Dec. 25, 1945. F. R. HENSEL 2,391,459

SPARK PLUG AND ELECTRODE THEREFOR

Filed May 2, 1944

Fig. 1

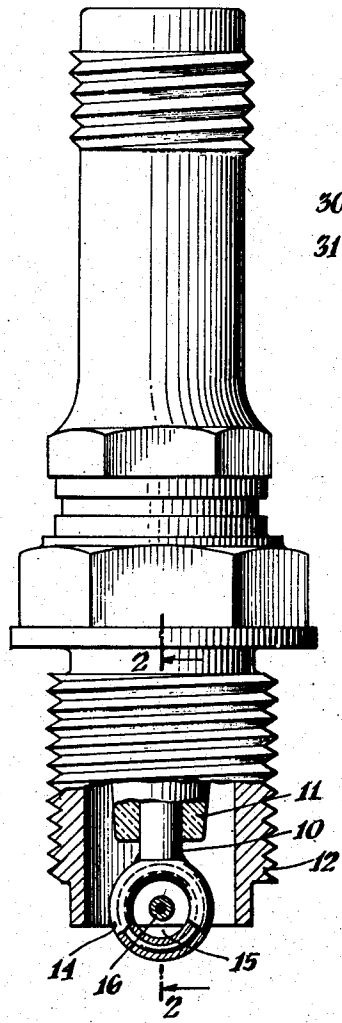


Fig. 3

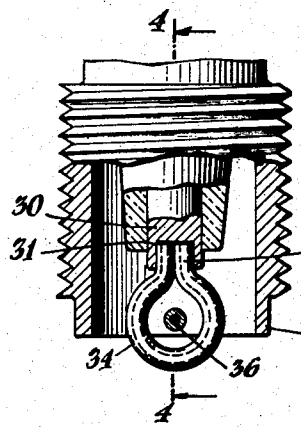


Fig. 4

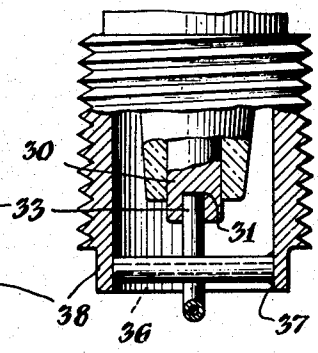


Fig. 2

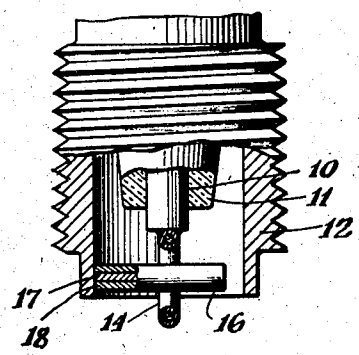


Fig. 5

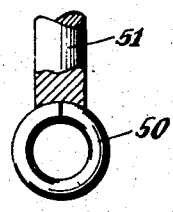
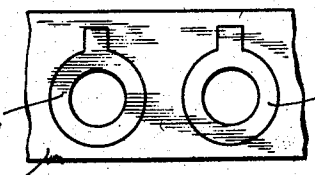


Fig. 6



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SPARK PLUG AND ELECTRODE THEREFOR

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Application May 2, 1944, Serial No. 533,689

10 Claims. (Cl. 123—169)

The present invention relates to spark plugs, and more particularly to improvements in the construction of electrodes for use in spark plugs for internal combustion engines.

The development of modern high-compression internal combustion engines with higher operating temperatures and a great variety of heat conditions necessitates the use of properly designed spark plugs in order to maintain a satisfactory low temperature thereof and to avoid overheating of the insulator while at the same time retaining sufficient heat to burn the carbon deposited upon the electrodes and their immediate vicinity. High temperature engines require a spark plug which will dissipate the heat at a rate sufficiently rapid to avoid overheating of the center electrode and of the insulator which are primary causes of pre-ignition.

An object of this invention is to provide a spark plug less susceptible to over-heating and pre-ignition.

Another object of this invention is to provide a spark plug having electrodes with large sparking surfaces and hence increased useful life.

