

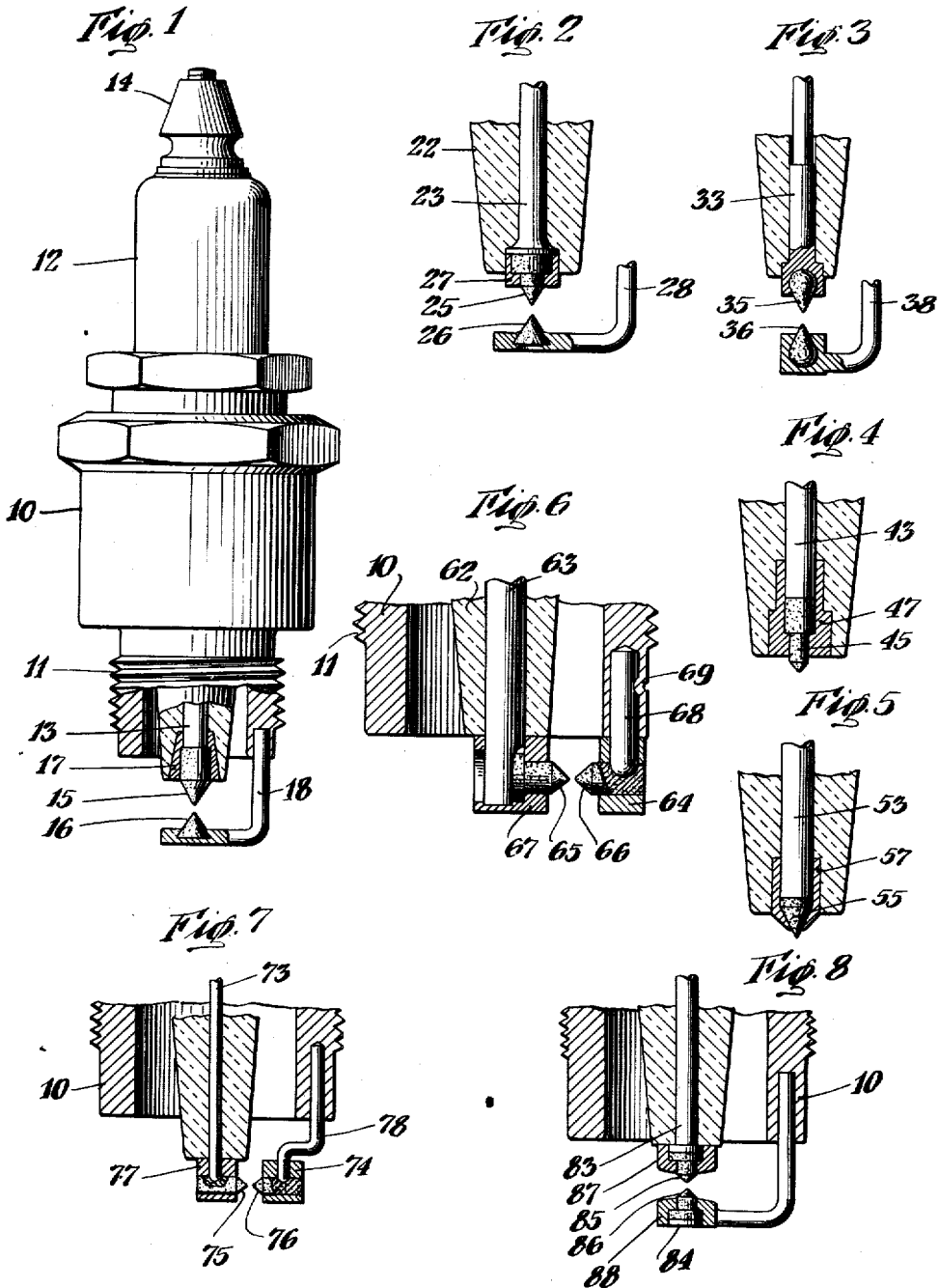
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SPARK PLUG

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SPARK PLUG

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11 Claims. (Cl. 123—169)

This invention relates to spark plugs.

