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SPARK PLUGS

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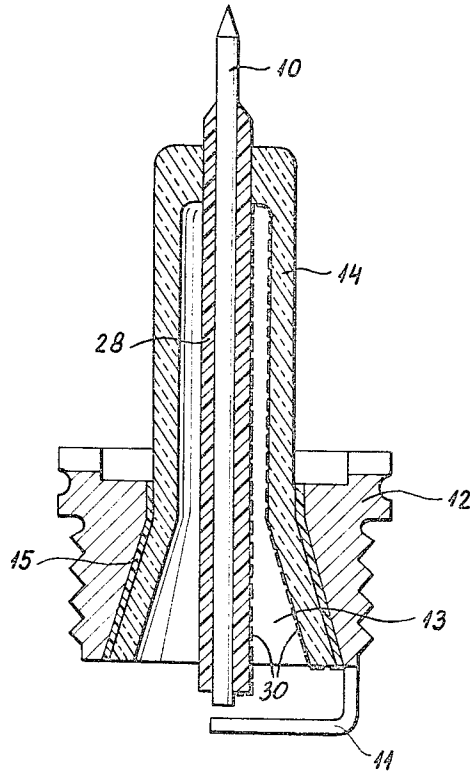

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SPARK PLUGS

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Continuation-in-part of application Ser. No. 391,905, Aug. 25, 1964. This application May 31, 1967, Ser. No. 649,777
Claims priority, application Hungary, Sept. 17, 1963, SI-860
1 Claim. (Cl. 313—143)

ABSTRACT OF THE DISCLOSURE

A spark plug has a middle electrode having a hot end and a cold end and a casing having a counter electrode at the hot end, and an insulating shell holding and surrounding the middle electrode but leaving an interstice therearound. The shell is fixed to the casing by a bonding layer, along a conical surface that converges toward the cold end. This shell is a part cylindrical and part conical tubular body of constant wall thickness, and the middle electrode is fixed in the shell at the cold end. The interstice is unobstructed along its whole length, thereby to provide a long creeping path between the electrodes. An insulating layer covers the middle electrode up to its hot end.

Cross reference to related application

This application is a continuation-in-part of copending application Ser. No. 391,905, filed Aug. 25, 1964.

This invention is concerned with spark plugs of the type having a center or middle electrode, a casing made of electrically conductive material and provided with a counter electrode, and a shell made of insulating material and surrounding said middle electrode but leaving an interstice therebetween.

Such spark plugs are already known and are called gas-insulated spark plugs. They are distinguished by having no insulating component parts which would glow at high temperatures, because the middle electrode of the spark plug is surrounded and insulated by exploding gas under pressure. The covering shell of insulating material is, as a rule, made of glass by which it is rendered possible to observe the spark discharge between electrode and counter electrode as well as the course of explosion. The small amount of gas inside the shell is ignited upon the spark being discharged and ignites, in turn, the mixture present in the adjacent explosion chamber.

As is known, such gas-insulated spark plugs are distinguished by the great advantages of reliable ignition, considerable saving in fuel, a relatively higher engine output and performance, improved acceleration conditions, perfect controllability of ignition and carburetion, and a surprisingly easy readiness of starting. Furthermore, they permit the employment of relatively inexpensive glass instead of expensive corundum.

The main object of the present invention is to provide a spark plug of the above-described type distinguished by a long lifetime and by great reliability of operation. At the same time, the new spark plug is of very simple construction and inexpensive to produce. For this purpose, the invention is based on a spark plug having, in a manner known per se, a middle electrode defining a hot and a cold end, a casing provided with a counter electrode at said hot end, and an insulating shell holding and surrounding said middle electrode but leaving an interstice therearound and fixed in said casing along a conical surface converging toward said cold end. The said shell is a tubular body of substantially invariable wall thickness fixed to said casing by means of a bonding layer, said middle electrode being fixed in said shell at said cold

end so as to leave said interstice unobstructed along its whole length, and being covered by an insulating layer so as to provide a long creeping path inside said interstice between said electrodes.

It has been found that the employment of a bonding layer ensures a uniform warming up of the wall of the insulating shell along its whole length, besides compensating differences in thermal expansion between the insulating shell and the metal casing. Thereby, also abrupt changes of the temperature of the shell where it emerges from the casing are avoided. This is vital for the long lifetime of the new spark plug.

If it is considered that the shell is not incandescent in operation, because of the gases by which its walls are constantly swept and cooled, the long creeping path obviously ensures a reliable operation of the new spark plug in which deposits will not be transformed into conductive components short-circuiting the spark gap even if such deposits were able to cling to the smooth glass wall, which they are not.

