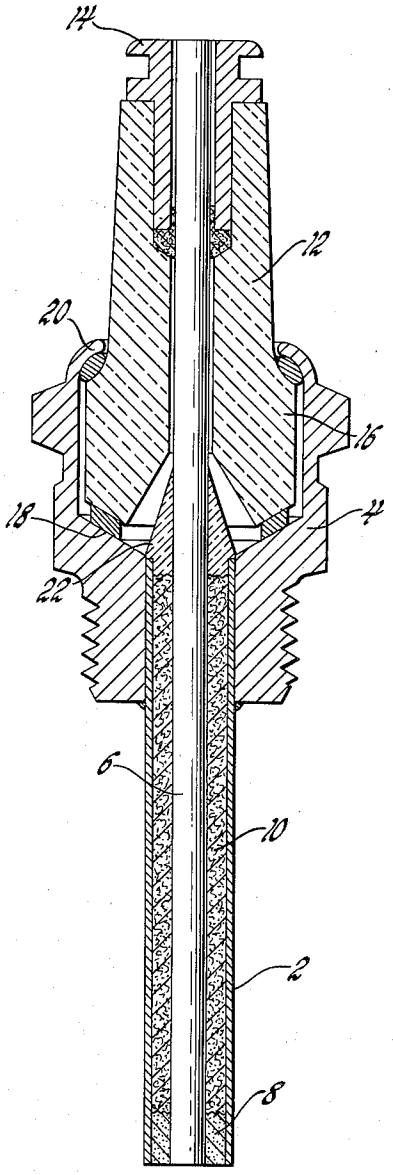
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SPARK PLUG

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SPARK PLUG

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This invention relates to an improved spark plug and has as its principal object the provision of a spark plug of the low tension type which is of simple and therefore economical construction and yet which is rugged, durable, and efficient. Spark plugs made in accordance with the invention are intended for wide utility in aircraft, automotive, marine, stationary and miniature engines. Other objects and advantages of the invention will appear more clearly from the following detailed description thereof made with reference to the appended drawing which shows a side view in section of a preferred embodiment of the invention.

Briefly, the invention comprehends a spark plug comprising a metal tube having a center electrode extending therethrough and packed tightly with a powdered ceramic material which electrically separates the center electrode from the shell. Extending between one end of the shell and the adjacent end of the center electrode is an annular semi-conductive mass which forms a low tension spark path between the shell and the center electrode.

The invention will be described in detail by reference to the accompanying drawing which shows a side view in section of a preferred embodiment thereof.

Referring now to the drawing, **2** is a thin walled cylindrical metal tube having its upper end brazed within a metal shell **4** which is threaded at the lower end for securement of the spark plug in the combustion chamber of an internal combustion engine. A metal center electrode wire **6** is positioned axially and concentrically within, and terminates flush with the lower end of the tube. The annular space between the lower end of the tube and the lower end of the center electrode is filled with a mass of semi-conductive material **8** which is bonded to the tube and to the center electrode and which serves as a low tension path for arcing between the bottom of the center electrode and the bottom of the tube which serves as the ground electrode. The remainder of the space between the center electrode **6** and the tube **4** is filled with a tightly compacted mass of powdered ceramic material **10**.

Center electrode **6** extends upwardly from the tube through a ceramic insulator block **12** and terminates with a metal contact element **14** brazed thereto for electrical connection of the plug to an ignition lead. A shoulder **16** on the insulator block together with upper and lower metal gaskets cooperates with an internal annular shoulder **18** and an inturned flange **20** on the shell **4** to secure the insulator block within the shell in the conventional manner. To prevent internal flash-over, the otherwise exposed portion of the center electrode **6** within the shell **4** is coated with a nonconductive enamel **22**.

To obtain maximum durability the tube and center electrode should preferably be of nickel or other high heat and wear resistant metal, since the lower ends of these elements form the electrodes of the spark plug. If desired, the upper portion of the tube may be of a relatively inexpensive material such as steel and the lower end, which forms the ground electrode, of nickel or the like welded to the upper portion. The center electrode can likewise be of steel with a nickel firing tip welded to the lower end thereof. Also, if desired, the spark gap size may be reduced by providing the end of the center electrode with a head portion of increased diameter or by forming the end of the tube with an inwardly extending thickened portion to serve as the ground electrode. However, at least the lower portion of the center electrode and the lower portion of the tube should be of uniform thickness such that, as these elements and the semi-conductive mass wear away from arcing, the gap size remains constant.

