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SPARK PLUG CONSTRUCTION

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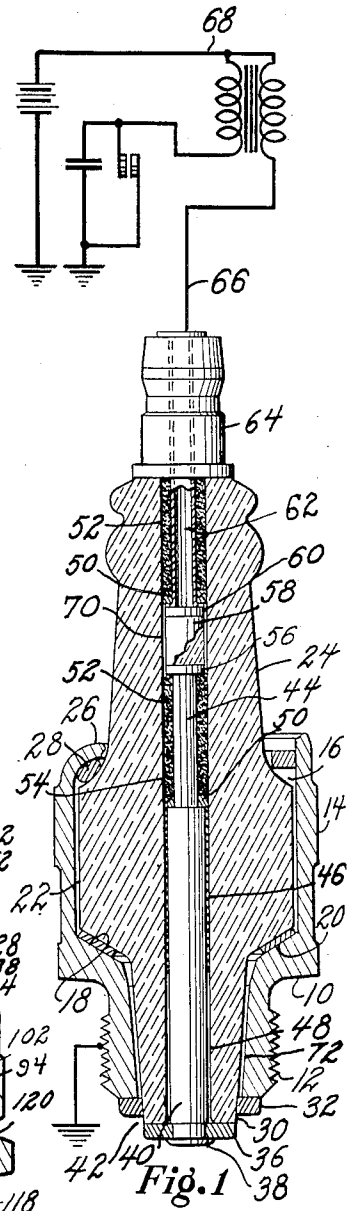


Fig. 1

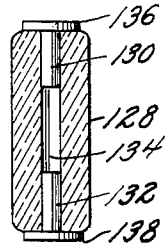


Fig. 4

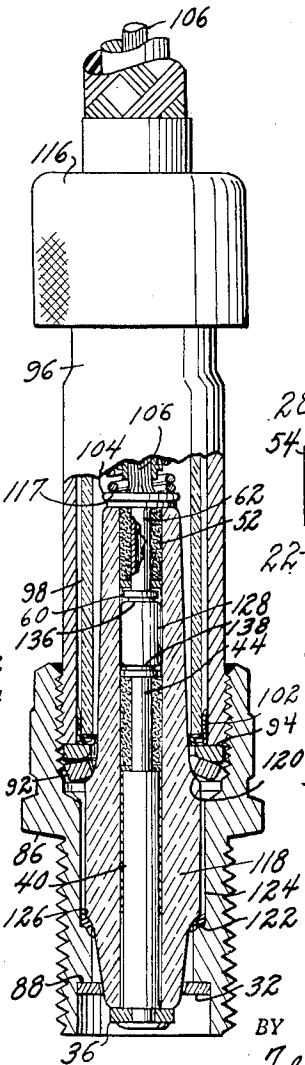


Fig. 3

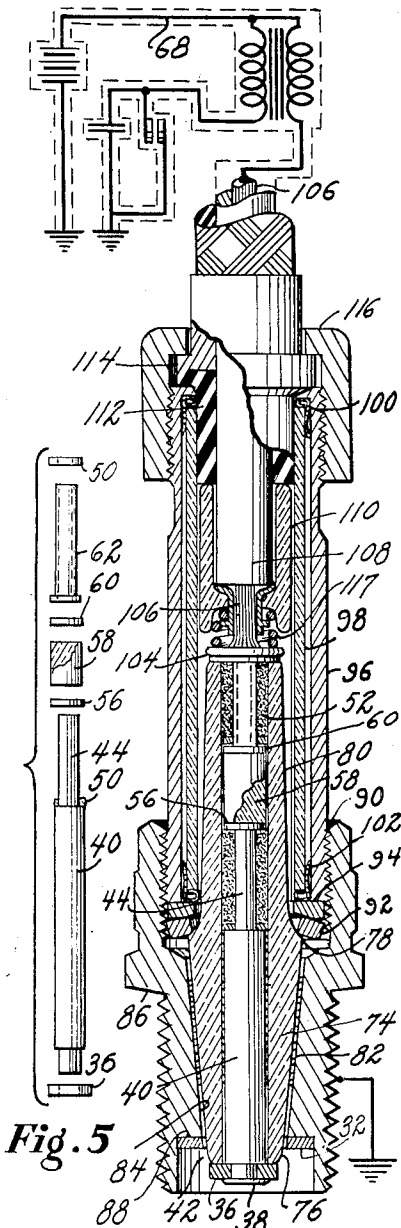


Fig. 5

Fig. 2

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SPARK PLUG CONSTRUCTION

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4 Claims. (Cl. 123—169)

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This invention relates to spark plugs, more particularly to the electrodes thereof, and to an efficient cooperating temperature distribution in the spark plugs.