It is an object of the present invention to provide an electrode for spark plugs which will ignite a combustion mixture of gases, such as are used generally in internal combustion engines, more reliably and at lower voltages at the plug and less energy in the primary of an induction coil.

It is a further object to provide a spark plug electrode which will resist the corrosion and erosion produced by modern fuel gases.

It is a further object to provide an improved spark plug electrode which is simple, inexpensive to manufacture and which has a long period of usefulness without replacement or adjustment.

It is a further object to provide a spark plug which will use less current in the secondary and primary ignition circuit and thereby lengthen the life of the primary contact points.

Other objects of the invention will be apparent from the following description and accompanying drawing taken in connection with the appended claims.

The invention comprises the features of construction, combination of elements, arrangement of parts and methods of manufacture and operation referred to above or which will be brought out and exemplified in the disclosure hereinafter set forth, including the illustrations in the drawing.

In the drawing:

Figure 1 is a side elevation of a spark plug for internal combustion engines, shown partly in section, embodying features of the present invention;

Figure 2 is a detail section showing spark plug electrodes of a modified construction;

Figure 3 shows a further modification;

Figures 4 and 5 represent still further modifications of one of the electrodes; and

Figures 6, 7 and 8 show additional forms of electrode assemblies.

The conventional system of ignition depends on an electric spark jumping from one electrode to the other. Measurements have shown that such a spark contains at least ten times as much energy as is necessary for complete ignition.

It has also been shown that very effective ignition can be obtained from an electric discharge from a sharp point. Such a phenomenon is usually known as brush, corona, silent, or simply point discharge.

The generally accepted explanation of ignition by point discharge is that there exists a large voltage gradient at such a point which will cause

acceleration of charged particles which will bombard the gas and cause ignition.

The above-mentioned facts have been known previously and attempts were made to obtain such point discharges from metallic points. The corrosion and erosion, however, caused by the heated atmosphere surrounding the electrode, or by the heat of the spark itself from and to the points caused a very rapid deterioration of such points and after one or two thousand miles considerable blunting and also gap growth occurred.

I have discovered a means by which point discharge can be obtained over long periods of operation without deterioration of such points. My invention is based on the use of a highly refractory material in the construction of such points. The refractory points are so placed that a "point" discharge can occur from the points but if a regular spark is made to jump it will jump from and to the metal parts surrounding the points thus protecting the points themselves from the very high temperature and current density of a regular "spark".

Referring to the drawing, Figure 1 shows a spark plug having discharge electrodes according to my invention, the remaining parts of the spark plug illustrated corresponding to conventional spark plugs at present in commercial use.

The spark plug illustrated comprises a metal sleeve 10 having external threads 11 whereby it may be screwed into operating position in the opening provided in the cylinder head of an internal combustion engine. Insulating core 12 of ceramic or the like is secured and sealed in the central bore of sleeve 10 and a metal terminal rod 13 passes through core 12 thereby providing an external terminal 14 for connecting the ignition circuit of the engine to the spark plug.

According to my invention the discharge electrodes 15 and 16 of the spark plug are formed of refractory ceramic material or other non-metallic material of similar refractory characteristics. It is not essential that the material be electrically conductive and, in fact, most of the materials which I have tested and operated satisfactorily are generally known as insulators. It will be appreciated, however, that even the most highly insulating of substances will ordinarily have sufficient surface or internal conductivity to allow an electric potential to build up at the points when a high potential difference is applied to the terminals. Moreover, it is contemplated that, in some instances the electrodes may be formed of partially conductive material predominantly non-metallic in nature.

The following are examples of materials which are suitable for forming the discharge electrodes:

A. Refractory ceramics, such as refractory porcelains, kaolins and other silicates.

5 B. Refractory oxides of some of the metals, for instance, magnesium oxide and aluminum oxide.

C. Refractory carbides, such as silicon, tungsten and boron carbides.

10 D. Refractory carbonates, such as barium carbonate.

E. Refractory borides, such as titanium boride.

F. Refractory nitrides, such as iron nitride.

G. Refractory glasses and fused or cut quartz.

The materials listed can be produced by well known and standard methods such as fusing, sintering, fritting, firing or the like and may be formed into the shapes desired for the electrodes by molding, cutting, grinding or other methods applicable to the substances used. Where possible, it is to be preferred that the outer surface of the electrodes be smooth or glazed in order better to resist the erosive effects of the exploding gases.