A further object of the invention is to provide spark plug electrodes the operating temperatures of which substantially approximate the temperatures of the ambient gases in the cylinders, and in which the heat is dissipated to a considerable extent by radiation and surface contact with gases.

A still further object of the invention is to provide spark plug electrodes which are highly resistant to the corrosive effects of the atmosphere and the high temperature conditions present in modern combustion engines.

Other objects and advantages of the present invention will in part be obvious and will in part become apparent from the following description of preferred embodiments thereof when read in conjunction with the accompanying drawing, in which

Figure 1 is a side view, partly in cross-section, of a spark plug comprising electrodes in accordance with this invention;

Figure 2 is a partly cross-sectional view taken along line 2—2 of the spark plug shown in Figure 1;

Figure 3 is a view, partly in section, of a modification of Figure 1;

Figure 4 is a view, partly in section, along line 4—4 of Figure 3; and

Figures 5 and 6 illustrate loop electrodes of modified construction.

Referring now to the drawing, there is shown, in Figure 1, a spark plug having a center electrode or spindle 10 which may consist of any suitable conventional material surrounded by an insulator 11 which electrically separates the electrode 10 from the outer conductor shell 12. Securely attached, as by welding it to the lower extremity of the center electrode spindle 10, there is provided an electrode 14 having the shape of a loop or toroid which is adapted to define a circular or loop-shaped spark gap 15 between the inner or sparking surface of the loop and the central portion of the outer surface of ground or bar electrode 16 which forms the lower terminal portion of the side electrode 12.

The rod or ground electrode 16 may be integrally united to the shell 12 as by welding, at either one or both ends of the bar, the advantage of one single point of connection being that this will facilitate the adjustment or setting of the spark gap by simple bending of the free end of the ground electrode, and one advantage of connecting both ends of the rod 16 to the ground electrode residing in the more rapid dissipation of the heat to the shell, there being provided two paths of heat conduction instead of one.

An important advantage of the combined electrode construction of this invention is derived from the large active sparking surface which is provided by the outer circumference of the ground electrode and the inner circumference of the loop electrode by virtue of which the rate of electrode erosion is considerably reduced and the useful life of the spark plug correspondingly increased.

In the embodiment of the invention which is shown in Figures 3 and 4, the central electrode 30 has at its lower end a bore adapted to receive the upper end 33 of the loop electrode 34 and is securely united therewith as by brazing. For example, a suitable brazing disc may first be placed in the bore of the central electrode, then the loop electrode may be inserted in contact therewith, and the assembly thus obtained may then he heated, as by high frequency induction or other suitable means, whereby there will be formed a brazed joint, as shown at 31. Preferably, the loop may be inserted into the bore so that a minor portion of the brazing metal will penetrate into the crevice or interstice formed by the contiguous portions of the loop member, thus increasing the strength of the brazed joint obtained. The side electrode 36 may be of the same construction as that shown in Figures 1 and 2 and may be similarly united as at 37, with the shell 38.

In addition to brazing other methods of joining may be employed such as butt, projection or flash welding. For example, as shown in Figure 5, the ends of the loop 50 may be buttwelded together and then attached to the center spindle 51 by welding or other joining methods.

As illustrated in Figure 6, it is further possible to produce the loop by a stamping or punching operation from a strip or blank of suitable electrode material 60. This stamping 61 thus obtained may be attached to the center spindle by

welding, brazing or any other suitable joining method.

Alternatively, the loop electrodes according to this invention may be prepared by powder metallurgical methods or any other suitable manufacturing procedure.

While the electrodes of the spark plug contemplated by this invention may be formed of any suitable material, in a preferred embodiment either one or both the electrodes 14 and 16 consist of a core 17 (see Fig. 2) formed of a metallic composition having a high thermal and electrical conductivity and a sheath 18 of a metallic composition having a relatively high melting point and characterized by a high resistance to pitting, oxidation, corrosion and erosion. It has been found that a combination of (1) copper and/or silver compositions for the core and (2) austenitic iron alloys for the sheath of the electrodes is of particular value by virtue of a number of favorable factors, among which the closely matching co-efficients of thermal expansion of these materials. For example, the commonly known austenitic nickel steels, nickel-chromium steels, manganese steels, etc., have coefficients of thermal expansion of the order of about 16 to 21×10^{-6}, the corresponding values for copper and silver being 17×10^{-6} and 18 or 19×10^{-6}, respectively.