In internal combustion engine ignition systems it has long been desirable to provide a self-cleaning spark plug which would not foul even though the engine was operating under the widest possible, most exacting conditions. Self-cleaning features of a spark plug have been sought by attempting to control the heat range of the plug whereby the temperature conditions in the parts of the plug exposed to burning gases in the combustion chamber of the engine were such that formation and deposition of carbon and other residues were retarded or burned away as rapidly as deposited. It has been attempted to maintain the temperature of the firing tip of the insulator body within a range where the self-cleaning process would be continuous or at least sufficiently intermittent to maintain the plug in efficient firing condition. Often the selected heat range resulted in the plug remaining too cold when the engine was operated under idling conditions and fouling resulted, and if the heat range maintained resulted in providing a self-cleaning plug at idling speeds, the resultant hotter plug would break down at high speed, full load conditions. Furthermore, when plugs of this type were used in two-cycle engines, this condition was materially aggravated and results were very unsatisfactory.

In two cycle engines, a cold plug would quickly foul at idling, while a hot plug, while not so fouling in the same sense, would be destroyed in a very short time under high speed, full load operating conditions.

The present invention results in the production of a spark plug which is inherently self-cleaning at the spark gap and is not dependent upon temperature conditions for the cleaning action to be efficient. The heat range of a plug utilizing the present invention is not a particularly material factor, except that the plug must be uniformly cold to be highly resistant to localized temperatures of high order so any disrupted temperature will not be maintained and hence the plug experiences a long life under the most onerous operating conditions.

The invention further embraces the provision of a spark plug which includes an annular spark gap, preferably having an intervening ceramic insulator surface which is scrubbed or swept by the action of the spark so as to be completely self-cleaning. A series intensifier gap integral with the plug is provided in coacting combination with

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the annular gap to control the breakdown voltage at the gap. The series gap is preferably sealed from the atmosphere to insure uniform breakdown voltage, despite variations in ambient atmospheric conditions arising from pressure and/or relative humidity.

It is, therefore, a principal object of this invention to provide a spark plug which is self-cleaning under all conditions in the firing chamber of an internal combustion engine and is particularly independent of temperature conditions in its self-cleaning operation.

It is a further object of this invention to provide a spark plug satisfactorily operable with heat ranges which are encountered in all automotive engines.

It is a further object of this invention to provide a spark plug having an annular spark gap in series with an intensifier gap, which annular gap is self-cleansing and will not foul under widely varying conditions in the combustion chamber of an internal combustion engine.

It is still a further object of this invention to provide a self-cleaning spark plug which is suitable for use in two-cycle engines.

Still an additional object of the invention is to provide an economical spark intensifier construction of constant characteristics under variable operating conditions and which is readily incorporated within the plug as a component of an electrode.

Other objects and advantages of this invention relating to the arrangement, operation and function of the related elements of the structure, to various details of construction, to combinations of parts and to economies of manufacture, will be apparent to those skilled in the art upon consideration of the following description and appended claims, reference being had to the accompanying drawings forming a part of this specification wherein like reference characters designate corresponding parts in the several views.

Referring to the drawings:

Fig. 1 is a longitudinal section through a spark plug for an internal combustion engine, the plug embodying features of the invention herein;

Fig. 2 is a longitudinal section through a spark plug of the shielded type and embodying additional features of the invention;

Fig. 3 is a view, similar to Fig. 2, showing a modified form of the spark intensifier and of the heat distribution features;

Fig. 4 is a longitudinal section, on an enlarged scale, through the spark intensifier element disclosed in the structure of Fig. 3; and

Fig. 5 is a distributed view of the parts form-

ing the assembly of a center electrode employed in a construction of a spark plug of the invention herein.

Referring to Fig. 1, the spark plug disclosed comprises a base or shell member 10 having threaded extension 12 for mounting the plug on an engine with the extension extending into the firing chamber thereof (not shown). This shell is provided with external polygonal portion 14 by which the plug may be securely mounted in operative position, and internal chamber 16 having ledge 18 as a seat for sealing gasket 20, upon which enlarged portion 22 of insulator 24 is mounted and held in gas-tight relationship as by spinning the upper edge 26 of the shell over compression ring 28 which is forced against the upper perimeter of the enlarged portion of the insulator.

The ceramic insulator has extension 30 through the threaded portion 12 extending into a firing chamber. Ground electrode 32, in the form of a nickel or suitable alloy ring, surrounds the extension 30 and is fixed to the portion 12 by brazing or welding, employing, for example, a silver solder. The lower terminus of the extension 30 is juxtaposed to and extends beyond the electrode 32 for a predetermined distance whereby an annular portion of the insulator surface is exposed.