The simplicity of the construction follows from the small number of component parts and the fixing of their mutual positions by means of bonding the glass shell in the casing and of soldering the middle electrode in the glass shell.

Further details of the invention will be described by taking reference to the accompanying drawing which shows, by way of example, a longitudinal sectional view of an exemplified embodiment of the gas-insulated spark plug according to the invention.

A middle electrode **10** of the spark plug according to the invention defines a hot end which is at its extremity adjacent to the spark gap of the plug, and a cold end which is opposite to the former. The middle electrode **10** cooperates, in a manner known per se, with a counter electrode **11** which is fixed in a casing **12** made of electrically conductive material such as metal. The middle electrode **10** is surrounded by a shell **14** of unobstructed annular cross-sectional area made of insulating material, an interstice **13** being left therebetween.

The shell forms a tubular body **14** made of glass or the like, and has unvarying wall thickness. It is cemented into a bore of the casing **12**. A bonding layer is designated by reference character **15**. The suitability of cementing for such purpose has amply been provided in the course of experiments. Viz, the outer threaded portion of the casing **12** of the spark plug shown in the drawing is, in all cases, connected with a seat well cooled by air or water. Being made of highly heat-conductive material, it assumes the low temperature of its ambiency. On the other hand, the glass body **14** covering the greater portion of the bore in the casing **12** and being made of a material of relatively poor heat conductivity likewise protects the metal parts of the spark plug against heat action of exploding gases. Thus, it is easy to find a bond the melting point of which suitably surpasses the maximum temperature to which the layer **15** may be exposed. Most epoxy resins are suitable for the purpose. They should withstand temperatures up to 350° F. and have a bonding strength of at least about 1500 p.s.i. Suitable examples are the epoxy resins sold under the trade names "Araldite" and "Devcon."

The casing **12**, the shell or glass body **14** and the bonding layer **15** fit one another along partly conical and partly cylindrical surfaces. The conical portion diverges toward the hot end of the spark plug and converges toward the cold end thereof, that is, downwardly and upwardly, respectively, as regards the drawing. Obviously, the surface of the bore in the casing **12** or the outer surface of the glass body **14** may be graduated

or composed of surface portions associated with various cone angles as well.

The construction by which shell **14** is partly cylindrical and partly conical is particularly advantageous. The conical portion facilitates the insertion and positioning of shell **14** in casing **12** during manufacture, and also ensures that the pressure in the cylinder will help retain the shell **14** assembled in casing **12**. The cylindrical portion provides enough cross-sectional area at the cold end to facilitate the attachment of middle electrode **10** at that end and also ensures the provision of an interstice **13** whose shape promotes turbulence of the gas and hence cooling of the middle electrode **10**. Finally, it is to be noted that length of the cylindrical portion of shell **14** extends within casing **12**. The resulting uniformity of cross section of shell **14** where it emerges from the cold side of casing **12** provides protection against damage from steep temperature gradient at this point of emergence and resultant concentrations of mechanical stress.

Furthermore, the middle electrode **10** is covered by a layer **28** made of a material of low thermal capacity. Such layer may consist for example of a thin-walled insulating pipe, whose thickness is exaggerated in the drawing, of enamel or any sealing glass, whose coefficient of thermal expansion lies between those of middle electrode **10** and shell **14**. Due to the low thermal capacity, the thermal variations occurring in an associated internal combustion engine can easily be followed by the electrode **10** and its protecting layer **28**. Moreover, the "creeping path" of the spark plug, illustrated by dotted line **30**, becomes doubled in length, which is of particular significance in the case of heavy loads. The "creeping path" is the shortest path by which an electrical discharge or leakage could occur along a solid surface between electrodes **10** and **11** instead of across the air gap between the electrodes.

From a consideration of the foregoing disclosure, therefore, it will be evident that the recited object of the present invention has been achieved.

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

Having described my invention, I claim:

1. A spark plug having a middle electrode having a hot end and a cold end, a casing having a counter electrode at said hot end, an insulating shell holding and surrounding said middle electrode but leaving an interstice therearound, said shell being fixed in said casing along a conical surface converging toward said cold end, said shell being a tubular body of substantially constant wall thickness, said middle electrode being fixed in said shell at said cold end so as to leave said interstice unobstructed along its whole length thereby to provide a long creeping path inside said interstice between said electrodes, and an insulating layer covering said middle electrode up to the hot end of the electrode thereby to increase the length of said creeping path between said electrodes.

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