

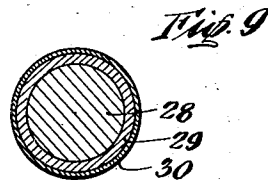
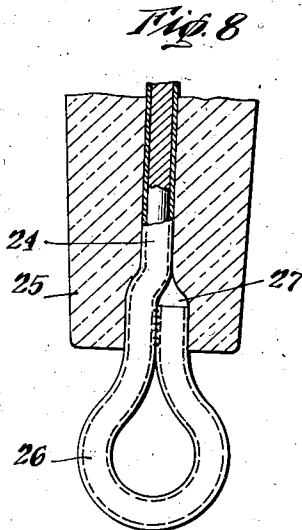
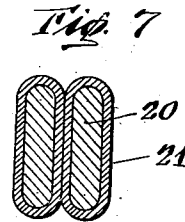
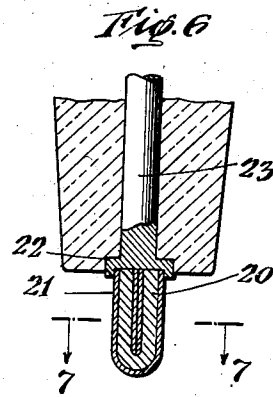
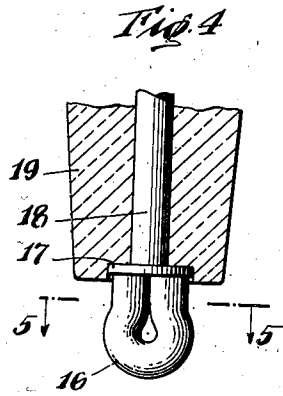
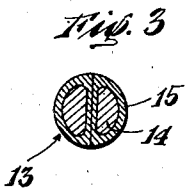
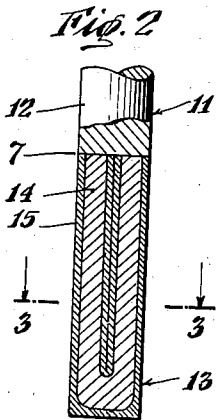
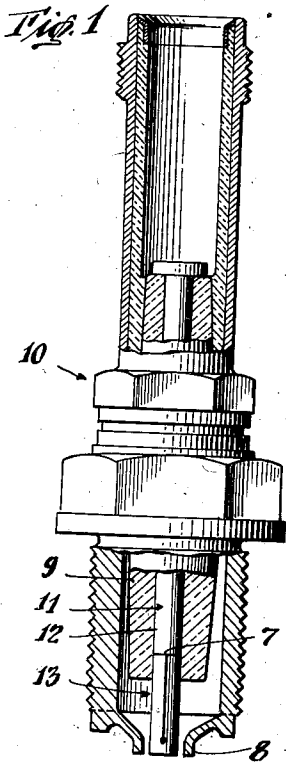
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2,391,457

SPARK PLUG ELECTRODE CONSTRUCTION

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SPARK PLUG ELECTRODE CONSTRUCTION

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3 Claims. (CL 123—169)

This invention relates to spark plugs and electrodes therefor.

An object of the invention is to improve spark plug electrodes and the plugs in which they are incorporated.

Other objects of the invention will be apparent from the description and claims.

In the drawing:

Figure 1 shows a spark plug, partly in section, having a center electrode embodying features of the invention;

Figure 2 is an enlarged section of the end of the center electrode of Figure 1;

Figure 3 is a section on the line 3—3 of Figure 2;

Figure 4 shows a modified electrode;

Figure 5 is a section on the line 5—5 of Figure 4;

Figure 6 shows a further modification;

Figure 7 is a section on the line 7—7 of Figure 6;

Figure 8 shows a still further modification; and

Figure 9 is a section through a modified electrode.

It is difficult to find a single metal or alloy which combines all the properties desired in a spark plug electrode and which can stand up under heavy service for long periods. The sparking surface must be formed of a material which is resistant to the erosive effects of the sparks or arcs formed during ignition and also the exploding gases, which contain lead and other reactive compounds. The electrode must also have adequate strength at the high temperatures encountered, such as red heat, and must have sufficient thermal conductivity to carry heat away from the hot tip at a rate which will cool it below ignition temperature of the explosive mixture between explosions, to avoid pre-ignition. Where precious metals are used, economy is also an important consideration.

