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LOW TENSION SPARK PLUG AND PROCESS FOR MAKING SAME

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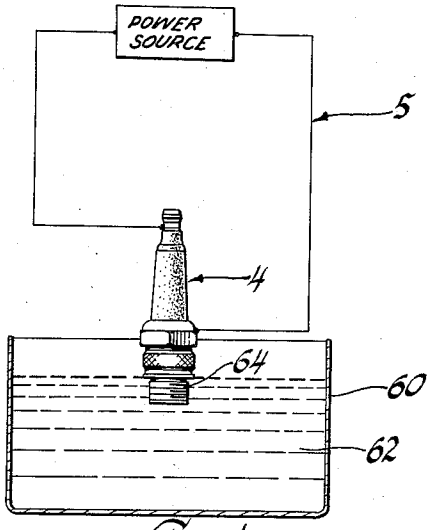


Fig. 1

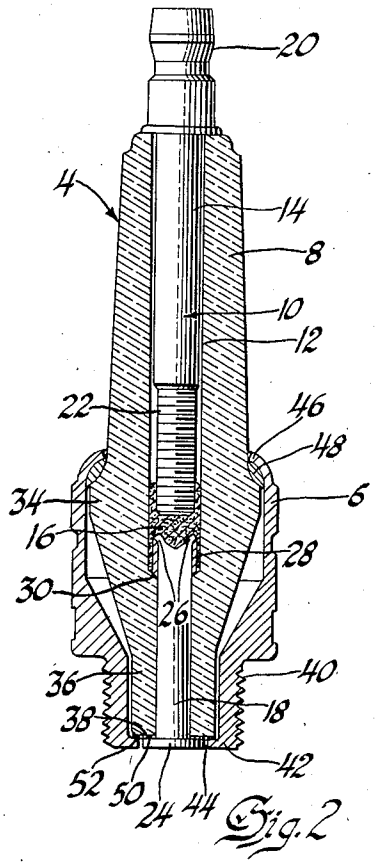


Fig. 2

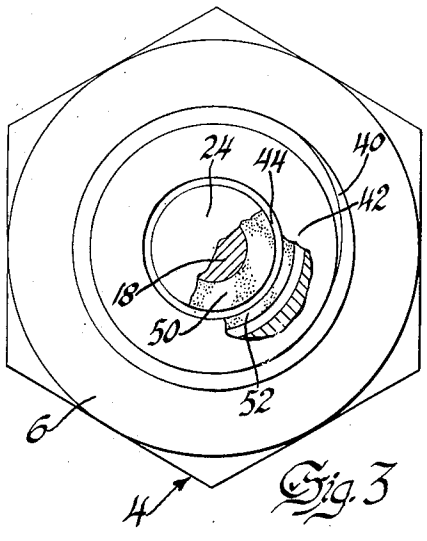


Fig. 3

Inventor
Karl Stuermer

By Willits, Helmig & Baillio
Attorneys

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Karl Stuermer, Cleveland, Ohio, assignor to General Motors Corporation, Detroit, Mich., a corporation of Delaware

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This invention relates to spark plugs and to a process for making same. More particularly, this invention concerns spark plugs of the type which operate at relatively low voltages and are commonly referred to as low tension or creep gap spark plugs.

One of the objects of this invention is to provide a durable and efficient spark plug which is operative at relatively low voltages and high energies to give an extremely hot spark. Another object of the invention is to provide a low tension spark plug of the type wherein the spark path abutting surface of the insulator has increased wear resistance, thus greatly increasing the efficiency and operating life of the plug. Still another object of the invention is the provision of a novel process for making low tension spark plugs of increased efficiency and durability.

These objects are carried out in accordance with the invention by providing a spark plug having a surface portion of the insulator abutting the spark gap and then treating the spark gap abutting surface portion of the insulator in the manner hereinafter described to condition the plug for low tension operation.

Other objects and advantages of my invention will be apparent in the following description and from the accompanying drawings in which Figure 1 is a schematic showing of apparatus which may be used for the practice of the process of this invention. Figure 2 is a side view in section of one embodiment of a low tension spark plug of this invention, and Figure 3 is a bottom view with parts broken away of the embodiment shown in Figure 2.

Referring now to the drawing, Figure 1 shows a spark plug 4, an electrical circuit 5 for applying a voltage to the spark plug and including an electrical power source as indicated.

The construction of the particular spark plug 4 in Figure 1 is shown in detail by Figure 2. In order to more clearly describe and explain the invention, the structure of the spark plug prior to the conditioning process will now be described.

Referring to Figure 2, the spark plug includes an outer shell 6, an insulator 8, and a centerwire 10 positioned in the longitudinally extending centerbore 12 of the insulator 8.

The centerwire 10 comprises a centerwire screw 14, an electrical conducting seal 16 and a central electrode spindle 18. The centerwire screw 14 is provided with an electrical contact head 20 for connection with the ignition wiring system and a threaded portion 22 which is embedded in the electrical conducting seal 16 to retain the centerwire screw within the bore 12. The conductive seal 16, which may consist of a mixture of glass and some conductive material such as copper or nickel powder, is bonded to the walls of the insulator centerbore 12, thus providing a gas-tight seal and is also bonded to the top of the central electrode 18 and to the centerwire screw to secure these parts in position.

