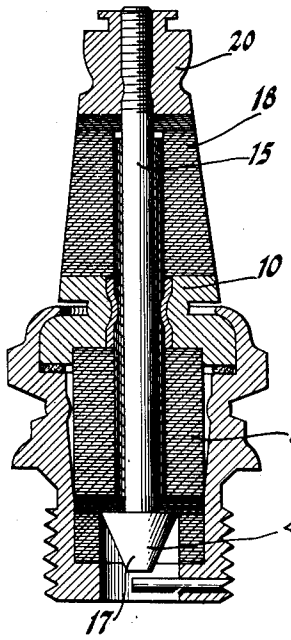
Dec. 19, 1933. T. G. McDOUGAL 1,940,314

SPARK PLUG ELECTRODE

Filed Jan. 31, 1930



ELECTRODE PREFERABLY MADE OF STAINLESS STEEL CONTAINING

CARBON	.10%
CHROMIUM	14.0%
ZIRCONIUM SULPHIDE	.4%
MANGANESE	.1%

WITH OR WITHOUT APPROXIMATELY .4% BARIUM.

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SPARK PLUG ELECTRODE

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8 Claims. (Cl. 123—169)

This invention has to do with electrodes for spark plugs such as are used in internal combustion engines.

Such electrodes are usually made of nickel base alloys, chromium sometimes being added to increase the resistance to corrosion. While nickel is desirable for this use, it possesses the disadvantage that at the high operating temperatures and in the sulphurous atmosphere of the combustion chamber it deteriorates by intercrystalline corrosion with resultant decrease in tensile strength and shortening of the life of the plug. The effect of the decrease in tensile strength is particularly bad when the alloy is used in spark plugs of the type described and claimed in the prior application of Hector Rabezzana, Serial Number 324,511, filed December 7, 1928. In this type of plug, the insulation consists of apertured mica discs encircling the center wire, and compressed and clamped to it. With the nickel base electrodes after a period of use in the engine, the tensile strength of the wire is so reduced that the wire will lengthen under pressure of the compressed mica discs allowing electrically conducting liquids and particles to penetrate between them, resulting in short-circuiting of the plug. In extreme cases the heads or sparking tips of the center electrodes fall off while the plugs are in use, thus destroying them.

To avoid this difficulty it was proposed to use for the center wires stainless steel, that is, steel containing a percentage of chromium to resist corrosion. It was found in practice that stainless steel center wires have the desired increased tensile strength although the result of exposure to the sulphurous gases of the combustion chamber is to reduce the original tensile strength by a considerable amount,—more than one-third in certain cases. The stainless steel electrodes also corrode and scale on the surface exposed to the combustion gases of the motor, this resulting in rapid wearing away of the electrodes and short life for the plugs. Another bad result was that the corroded terminals required higher sparking voltages, this causing the plugs to fail at times for lack of sufficient applied voltage to produce the spark discharge.

In studying this problem it became apparent that the corrosion is due principally to the presence of sulphur and its compounds in the combustion gases and it occured to me to alloy with steel some form of sulphur, such as a sulphide, which would at one and the same time render the steel (or iron) resistant to corrosion and because of "mass action," as known in physical chemistry, render the metal less susceptible to attack by the sulphur of the combustion gases. To be suitable for this purpose the sulphide must exist in the steel in the form of stable inclusions. I have found that the sulphides of the following elements possess this property: zirconium, titanium, cerium, thorium. As the above elements form no recognized chemical group I have given them the group name of "stable sulphides." Of this group I have found zirconium sulphide particularly suitable for the purpose. I have made up center wires of steel to which has been added a proportion of zirconium sulphide. The steel employed is preferably in the form of one of the well known alloys known as stainless steel. Experiments with plugs in which the center wires have been made of this material indicates that they possess the required tensile strength, that this strength is not materially reduced in service, and that they resist corrosion to a high degree. The only disadvantage these alloys possess for this use is the fact that the sparking voltage is rather high but this may be overcome by the addition of a small amount of barium as described and claimed in the prior application of Ora S. Duffendack and Hector Rabezzana, S. N. 302,904, filed August 30, 1928.