The spark plug is provided with a sectional center or firing electrode, mounted axially of the insulator, which electrode comprises a firing plate 36 having a peened or other suitable connection 38 with stem 40 extending upwardly as a core into the insulator 24. The ring 36 is fixedly held against the insulator terminus 30 in concentric relation as to the ground electrode 32, thereby forming an annular spark gap 42, across which there may be an ionized electronic flow in the sparking operation. This flow may be of a sweeping or scrubbng nature across the exposed surface of the insulator which maintains this region free from any deleterious accumulations and hence resulting in a self-cleaning plug. The stem 40 terminates in a reduced diameter portion 44 within the body of the ceramic insulator.

As an assembling and sealing means for this electrode and insulator, a suitable cement 46 may surround the upper portion of the stem 40, leaving a clearance or washback 48 within the plug body between the ring 36 and the cement, which clearance may be of a predetermined length and insures against fracture of the firing tip and along the insulator extension 30, due to the wide changes in temperature encountered in this region.

A washer 50 of asbestos or other suitable material may be placed around the stem portion 44 adjacent the terminus of the major diameter stem portion 40, and a filler placed about the remainder of the portion 44 in the form of a powder-pack 52 of talc, ceramic powder, or the like.

Resting against the free end of the stem portion 44, within the axial bore 54 through the insulator, is metallic plate 56, on which is mounted a ceramic pellet or rod 58 of predetermined dimensions. This element, as an example of one desired construction, may be approximately .150" and of a diameter about .010" less than the diameter of the bore or duct 54. These dimensions are quoted as a typical example but, of course, are subject to considerable variation in a range of spark plug designs. Against the rod end, remote from the plate 56, there is disposed a second plate 60, against which the expanded head or a tubular eyelet or rivet type conductor 62 may be placed in electrical communication therewith. This member 62 extends outwardly toward upper portion of the insulator to there engage a terminal 64, which is mounted on the insulator and which terminal is adapted to be engaged by a suitable connector with lead 66 extending from a high tension electrical energy source 68, such as an ignition circuit for an internal combustion engine.

It will be seen energy flow in the circuit is from the source 68, through lead 66, terminal 64, tubular conductor 62, to the plate 60 and then jumps or by-passes the ceramic rod element to plate 56. There is thus formed a controlled intensifier gap 70 in series with the stem portions 44, 40, the annular ring 36, the spark gap 42 to ground. The intensifier gap 70 is of relatively higher voltage breakdown than the ignition spark gap 42. By the use of one or more plugs in cooperation with a firing chamber of an internal combustion engine, a continued desirable igniter source is provided for fuel. The member 62 may also be surrounded by a sealing pack 52 on washer or gasket 50, resting against the expanded head, which pack fills and seals the duct 54 about this portion of the electrode. In the construction so described, heat from the region of the gap 42 is readily radiated by the insulator portion 22, through the shell and dissipated into the atmosphere or transmitted to the engine block and with the washback 48 and the clearance 72 between the extensions 12 and 30 fractures are reduced to a minimum by elimination of any localized heating.

The invention may be satisfactorily incorporated in plugs not only enjoying the full self-cleaning advantages but adapted, through body design, to meet the problems encountered in various temperature ranges so a plug of maximum cold range operation results.

For example, referring to Fig. 2, showing a shielded type of spark plug, the sectional electrode, including the spark gap defining elements, may be mounted in insulator 74 having portion 76 downwardly tapering and terminating in the spark gap 42, said portion upwardly terminating in shoulder 78, and from which there extends tapered portion 80. Surrounding a fraction of the surface of the portion 76 is a high heat conductive metallic sheath or gasket 82 which may be of copper, silver, or the like. This gasket rests on inner face 84 of shell 86, the extent of the face 84 being complementary to the taper of the insulator portion 76. The shell 86 is provided with lower internal seat 88, in which the ground electrode 32 may be fixed.

The shell 86 is also provided with an upwardly extending chamber 90.

Resting upon the shoulder 78 within the chamber 90 is a compensator spring 92, abutted by spring rest 94 which, by the threaded action between shielding sleeve 96 and the shell 86, the spring rest is forced against the compensator spring, thereby assembling these parts in sealing relation.