The bottom of the central electrode spindle 18 extends

to the exterior of the centerbore and is provided with a head 24, while the top is bifurcated to provide a pair of prongs 26 which are bent outwardly and over the top of a metal electrode retainer ring 28 to secure the central electrode in the lower end of the insulator centerbore 12. It will be noted that the lower end of the centerbore is of reduced diameter, thus providing a centerbore shoulder 30 to support the retainer ring 28.

In the particular embodiment shown in Figure 2, the insulator 8 is of one-piece construction and is provided with an outwardly extending annular shoulder 34 and a cylindrical base portion 36 which terminates in a flat surface 38. The surface 38 is conditioned to provide low tension spark plug operation by the process hereinafter described. It is this spark gap abutting insulator surface 38 to which this invention chiefly relates.

The outer metal shell 6 has a threaded portion 40 of reduced diameter for engagement with a threaded hole provided in the cylinder head of an internal combustion engine.

The outer or ground electrode consists of an inwardly extending annular flange 42 which is secured to the metal shell 6 and which, in the embodiment shown, is integral with the ground shell. The edge of the ground electrode is in continuous spaced relation to the edge of the central electrode head, thus providing a circular spark gap 44.

Besides serving as the ground electrode, the flange 42 also cooperates with a circumferential inwardly turned lip 46 on the top of the shell 6 to retain the insulator in position. A metal washer 48 between the insulator shoulder 34 and the lip 46 serves to seal the structure and also to assure a secure fit.

Interposed between the head 24 of the central electrode spindle 18 and the flat base surface 38 of the insulator 8 is an annular gasket 50 of some suitable heat and wear-resistant metal such as nickel or a nickel alloy. A second annular gasket 52 also of a heat and wear-resistant metal such as nickel or a nickel alloy, is interposed between the outer electrode 42 and the base surface 38 of the insulator.

The gaskets 50 and 52 are pressed tightly into continuous mechanical and electrical contact with the abutting surfaces of the electrodes and of the insulator and thus serve not only to inhibit gap erosion and electrode undermining but also as a gas-tight seal for the assembly.

The insulator 8, or at least that portion of the insulator adjacent the spark gap, should preferably have a particularly high heat resistance to withstand the high discharge temperatures. I prefer to use a sintered alumina type insulator material principally because of its high mechanical strength, high heat resistance and high fusing temperature.

It is to be understood that the specific structure of the spark plug shown and described herein is given merely for purposes of illustration and that numerous other embodiments and modifications are possible and are within the full and intended scope of the invention. The only essential characteristic of the spark plug structure is that it be provided with an insulator having a surface portion positioned between the electrode firing tips and adjacent the spark gap so as to provide an insulator surface abutting path for the electrical discharge during operation of the plug.

As thus far described, the spark plug is not adapted for use in a low tension ignition system. It is the conditioning process now to be described which adapts the plug for low tension operation.

Referring again to Figure 1, the spark plug 4, having an insulator surface abutting the spark gap as previously described, is placed in the electrical circuit as shown and a high voltage is applied across the spark gap.

The amount of voltage used can vary. It is essential,

however, that the initial voltage used in the conditioning treatment be greater than the operating voltage for which the plug is designed. By the term "high voltage," therefore, I refer to voltages greater than the voltage output of the system for which the spark plug is designed for use after conditioning. Thus, for example, if the spark plug is designed for use at 1000 volts after conditioning, the initial voltage used in the conditioning treatment must be greater than 1000 volts. To state this in another way, the voltage initially applied in the conditioning treatment must be high enough to cause a discharge. This voltage will of course always be higher than the voltage required to cause discharge after the treatment is complete since, during the treatment, the plug is conditioned for low tension operation. It will also be apparent that, as the treatment continues, a lower voltage than that initially required can be applied.

The time of this conditioning treatment depends of course on the type of spark plug, on the amount of voltage used and on the precise conditions under which the voltage is applied. For example, a short surge of an extremely high voltage might be used, or a somewhat longer surge of a lower voltage. Thus, the time can be anywhere from a fraction of a second up to a number of minutes.

It is preferable to use a series of high tension discharges for the conditioning treatment rather than one continuous discharge. I prefer to use repeated condenser discharges as the source of high voltage; however, either a capacitive or an inductive discharge system may of course be used. Polarity is not significant in the process; either the positive or negative pole may be connected to the center electrode.

It is often preferable during the conditioning process, or at least during a portion of the conditioning process, to submerge the firing end of the spark plug in an electrical insulating oil such as kerosene or other light mineral oil during the application of the high voltage. This is shown in Figure 1 wherein **60** represents any suitable tank containing an insulating oil **62**, the firing end **64** of the spark plug being submerged therein while the high voltage is applied. The oil serves the purpose of confining the discharge within the spark gap and this has been found to enhance the conditioning treatment. Ordinarily, during operation in air, the discharge tends to bulge out of the gap due to magnetic and thermal effects. This is of course quite desirable during operation of the plug as an internal combustion engine igniter; however, during the conditioning treatment, it is preferable to confine the spark within the gap and this is what is accomplished by the use of the liquid electrical insulating medium as above described.