25 While electrodes of pointed or conical shape are preferred because of their ability to produce a point discharge, either one of both electrodes may be of other shapes such as plane or rounded.

Refractory electrode 15 has a conical point and a cylindrical base which rests against terminal rod 13. The abutting ends are embedded in a sleeve 17 of metal. Refractory electrode 16 is conical in shape and is secured in the end of metal support rod 18 by providing a recess in the side of rod 18 into which the base of conical electrode 16 is inserted after which the walls of the recess are spun over the edge of the electrode. Electrode 16, in use, will be grounded to the engine block through rod 18 and shell 10.

Figure 2 shows other means of mounting the electrodes in the supporting members. In this form the terminal rod 23, passing through ceramic insulator 22, is enlarged at its inner end to provide a flat table portion. Refractory electrode 25 is provided with a disc-shaped head portion which rests against the table portion of the rod and a metal retaining shell 27 is placed over the electrode head and welded to the rod table portion around the edge as shown. Conical refractory electrode 26 is inserted in a conical aperture in metal support 28 and the metal is then spun over the base of the cone.

The refractory electrodes 35 and 36 shown in Figure 3 are tear-shaped and the metal supports 33 and 38 are provided with suitable rounded recesses to receive the rounded heads of the electrodes. The metal is then pressed around the tapered parts of the electrodes to secure them in the holders. This shape may be especially well suited for use where the electrodes are of glass or fused quartz.

Figure 4 shows an electrode 45 of somewhat more elongated form which is in abutment with the end of terminal rod 43, both the head of the electrode and the end of the rod being surrounded by a metal sleeve 47 which is welded to rod 43.

In Figure 5 the electrode 55 is conical in shape and in abutment with the end of terminal rod 53. Metal sleeve 57 encloses the end portion of rod 53 and is welded to it. The end of sleeve 57 is spun inward over the conical surface of the electrode leaving the tip of the electrode exposed. Sleeve 57 can also be made by machining to shape.

According to the arrangement of Figure 6 the terminal rod 63 projects beyond the end of insulator 62 and is flattened on one side. The head

of electrode 65 rests against the flattened portion and a metal shell 67 surrounds the assembly, the shell being welded to the rod. Electrode 66 has a cylindrical base portion provided with a recess in its side which receives the rounded end of metal support rod 68. A metal sleeve 64 surrounds the assembled parts and is welded to rod 68. Rod 68 is fitted into a recess in the wall of shell 10 and has an indent 69 in its side into which the material of shell 10 is forced to secure the parts together.

In Figure 7 both electrodes 75 and 76 are pointed pencils of refractory material having recesses in their sides into which the rounded tips of metal supports 73 and 78 extend. Metal shells 74 and 77 surround the electrodes and are welded to the supports.

Figure 8 shows a form in which both electrodes 85 and 86 are provided with integral disc-shaped head portions by which the electrodes may be supported in apertures in surrounding shells 87 and 88, respectively. Electrode 85 abuts against a table portion formed on the end of rod 83. Electrode 86 is retained in place by a metal disc insert which is welded into the opening of shell 88 against the head of the electrode.

I have made a series of tests under actual service conditions of spark plugs having ceramic points mounted as shown in Figure 8. Six of these plugs were mounted in the engine of a 1934 model Studebaker automobile. The ceramic point spacing was .015 inch and the spacing of metal parts 87, 88 was .057 inch. The ignition circuit of the engine was opened at the switch and a potentiometer was inserted so that the battery voltage could be varied.