Heretofore it has been proposed to form a composite electrode tip having a sparking tip of one metal on a rod of another metal. This has the disadvantage of exposing a welded or brazed joint near the sparking area. It has been found that erosion is increased at or near such joints, probably due to the presence of minute impurities at the joint or to a discontinuity in the crystal structure. There is also the danger of failure of the weld and loss of the sparking tip during operation.

Another construction has been proposed in which a metal tube having a closed end is filled

with another metal. This results in a desirable construction but is expensive to produce and can only be used where the core is of lower melting point and can be cast in the shell, or the two metals can be readily brazed together. It is also difficult to insure that a perfect metal-to-metal bond is obtained inside the closed end of the shell.

Coatings produced by electric plating generally have insufficient density and erosion resistance to withstand the erosive effects of sparking over long periods of operation.

According to the present invention a spark plug electrode is formed of a wire or rod having a core of one metal clad with a bonded sheath of a second metal and doubled upon itself to provide a bend or loop at the sparking tip. This provides a composite construction of improved performance and lower cost which can be readily produced with conventional manufacturing equipment.

The clad wire or rod may be made by several methods. One method is to pass a wire of the core material through an electro-plating bath where the sheath of desired thickness and composition is applied. After plating, the wire is passed through a series of hot or cold drawing steps to reduce it to the diameter desired and to apply sufficient hot or cold working of the sheath metal to change its metallurgical structure and increase its density and erosion resistance.

Another method is to braze a rod of one metal into a tube of another metal followed by drawing to the desired diameter.

A further method is to shrink a tube of one metal onto a rod of another metal and furnace the assembly in a reducing atmosphere to produce pressure welding or bonding of the two layers without fusion.

A still further method is to fill a tube with a molten metal of lower melting point.

One desirable composite wire or rod comprises a core of a high thermal conductivity metal such as silver, copper and their various alloys and a sheath of good resistance to spark erosion such as nickel.

Another combination comprises a core of ductile molybdenum wire having a sheath of platinum or of a nickel alloy having low coefficient of expansion, such nickel-chromium, nickel-manganese, nickel-molybdenum, nickel-iron-molybdenum, nickel-iron-chromium-molybdenum alloys.

Figures 1, 2 and 3 illustrate an aviation spark plug 10 and a center electrode 11 therefor. The

electrode 11 is of a composite construction comprising a round nickel rod 12 having a sparking tip 13 welded thereto, formed of a folded and swaged wire or rod having a core 14 of one metal and a sheath 15 of another metal.

The electrode can be made in the following manner. A length of clad wire, such as nickel-clad copper, which has been drawn to improve the bond and the properties of the nickel coating, is bent double and hot or cold swaged to deform the original shape of the wire and bring the doubled section or loop into substantially cylindrical cross-section with flat ends. Squaring of the ends may be completed by grinding or swaging, but the coating layer is not cut through at the folded end. The end at which the core material is exposed is then butt welded to the end of nickel rod 12, by resistance or flash-arc welding, for example, by the method described in Holt Patent 2,323,660 issued July 6, 1943.

Any burr produced by welding is ground off and the composite rod is then ground smooth in a centerless grinder. The electrode is then sealed in the center of the spark plug insulator 9 by conventional methods.

The ground electrode 8 of the spark plug projects toward the folded end of the sparking tip 13. It will be noted that the only place where the core material 14 can be exposed is at the welded joint 7, which is remote from the sparking zone and is protected within the bore of the insulator.

It is contemplated that the entire center electrode member 11 may be formed from the folded and swaged wire in some cases.

Figures 4 and 5 show a modified electrode in which the coated wire or rod is bent into a loop 16, preserving the round form of the wire. The two ends of the wire section are brought into parallel relation side-by-side and welded onto the face of a flange 17 on the end of a rod 18 which passes through the ceramic insulator 19 of the plug.

Figures 6 and 7 illustrate a form in which a core 20 of flat strip stock is coated with a layer 21 of erosion resistant metal. The coated strip is doubled upon itself and welded in a recessed flange 22 on the end of center rod 23.

Figure 8 illustrates a form in which the coated wire 24 is sealed in the center of ceramic insulator 25 and the end section is bent into loop 26. The end of the wire is inserted in a recess 27 in the ceramic alongside the opposite side of the loop. In some cases the end may be welded to the opposite side of the loop where they are in contact.