The following example of a typical conditioning process will serve to better illustrate the invention:

Step 1.—Spark the plug by discharge of a condenser of approximately 4 mfd. charged to a voltage in the range of 2000 to 5000 at a rate of 10 to 30 sparks per second for a time of the order of one minute. 4 to 10 joules.

Step 2.—Spark the plug under oil (insulating oil or kerosene) by discharge of a condenser of approximately 2 mfd. charged to a voltage of the order of 1500 volts at a rate of 10 to 30 sparks per second for a time of the order of one minute. Approximately 2 joules.

Step 3.—Spark the plug in air under identical conditions as in Step 2 for a time of the order of one minute or until the minimum sparking voltage of the plug is 500 volts or lower.

The spark plug conditioned by the above outlined process was of the type shown in Figure 1 and had a gap size of .01 inch. After treatment, it operated efficiently as a creepage gap plug in a 2000 volt circuit and had an extremely long life.

Various types of spark plugs for various uses may be produced by the process of this invention. For jet engine application, energies in the order of 1 joule per spark and an ignition system voltage of about 1500 volts may be used. A spark gap of .025 inch can be utilized in this application, and an initial conditioning voltage of over 1500 volts and generally about 5000 volts is required. For piston engine type plugs, energies in the order of .05 joul per spark and an ignition system voltage of about 3000 volts may be used. In this instance the spark gap can be in the order of .01 inch and an initial conditioning voltage of over 2000 volts and perhaps as high as 10,000 volts will be required.

It is to be understood that the above examples are given merely for purposes of illustration and that other modifications can be used within the full and intended scope of the invention.

Exactly what occurs to the plug during the application of the high voltage to render the plug adaptable for use in low tension systems is not fully known. It is believed that minute amounts of the electrode materials, or of the oil decomposition products, or some combination of these, are spattered onto the surface of the insulator shown at **38** in Figure 2 to render it semi-conductive. Whatever the precise nature of the spark plug or of the insulator surface might be after the high voltage treatment, it has been found that the thus conditioned plugs not only operate very efficiently in a low tension system, but also have a greatly increased operating life over other and prior types of creepage gap plugs.

One reason for the longer life of the spark plugs of this invention is that, in order to obtain creepage gap operation, no layer on the face of the insulator of the type used in prior low tension igniters is used. Because of this, the material for the spark abutting face of the insulator can be chosen solely for its properties of heat and wear resistance and mechanical strength. Thus, that part of the igniter most subject to wear and stress can be specifically designed to meet the high demand for strength and durability, and then, by means of the novel process of this invention, creep gap properties may be imparted.

Various changes and modifications of the embodiments of the invention described herein may be made by those skilled in the art without departing from the spirit and principles of the invention.

I claim:

1. A process for treating a spark plug of the type comprising a pair of electrodes having end portions in spaced relationship to form a spark gap therebetween and an electrical insulator separating said electrodes and having a surface portion interposed between said electrode end portions and adjacent said spark gap, said process comprising the steps of submerging the spark gap of said spark plug in a liquid electrical insulating medium and applying a high voltage discharge across said spark gap while submerged to condition said spark plug for operation in a low voltage system.

2. A process for making a low tension spark plug of the type having a pair of electrodes with end portions in spaced relationship to form a spark gap therebetween, comprising the steps of positioning a surface having good electrical insulating properties between said electrode end portions and adjacent said spark gap, and conditioning said spark plug for low voltage operation by the steps of applying a series of high voltage discharges across said gap while in air, submerging said spark gap in a liquid electrical insulating medium and applying a series of high voltage discharges across said gap while submerged and then removing said spark gap from said medium and applying a series of high voltage discharges across said spark gap while in air.

3. A process for making a low tension spark plug of the type having a pair of electrodes with end portions in spaced relationship to form a spark gap therebetween, comprising the steps of positioning a surface having good electrical insulating properties between said electrode end portions and adjacent said spark gap, and conditioning said spark plug for low voltage operation by the steps of applying a series of discharges of from 2000 to 5000 volts across said spark gap for about one minute while in air, submerging

said spark gap in an electrical insulating oil and applying a series of discharges of about 1500 volts across said spark gap for about one minute while submerged and then removing said spark gap from said medium and applying a series of discharges of about 1500 volts across said spark gap while in air.

4. A process for treating a spark plug of the type comprising a pair of electrodes having end portions in spaced relationship to form a spark gap therebetween and an electrical insulator separating said electrodes and having a surface portion interposed between said electrode end portions and adjacent said spark gap, said process comprising the steps of submerging the spark gap of said spark plug in a liquid electrical insulating medium and applying

a series of high voltage discharges across said spark gap while submerged to condition said spark plug for operation in a low voltage system.

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