On the drawing I have illustrated one type of spark plug in which my invention is embodied. This plug is described and claimed in the prior Rabezzana application above referred to. The center electrode 15 is surrounded by a "cigarette" of mica, and upon it are assembled the metal collar 10 and the mica disks 16 and 18. The parts described are compressed axially against the head 17 of the center electrode and are held in place by nut 20 which is permanently locked in position by distortion of the metal of the nut and of the threads on the wire by means of a welding operation. The other details of the plug need not be described as they have no bearing on the present invention.

With the described arrangement it is apparent that the mica discs are held under compression between the enlarged head or sparking point 17 and the anchored nut 20. The electrode is thus placed under tensile stress.

According to the preferred embodiment of my invention, the electrode 15 is made of a stainless steel alloy to which zirconium sulphide has been added to provide resistance to corrosion and the requisite tensile strength over long periods of use in the corrosive atmosphere of the combustion chamber. To offset the increase in sparking voltage I may also add to the alloy a small percentage of barium. For purposes of illustration I

have given below the analysis of one steel from which I have made spark plug electrodes in accordance with this invention:

	Percent
Carbon	.10
Chromium	14.0
Zirconium sulphide	0.4
Manganese	0.1

To this steel may be added approximately .4% of barium to reduce the sparking voltage.

It will be understood that the proportions of ingredients in the formula may be varied considerably without losing the benefits set forth in this application or departing from the spirit of the invention. The barium content particularly may be varied over a considerable range in accordance with the sparking voltage which it is desired to maintain across the electrodes of the plug.

Examination of the alloys herein described indicates that the sulphides mentioned do not form alloys with the steel but are present in the form of foreign inclusions or conglomerates. The sulphides occur at the grain boundaries and increase the concentration of sulphur at these points. In addition to the sulphides thus introduced there is also a proportion of stable manganese and iron sulphides formed in the steel and retained as such in the final product. With the base metal, in this case the steel or the stainless steel alloy, thus "satisfied" with sulphur, the electrodes do not have a tendency to absorb sulphur from the hot sulphurous gases of the motor, which absorption would result in intercrystalline corrosion. The life of the electrode is thereby greatly increased.

While electrodes of the composition herein set forth are particularly useful in the type of spark plug herein described in which the electrode is under tensile stress, it is apparent that they are also very desirable in plugs of any design, and for side as well as for center electrodes, particularly because of their high resistance to corrosion, and low cost.

For the convenience of the public a legend has been placed on the drawing stating the preferred composition of the electrode, but it is to be understood that the scope of the invention is not limited to that composition, nor otherwise than as set forth in the claims.

I claim:

1. A spark plug electrode made of stainless steel containing chromium and a stable sulphide.

2. A spark plug electrode made of steel containing chromium and zirconium sulphide.

3. A spark plug electrode made of stainless steel containing chromium, manganese and zirconium sulphide.

4. A spark plug electrode made of stainless steel containing chromium, manganese and zirconium sulphide, and barium.

5. A center electrode for spark plugs of the type in which said electrode is employed as a tension member to secure the insulator parts in assembled relation, made of stainless steel containing chromium, manganese and zirconium sulphide.

6. A center electrode for spark plugs of the type in which said electrode is employed as a tension member to secure the insulator parts in assembled relation, made of stainless steel containing chromium, manganese and zirconium sulphide and a material for reducing the sparking voltage.

7. A center electrode for spark plugs of the type in which said electrode is employed as a tension member to secure the insulator parts in assembled relation, made of steel of approximately the following analysis: carbon .10%, chromium 14.0%, zirconium sulphide .4% manganese .1%.

8. A center electrode for spark plugs of the type in which said electrode is employed as a tension member to secure the insulator parts in assembled relation, made of steel of approximately the following analysis: carbon .10%, chromium 14.0%, zirconium sulphide .4%, manganese .1% and barium up to approximately .4%.

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