The semi-conductor **8** may be in the form of a fused mass of either semi-conductive material or a mixture of conductive and nonconductive materials. For example, a mixture of about 55% finely divided powdered metal, such as nickel, chromium cobalt or a mixture thereof, and 45% alkali borosilicate glass may be used. Alternatively, a glass-bonded semi-conductive metal oxide may be used if desired. Various semi-conductors for low tension type spark plugs are well known in the art, and the precise composition of the mass **8** forms no part of the present invention.

The insulator material **10** may be any suitable ceramic powder, preferably magnesium oxide. To obtain a compact mass, it is preferable that a grain size of 100 mesh and finer be used. If desired, a suitable ceramic cement may be admixed with the powder.

The following method may be used to manufacture the spark plug at low cost. Center electrode **6** is centered in tube **2** and the tube completely filled with powdered magnesium oxide having a grain size of 100 mesh and finer. The powder is compacted tightly by tamping and by swaging of the tube. Nonconductive layer **22** is then applied and the upper end of tube **2** brazed within the shell **4**. As the nonconductive layer **22**, the glass composition covered by United States Patent 2,949,376, issued August 16, 1960, to Richard L. Comer, may be used to advantage. Insulator **12** along with associated gaskets is positioned in the shell, flange **20** turned inwardly to secure the insulator within the shell as shown, and contact element **14** secured to the upper end of the center electrode. Then the lower end of the packed magnesia is abraded away as by sand blasting, and the opposed surfaces of the lower ends of tube **2** and electrode **6** thoroughly cleaned to remove any last traces of magnesia or any oxide film. The annular space resulting from removal of the magnesia is filled with a pulverized mixture of a semi-conductor material such as glass-bonded semi-conductive metal oxide, and heat is then applied to soften the mixture which flows against and bonds to the tube and the electrode. Upon cooling, the firing end is abraded to remove any semi-conductor on the bottom surfaces of the center electrode and shell and the spark plug is then ready for use. The steps of abrading away the magnesia and adding the layer of semi-conductor may, of course, be performed at any convenient stage in the process after the initial operations of adding and compacting the insulating material **10**.

It is to be understood that while the invention has been described chiefly by reference to a particular embodiment thereof, it is not so limited since various changes and modifications may be made, all within the full and intended scope of the claims which follow.

I claim:

1. A spark plug comprising a thin walled metal tube packed with powdered insulating material, a center electrode wire extending through said insulating material having an end portion adjacent the end portion of said tube, and an elongated annular semi-conductive mass between and bonded to the end portion of said tube and the end portion of said center electrode, at least the end portions of each of said tube and said center electrode being of uniform thickness and of a high heat and wear resistant metal.

2. A spark plug comprising a metal shell, an insulator block within the upper end of said shell having an elec-

trical terminal secured therein, a thin walled metal tube secured within and extending below the lower end of said shell and containing a tightly packed powdered insulating material, a metal center electrode wire electrically connected to said terminal extending through said insulator block and said insulating material, said center electrode wire terminating adjacent the end of said tube and an elongated annular mass of semi-conductive material between the end of said tube and said center electrode wire, at least the end portions of each of said tube and said center electrode being of uniform thickness and of a high heat and wear resistant metal.

3. A spark plug comprising a metal shell, an insulator block within the upper end of said shell having an electrical terminal secured therein, a thin walled metal tube having an upper portion secured within said shell and a lower portion extending below the lower end of said shell, said tube containing tightly packed powdered magnesium oxide insulating material, a metal center electrode wire electrically connected to said terminal extending through said insulator block and said insulating material, said center electrode wire terminating adjacent the end of said tube, an elongated annular mass of semi-conductive material between the end of said tube and said center electrode wire, and a layer of nonconductive material over that portion of said center electrode wire which is immediately above said tube and between said insulating material and said insulator block, at least the end portions of each of said tube and said center electrode being of uniform thickness and of a high heat and wear resistant metal.

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