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SPARKING PLUG ELECTRODES

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1 Claim. (Cl. 75—171)

The present invention relates to electrodes and, more particularly, to new and improved sparking plug electrodes characterized by a highly satisfactory combination of properties including resistance to arc erosion, to corrosion and to oxidation, adequate thermal conductivity and amenability to hot and cold working operations.

As is well known to those skilled in the art, electrodes of sparking plugs for internal-combustion engines must combine high resistance to spark erosion and to oxidation and to corrosion normally caused by the destructive influence of the products of combustion of fuels to which lead compounds, such as lead tetraethyl, ethylene dibromide, ethylene dichloride and other compounds, are often added. Further, it is desirable that the temperature of the electrodes should vary only within a fairly narrow range while the engine is running. If the electrodes become too hot, there is a danger of preignition of the fuel mixture; and if they become too cool, there is a danger that they may become covered with oil, with consequent interference with sparking. A suitable operating temperature range of the electrodes used in sparking plugs employed in ordinarily motorcar engines is 500 to 900° C. The need for compliance with this condition places limitations upon the thermal conductivity of the alloys which can be used.

Because the alloys used as the electrodes are drawn to wire of special sizes, it is extremely important that the alloys possess good hot and cold working properties. Moreover, the alloys should also be capable when drawn to wire of affording a high degree of ductility and tensile strength. Furthermore, the alloy wire must exhibit the property of rigidity, i.e., the ability to maintain dimensional tolerance in use.

Spark plugs heretofore used have not provided a satisfactory combination of the aforementioned properties. Spark plugs fail, in the main, generally as a result of corrosion of the central and ground electrodes. This corrosion is progressive and is caused principally by two factors, viz. lead attack and spark erosion. Alloys have been used heretofore which provided good oxidation and corrosion resistance but these properties often have been achieved at the expense or sacrifice of other important properties. For example, it is well known that the so-called 80/20 nickel-chromium alloys have excellent resistance to oxidation and corrosion, and can be more readily worked, both hot and cold, than many other heat-resisting alloys. However, they are not satisfactory for use as sparking plug electrodes particularly because of their susceptibility to spark erosion.

One nickel-base alloy commonly used for making sparking plug electrodes contains from 1.8 to 2.2% of silicon together with fractions of one percent of manganese, copper and magnesium. Electrodes made of this alloy are not altogether satisfactory, even when their oxidation resistance is increased by providing them with a surface coating of chromium by the costly process known as "chromising."

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Although many attempts were made to overcome the foregoing difficulties and other disadvantages, none, as far as I am aware, was entirely successful when carried into practice commercially on an industrial scale.

5 The present invention is based on the surprising discovery that alloys of the 80/20 nickel-chromium type can be made eminently suitable for use as sparking plug electrodes by the addition of special amounts of tungsten to the alloys.

10 It is an object of the present invention to provide sparking plug electrodes made of alloys which manifest a highly satisfactory combination of properties including resistance to arc erosion, resistance to oxidation and corrosion and adequate thermal conductivity.

15 Another object of the invention is to provide sparking plug electrodes made of alloys which are capable of being easily hot and cold worked.

The invention also contemplates providing sparking plug electrode made of alloys capable of being readily hot and cold worked and which manifest highly satisfactory resistance to arc erosion, to oxidation and to corrosion while possessing adequate thermal conductivity.

Generally speaking, the present invention contemplates providing sparking plug electrodes comprised of thermally conductive nickel-chromium alloys of the 80/20 type which can be readily worked and exhibit substantial resistance to arc erosion, to oxidation and to corrosion in use. In accordance with the principles of the present invention, the sparking plug electrode alloys contain about 18% to 22% chromium, about 1% to 9% tungsten, up to about 0.8% carbon, up to about 2% iron, up to about 4% silicon, up to about 3% manganese, up to about 20% cobalt, the balance being substantially nickel except for residual deoxidants, such as magnesium, and incidental elements and/or impurities normally associated therewith in small amounts which do not adversely affect the basic characteristics of the alloys. I have found that when from 1% to 9% tungsten is added to nickel-chromium alloys containing 18% to 22% chromium, sparking plug electrodes made thereof are markedly less susceptible to arc erosion while the high degree of resistance to oxidation and corrosion is not adversely affected. Moreover, the alloys of the present invention afford adequate thermal conductivity and are readily capable of being hot and cold worked.