The engine was allowed to warm up and then was stopped in the conventional way, except that the hand throttle was set permanently to give good starting and running corresponding to about 10 miles per hour. The voltage was lowered until failure of starting and running was obtained. The standard commercial spark plugs, in good condition and having a gap setting of .030 inch were then tested under the same conditions and within the same half hour of engine operation. The engine was started and run satisfactorily with my ceramic points at from 1.6 to 2.2 volts. With the standard plugs the lowest voltage at which the engine could be started and run was 3.3 volts.

The ceramic point plugs were tested for hill climbing, slow running and high speed running and the standard plugs were similarly tested over the same road during the same half hour. The ceramic point plugs operated satisfactorily under all these conditions. On the high speed test it was found that the ceramic plugs operated without missing up to the limit of the speed of the car, about 75 miles per hour, whereas the standard plugs began to show occasional missing at about 68 M. P. H.

After my ceramic plugs had been operated in the automobile for 2000 miles they were examined for wear and no appreciable change in point spacing was noted.

In the above tests the standard ignition coil and distributor were used. However, the special characteristics of this plug make it possible to redesign the ignition circuit to obtain further improvement in operating characteristics. I propose that the ignition coil be so designed as to provide a steeper wave front. This will further improve the ignition, starting and high speed running characteristics. The wave front can be

made steeper by reducing the primary-secondary and the secondary distributed capacity and can also be improved by reducing the capacity and inductance of the high tension conductors and connections.

With refractory, non-metallic spark plug electrodes it is possible to materially reduce the current consumed in the ignition circuit and to greatly lengthen the life of the spark plugs.

While the present invention, as to its objects and advantages, has been described herein as carried out in 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 a pair of discharge electrodes, at least one of said electrodes being composed of refractory ceramic insulating material.
2. A spark plug comprising a pair of discharge electrodes, at least one of said electrodes being composed of refractory insulating material.
3. A spark plug comprising a pair of discharge electrodes, both said electrodes being composed of refractory ceramic insulating material.
4. A spark plug comprising a pair of discharge electrodes, both said electrodes being composed of refractory insulating material.
5. A spark plug comprising a pair of discharge electrodes, at least one of said electrodes being formed with a pointed discharge terminal and being composed of refractory material.
6. A spark plug comprising a pair of discharge

electrodes, at least one of said electrodes being formed with a pointer discharge terminal and being composed of refractory non-metallic material.

7. A spark plug comprising a pair of discharge electrodes, at least one of said electrodes being formed with a discharge point and being composed of refractory ceramic material.

8. A spark plug comprising a pair of discharge electrodes, at least one of said electrodes being formed with a discharge point and being composed of refractory insulating material.

9. A spark plug comprising a pair of discharge electrodes of refractory insulating material and metallic terminal conductors in contact with said electrodes.

10. A spark plug comprising a pair of discharge electrodes, at least one of said electrodes being formed with a pointed discharge terminal of refractory non-metallic material selected from the group consisting of the refractory ceramics, oxides, carbides, carbonates, borides, nitrides, silicates, glasses and quartz.

11. A spark plug comprising a pair of pointed discharge electrodes of refractory insulating material mounted in spaced, opposed-point relation whereby point discharge may occur between them and individual metal terminals in contact with each of said electrodes, said metal terminals providing opposed metal surfaces spaced at greater distance than said insulating discharge electrodes whereby to provide a spark discharge path independent of said insulating discharge electrodes.

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CERTIFICATE OF CORRECTION.

Patent No. 2,159,791.

May 23, 1939.

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It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 3, second column, line 2, claim 6, for the word "pointer" read pointed; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 1st day of August, A. D. 1939.

(Seal)

Henry Van Arsdale,
Acting Commissioner of Patents.

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4. A spark plug comprising a pair of discharge electrodes, both said electrodes being composed of refractory insulating material.
5. A spark plug comprising a pair of discharge electrodes, at least one of said electrodes being formed with a pointed discharge terminal and being composed of refractory material.
6. A spark plug comprising a pair of discharge

electrodes, at least one of said electrodes being formed with a pointer discharge terminal and being composed of refractory non-metallic material.

7. A spark plug comprising a pair of discharge electrodes, at least one of said electrodes being formed with a discharge point and being composed of refractory ceramic material.

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