Figure 9 shows a tri-metallic wire which can be used in any of the preceding structures. Some materials, such as platinum and other precious metal alloys, are good sparking point materials, but if filled with a high conductivity metal such as copper or silver which has a high expansion coefficient, the platinum sheath will burst when the electrode becomes heated.

In the wire of Figure 9 the core 28 of copper, silver or other high conductivity metal is enclosed in an intermediate sheath 29 of a strong metal or alloy, such as nickel and nickel alloys, which will not burst under the expansion pressure of the core metal. An outer sheath 30 of spark resistant metal such as platinum, platinum alloys or other precious metals is applied over the intermediate sheath 29.

In the following claims the words "loops" and "fold" are to be construed broadly enough to cover a doubled portion whether sharply reversed

as shown in Figures 1 and 6 or bent into a rounded loop as shown in Figures 4 and 8.

While specific embodiments of the invention have been described, it is intended to cover the invention broadly within the spirit and scope of the appended claims.

What is claimed is:

1. A spark plug electrode comprising a wire having a core of a high thermal conductivity arranged to effectively disperse sparking heat from said electrode and a sheath integrally bonded thereto formed of a material of good resistance to spark erosion, said electrode wire being doubled upon itself to provide a sparking tip in the form of a loop, the ends of said wire being remote from the sparking area of said electrode.
2. A spark plug comprising an insulating body, an electrode member passing through said body and sealed therein, said electrode projecting from said body to form a sparking tip, at least the projecting portion of said electrode comprising a wire having a core of metal of high thermal conductivity arranged to effectively disperse sparking heat from said electrode and a sheath of metal of good spark erosion resistance, said wire being doubled upon itself to provide a loop at the sparking tip, and a second electrode member projecting toward said loop to form a sparking gap therewith.
3. A spark plug insulator and center electrode assembly comprising an insulating body having a passage therethrough, and an electrode member extending through said passage, said electrode member having at least a section thereof formed of a clad wire comprising a core of high conductivity metal arranged to effectively disperse sparking heat from said electrode and a sheath of metal of good spark erosion resistance, said wire being folded upon itself to provide a sparking tip in the form of a loop projecting from said insulating body, the ends of said loop being in lateral adjacency and both entering the passage in said insulator, whereby only the sheath of said wire is exposed.
4. A spark plug center electrode having a substantially circular cross-section, at least the sparking tip thereof being formed of a clad wire folded upon itself to form a fold or loop, said wire having a core of high conductivity metal arranged to effectively disperse sparking heat from said electrode and a sheath of metal of good spark erosion resistance, said folded wire having substantially semi-circular cross-section so that the two sides of the fold together form a rod of substantially circular cross section.
5. A spark plug electrode comprising a sparking tip formed of a section of clad wire having a core of high conductivity metal arranged to effectively disperse sparking heat from said electrode and a sheath of metal of good spark erosion resistance, said wire being doubled upon itself, and a body for said electrode comprising a metal rod, the two ends of said section of clad wire being welded to the end of said metal rod.
6. A spark plug electrode comprising a body formed of a metal rod, and a sparking tip welded to the end thereof formed of a section of clad wire having a core of high conductivity metal arranged to effectively disperse sparking heat from said electrode and a sheath of metal of good spark erosion resistance, said section of wire being doubled upon itself and having its ends welded to the end of said metal rod.
7. A spark plug electrode comprising a wire having a core of high conductivity metal, an in-

intermediate sheath of high strength metal and an outer sheath of metal resistant to spark erosion.

8. A spark plug electrode comprising a solid electrode rod and an end section on said rod in continuance of the contour and cross section dimension of said rod, said end section comprising a wire having a core of high thermal conductivity and an open ended sleeve bonded to said core and completely surrounding and covering said core between said sleeve ends, said sleeve being formed of material of good resistance to

5 spark erosion, and said wire being doubled on itself to form a sparking tip at its doubled portion, with the ends of said wire closely adjacent each other and secured to the end of said electrode rod, the sleeve legs formed by said doubling in contact with each other throughout their extent, the core legs formed by said doubling separated throughout their extent by portions of said sleeve legs, said core ends being covered by said electrode rod end, and the doubled wire being effectively in the form of a solid rod.

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