May 10, 1949. F. R. HENSEL 2,470,033

SPARK PLUG

Filed Nov. 27, 1945

Fig. 1

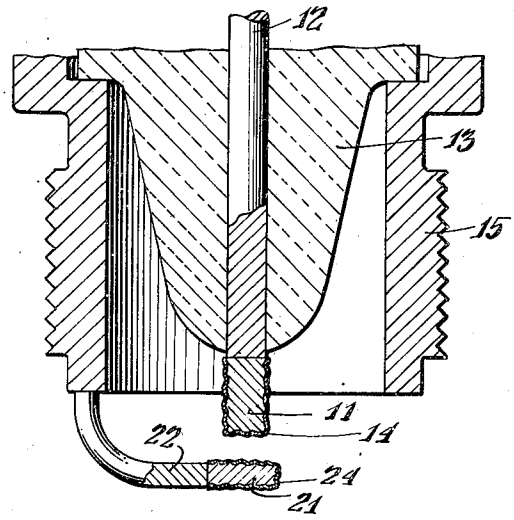


Fig. 2

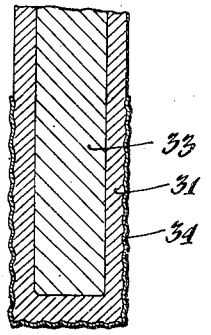
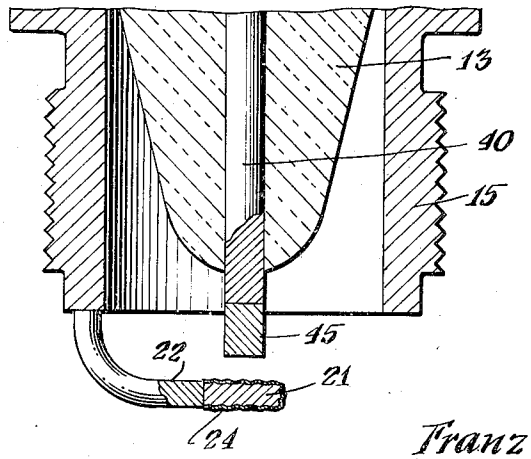


Fig. 3



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SPARK PLUG

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2 Claims. (Cl. 123—169)

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This invention relates to spark plugs.

An object of the invention is to improve spark plug electrodes.

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

In the drawing:

Figure 1 shows a portion of a spark plug, partly in section, illustrating the spark plug electrodes;

Figure 2 is an enlarged longitudinal section of a modification of the electrodes; and

Figure 3 is another electrode combination of the present invention.

The invention contemplates a spark plug with nickel electrodes having a roughened surface and an electrodeposited coating of platinum or palladium base materials.

Before deposition of the precious metal coating, the surface of the nickel electrode is first roughened by such means as etching, sand blasting, knurling, or any other suitable method. The purpose of this roughening is to create sharp protrusions which will promote corona discharge or lower the sparking voltage when the plug is fired.

Nickel is destroyed rather rapidly by spark erosion. According to the present invention the advantages of a roughened surface is obtained together with good resistance to spark erosion by use of an electroplate of platinum or palladium base material over the roughened nickel. The resulting electrode structure and composition has a long life and low and consistent sparking voltage.

In Figure 1, the center electrode may comprise a cylindrical section 11 of nickel or nickel base metal tip welded to the end of a nickel, nickel alloy, iron alloy or copper alloy rod 12 which is embedded in the ceramic insulator 13 of the spark plug. The roughened working surface of the electrode is coated with an electrodeposit 14 of palladium or platinum. The side electrode may be produced in a like manner with a roughened nickel tip 21, electroplated with a palladium or platinum base metal 24 and welded into a nickel, iron or copper alloy rod 22 which is welded to the metal shell 15 of the plug. If either one or both of the electrodes are wholly composed of nickel, the electrode rod may be formed of one piece of nickel, which obviates the necessity of welding the electrode tip.

The electrode may be made of a nickel-iron alloy, containing 42% nickel, for example, whose coefficient of expansion is lower than that of pure nickel or of high nickel alloys, and approximates the coefficient of expansion of platinum.

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Figure 2 shows a modification of the spark plug electrode which, besides the roughened nickel 31 and the palladium plate 34, contains a copper or silver core 33 to conduct heat away rapidly from the sparking tip.

Palladium is a highly satisfactory electrode material and approaches platinum in its performance. As disclosed in U. S. Patent 2,335,821 to E. M. Wise et al., a fairly heavy plate of palladium can be produced in accordance with the following bath composition and conditions:

Palladium as $PdCl_2$	50 grams per liter
Ammonium chloride	20 to 50 grams per liter
Temperature	50° C.
Current density	10 amperes per square foot
Agitation	Air lift

By using prepared palladium anodes the composition of the bath is maintained and there is no necessity for replenishing. Smooth ductile deposits can be made at a rapid rate. Deposits of .025" have been made in 16½ hours. When plating upon such metals as nickel, copper, iron and silver a preliminary strike from a low metal ion concentration bath of palladium, gold, platinum, rhodium or other noble metals is preferably deposited first.

The use of a palladium plate may be particularly desirable for side electrodes, with the palladium thickness being .010 inch. The gap growth in spark plug electrodes occurs not only on the center electrode but also on the side electrode. A combination of a palladium plated nickel side electrode versus a tungsten or tungsten alloy center electrode results in superior performance and decreased gap growth.

Figure 3 shows a combination of a center electrode tip 45 of tungsten or tungsten alloy welded to an electrode rod 40 with a side electrode tip of roughened nickel 21 electroplated with platinum or palladium 24.

The palladium may also be used for plating the center electrode. The base of the electrodes may be either nickel or a nickel alloy, or a copper or silver cored nickel. The electrode can be masked in such a manner that only the areas at which actual sparking occurs are electroplated.

Platinum may be electrodeposited from complex sodium platinate baths or from phosphate, sulfate or nitrite ammine baths.

Instead of platinum and palladium it is also possible to electroplate alloys of such metals. This may be accomplished by codeposition of the alloying elements or by plating the elements onto each other and forming the alloys by a diffusion

process such as heating the plated assembly in a non-oxidizing atmosphere.

These alloying methods may be employed to form platinum-palladium, platinum-rhodium or palladium-rhodium alloys. Suitable palladium-chromium and platinum-chromium alloys can be formed by electrodeposition. Other alloying elements for platinum or palladium are nickel, manganese, copper, silver and gold, all of which lend themselves to electrodeposition.

The palladium or platinum plated roughened nickel electrodes of the present invention when used in automotive or aircraft spark plugs have the advantage of withstanding the erosive action of the spark resulting in gap growth. Hence, frequent adjustment of electrodes is obviated. Also the sharp protrusions of the roughened nickel promote a corona discharge which lowers the sparking voltage. Thus, a spark plug containing one or both electrodes as described in the present invention effectively increases the efficiency of automotive, aircraft or stationary engines.

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 comprising a pair of spaced electrodes, one of said electrodes being formed predominantly of tungsten and at least the sparking area of the other electrode being formed predominantly of nickel the surface of which has been roughened, and an electrodeposited coating of palladium over said nickel surface.

2. A spark plug comprising a pair of spaced electrodes, at least the sparking areas of said electrodes being formed of nickel the surface of which has been roughened, and an electrodeposited coating of palladium over said nickel surface, the surface of said electroplated coating conforming to the configuration of the said nickel surface.

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