In addition, austenitic ferrous alloys and steels exhibit valuable anti-corrosive properties, and are furthermore characterized by excellent capacities for plastic deformation which in some cases almost parallel those of copper and silver. Hence the combination of the sheath and core materials contemplated by this invention results in advantages not only in the use but also in the manufacture of the bi-metallic electrode structures. For example, it is possible to first produce a wire bar having a core of copper or silver and a cladding of any of the austenitic materials mentioned above. These bars may then be hot rolled at any temperature below about 900° C. to produce a bimetallic wire suitable for the spark plug electrodes contemplated by this invention. It is also possible to reduce the cross-section by cold rolling, which process simultaneously hardens the austenitic case material to an appreciable extent.

The following are a number of typical austenitic compositions suitable for sheath materials as contemplated by this invention: Austenitic steels containing in addition to the usual carbon content from about 14% to about 36% of one or more of the elements chromium, nickel, manganese, typical examples of these being (*a*) a stainless steel containing about 18% chromium and 8% nickel; (*b*) a steel containing about 24% nickel and the balance chiefly iron; (*c*) a steel containing about 14% manganese, about 1% carbon, and the balance chiefly iron.

In addition to austenitic steels it is contemplated to use composite materials where the cladding consists of pure nickel or high nickel alloys, cobalt or chromium base compositions, platinum and/or palladium and their alloys. It is further contemplated to fabricate the loop from tungsten by hot punching from strip or from high tungsten base alloys by applying powder metallurgical methods.

It is further contemplated to produce composite loops by first punching the core from strip or buttwelding it from wire and then electroplating the core material with nickel or platinum group metals and alloys or rhenium or tungsten group metals.

While the invention, as to its objects and advantages, has been described herein as applied to specific embodiments thereof, it is not desired to be limited thereby, but 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 comprising an insulator having a passage therethrough, a center electrode spindle extending through said passage, the sparking end of said electrode being formed in the shape of a closed loop having its axis perpendicular to said spindle, a conductive shell surrounding said insulator and a rod extending through the central portion of said loop and being integrally united to at least one peripheral point of said shell, said rod comprising the other electrode of said plug.

2. Spark plug as claimed in claim 1 in which at least one of said gap-defining electrodes comprises a core of a material consisting of predominating proportions of at least one of the metals copper and silver, and a sheath or case of a material comprising predominating proportions of an austenitic alloy of iron.

3. A spark plug electrode at least a portion of which comprises a core of an electrically highly conductive metal, and a sheath of an austenitic ferrous material having a coefficient of thermal expansion approximating that of said core material.

4. Spark plug electrode as claimed in claim 3 in which said core is formed of copper wire and said sheath is formed of austenitic steel.

5. Spark plug electrode as claimed in claim 3 in which said core is formed of silver wire, and said sheath is made of austenitic chromium-nickel steel.

6. A spark plug electrode comprising a core of one of the metals copper and silver, and a sheath of an austenitic alloy of iron.

7. A spark plug having a central metal spindle terminating in a closed loop having its axis at a substantial angle to said spindle, said loop comprising the center electrode of said plug, and a side electrode comprising a rod extending through the aperture of said loop.

8. A spark plug having a central metal spindle terminating in a closed loop having its axis at a substantial angle to said spindle, said loop comprising the center electrode of said plug, and a side electrode comprising a rod extending through the aperture of said loop, said loop having a core of high conductivity metal selected from the group consisting of copper and silver and a sheath enclosing and bonded to said core, said sheath being formed of an austenitic iron alloy having a coefficient of expansion approximating that of said core.

9. A spark plug electrode comprising a core of high conductivity metal selected from the group consisting of copper and silver and a sheath enclosing and bonded to said core, said sheath being formed of an austenitic iron alloy having a coefficient of expansion approximating that of said core.

10. A spark plug electrode having at least the active sparking portion thereof formed of an austenitic iron alloy.

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