling a body member, an electrode and means for electrically insulating said electrode from said member, melting a quantity of phosphate in its meta form on the assembly, pressing the parts of said assembly into fully assembled relation while said phosphate is in melted condition, and maintaining said parts under pressure until said phosphate solidifies.

19. In a spark plug, a metallic body having a bore therein, an electrode extending into said bore, and electrical insulating means interposed between said member and said electrode, said means comprising a quantity of solidified metaphosphate.

20. The method of making a spark plug which comprises the steps of loosely assembling a body, a center electrode and means for electrically insulating said electrode from said body, applying a quantity of metaphosphate to at least some of the aforesaid assembled parts, heating said metaphosphate to render the same flowable, and pressing said parts into final assembled position while said metaphosphate is in a flowable condition.

21. The method of making a spark plug which comprises the steps of assembling a body member, a center electrode and means for electrically insulating said electrode from said body member, and causing a quantity of metaphosphate in a flowable condition to flow into minute spaces between said insulating means and at least one of the other assembled parts.

22. The method of making a spark plug which comprises a body member, a center electrode and means for electrically insulating said electrode from said body which includes the steps of causing a quantity of metaphosphate in a flowable condition to flow into spaces between at least some of the aforesaid parts, and causing said metaphosphate to solidify while said parts are held in assembled relation.

23. The method of making a spark plug comprising a body member, a center electrode and means including a stack of insulating washers for electrically insulating said electrode from said body which includes the steps of applying a quantity of metaphosphate intermediate the ends of said stack, heating said metaphosphate for reducing the same to a flowable condition, compressing said stack while said metaphosphate is in a flowable condition, and maintaining the compression pressure while said metaphosphate solidifies.

24. In apparatus of the class described, elongated electrical conducting means and electrical insulating means surrounding at least a portion of said conducting means, said insulating means including a stack of insulating washers embedded in a quantity of solidified metaphosphate.

25. The method which includes the steps of assembling electrical insulating means around electrical conducting means, causing a quantity of metaphosphate in a flowable condition to flow into the minute spaces in said assembly, and causing said metaphosphate to solidify for sealing said spaces.

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