Within the shielding sleeve 96 and concentric therewith is insulator tube 98, positioned by two retainers 100, 102, the tube being held in position by a spinning thereover of a portion of the upward terminus of the shielding sleeve 96. The tube retainer 100 is held against the upper end of the tube 98 and the retainer 102 may be between the upper surface of the spring rest 94

and the lower edge of the insulating tube **98** with retainer extensions between the tube and shielding sleeve. The electrical energy may be conducted to the sectional electrode by placing plate **104** on the upper terminus of the conductor **62**, against which high tension lead **106** may be positioned by means of fitting **108** in insulation bushing **110**, held in position within the insulating tube **98** by means of insulator grommet **112**, collar **114**, and gland nut **116** in threaded connection with the shielding sleeve **96**. Spring **117** may be inserted between the plate **104** and bushing **110** to improve the electric contacts and maintains the related parts in assembled position. This high tension cable **106**, together with the ignition system **68**, may be entirely shielded, as indicated by the dotted lines in Fig. 2, thereby defeating any transmissions which may interfere with radio reception in the neighborhood employing this invention.

The effect of this shielding is to also increase the capacitance of ignition system with the resulting benefits.

It is to be noted, by such an insulator mounting, heat is rapidly transferred from the portion **76** through the gasket **82** into the shell **86** to be dissipated thereby.

Referring to Fig. 3, the center electrode insulator embodies a cylindrical central portion **118** with upper and lower shoulders **120**, **122**, which portion **118** is mounted in complementary chamber **124** of the shell **86** with the shoulder **122** on sealing gasket **126** between it and the shell, while the shoulder **120** cooperates with a superstructure, similar to that shown in Fig. 2. Here again, a modified structure is disclosed for satisfactory operation within a predetermined heat range whereby all heat from the spark gap **42** is dissipated through the cylindrical portion **118** without any localizing.

While a satisfactory intensifier gap is formed by placing a dielectric separator **58** of calculated dimensions between plates **56**, **60**, improved results for some conditions may be had by using another form of spacer, such a dielectric tube **128** of glass or the like, having electrodes **130**, **132**, extending into bore **134** through the tube, the electrodes being provided with terminal plates **136**, **138** which may be placed in electrical contact relation in series with the center electrode. The electrodes **130**, **132** are hermetically sealed within the body **128**, and the space between their termini within the bore **134** may be evacuated or filled with an inert gas. By the use of this latter spacing element, a constant pressure in the intensifier gap is maintained, regardless of ambient pressures or relative humidity.

In a spark plug of the more common dimensions, this sealed series gap, especially adapted for use in a shielded plug, has an approximate overall length of 3/8" with a gap length approximating .160–.150 to give breakdown of 6,000–9,000 peak volts, the voltage to remain within these limits when the gap is subjected to 29" Hg vacuum and 650 degrees Fahr. temperature for 8 hours. Again, these figures are given to indicate but one satisfactory range well within limits allowable in either direction therefrom.

It is to be understood that the above detailed description of the present invention is intended to disclose an embodiment thereof to those skilled in the art, but that the invention is not to be construed as limited in its application to the details of construction and arrangement of parts illustrated in the accompanying drawings, since the invention is capable of being practiced and carried out in various ways without departing from the spirit of the invention. The language used in the specification relating to the operation and function of the elements of the invention is employed for purposes of description and not of limitation, and it is not intended to limit the scope of the following claims beyond the requirements of the prior art.

What is claimed and it is desired to secure by United States Letters Patent:

1. In combination with a source of high tension electrical energy, a spark plug having a spark gap defined by two electrodes one of which is grounded, an insulating body of ceramic material insulating the other electrode from said grounded electrode, said insulating body being exposed to the electric spark between the two electrodes in the spark gap and subject to the action of ionization of the electric spark, and an intensifier gap having a break-down voltage from 6 to 9 thousand peak volts, relatively higher than the break-down voltage of the spark gap, said intensifier gap being positioned in the spark plug adjacent the spark gap and connected in series with a source of electrical energy and the spark gap.

2. The combination set forth in claim 1 further characterized by having the intensifier gap positioned in a hermetically sealed chamber.

3. The combination set forth in claim 1 further characterized by having the intensifier gap positioned in a sealed chamber containing an inert gas.

4. In combination with a source of high tension electrical energy, a spark plug having a spark gap defined by two concentric electrodes, one of which is grounded, an insulating body of ceramic material insulating the other electrode, said insulating body being exposed to the electric spark between the electrodes and subject to the action of ionization of the electric spark, and an intensifier gap of relatively higher break-down voltage than the spark gap and positioned adjacent thereto in series with the source of electrical energy and the spark gap, said elements of the spark plug being arranged for maximum heat conductivity whereby a "cold" rating is acquired for the plug in its intended use.

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