At least 1% tungsten is required to render the alloy useful for its purpose, e.g., 2%, 5%, etc. In carrying the invention into practice, it is advantageous to include as much tungsten as possible, preferably about 4% to about 8% tungsten, while at the same time retaining the ability to cold draw the alloy to wire of the required size. I have found that both tungsten and carbon have an adverse effect on cold-working characteristics and the maximum contents specified hereinbefore are the limits at which cold-working is feasible. For example, it has been found that tungsten in amounts of 10% renders the alloys difficultly hot-workable. Some carbon is desirable in order to give sound ingots when the alloy is originally cast and to facilitate welding of the electrodes to the body of the sparking plug. Therefore, it is advantageous in accordance with the invention for achieving highly satisfactory results to include at least 0.2% and up to about 0.6% carbon in the alloy. When the amounts of tungsten used in the alloys fall within the upper end of the tungsten range, e.g. about 8% to about 9% tungsten, it is advantageous in achieving and maintaining good hot and cold working properties in accordance with the invention that the carbon content employed be in the lower range thereof, e.g., about 0.2% to about 0.4% carbon.

Manganese is usually present in the alloys as it is commonly used to deoxidize the melt in order to give sound ingots on casting.

The alloys according to the invention also have the advantage of being readily workable into the form of wire by forging, rolling and cold-drawing the original cast ingots. The wire can readily be flash butt-welded to the body of the plug in manufacture, and is then still ductile enough to be bent through an angle of 90°, and it also has the required rigidity for the maintenance of dimensional tolerances in use.

For the purpose of giving those skilled in the art a better appreciation of the advantages of the invention, the following illustrative example is given:

Example

Sparkign plugs of a standard commercial pattern in which the central electrodes were made of an alloy consisting of about 20% chromium, about 4.76% tungsten, about 0.5% carbon, about 0.15% iron, less than about 0.1% silicon, about 0.045% magnesium, about 0.89% manganese and the balance nickel were subjected to running tests in a motorcar engine. During the tests, the cars to which the engine was fitted were run for about 30,000 miles without changing the spark plugs. The fuel employed during the tests was S.C.R.D.E. 80 octane fuel which had a high sulfur content and also a high lead content.

Comparison of the plugs during and after these tests with others in which the electrodes were made of a chromiumised nickel-base alloy containing about 2% silicon and which had been tested under similar conditions showed that the electrodes according to the invention were in appreciably better condition. They suffered less corrosion, maintained the correct gap length for a longer period of time, and accumulated less surface deposits owing to higher oxidation resistance.

Various tungsten-containing nickel-chromium base alloys are known in themselves, and have previously been proposed for use in making turbine blades and the like, for valves and valve facings, and for machine parts work-

ing at high temperatures. These alloys have in fact been known for nearly 40 years. During a large part of this time there has been a demand for better sparking plug electrodes, but to the best of my knowledge no one has previously discovered that the incorporation of special amounts of tungsten in the particular alloys of the present invention would enable those alloys to satisfy the stringent requirements peculiar to sparking plug electrodes, and in particular to impart adequate resistance to arc erosion.

Although the present invention has been described in conjunction with preferred embodiments, it is to be understood that modifications and variations may be resorted to without departing from the spirit and scope of the invention, as those skilled in the art will readily understand. Such modifications and variations are considered to be within the purview and scope of the invention and appended claims.

I claim:

- 1 In a sparking plug, a new and improved sparking plug electrode composed of a thermal conductive nickel-base alloy possessing good resistance to sparking erosion, to oxidation and to corrosion and further possessing good hot and cold workability properties, said alloy consisting essentially of about 18% to about 22% chromium, up to 2% iron, about 1% to about 9% tungsten, up to about 0.8% carbon, the amounts of tungsten and carbon being so correlated for workability that when the amount of tungsten falls within the range of 8% to 9% the amount of carbon is present in the amount of 0.2% to 0.4%, the balance of said alloy being essentially nickel.

References Cited in the file of this patent

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

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November 1, 1960

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It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 1, line 36, for "of" read -- for --; line 64, for "susceptilibility" read -- susceptibility --.

Signed and sealed this 25th day of April 1961.

(SEAL)

Attest:

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