Feb. 12, 1946. F. I. McCARTHY ET AL 2,394,865

SPARK PLUG

Filed Dec. 10, 1942 2 Sheets-Sheet 1

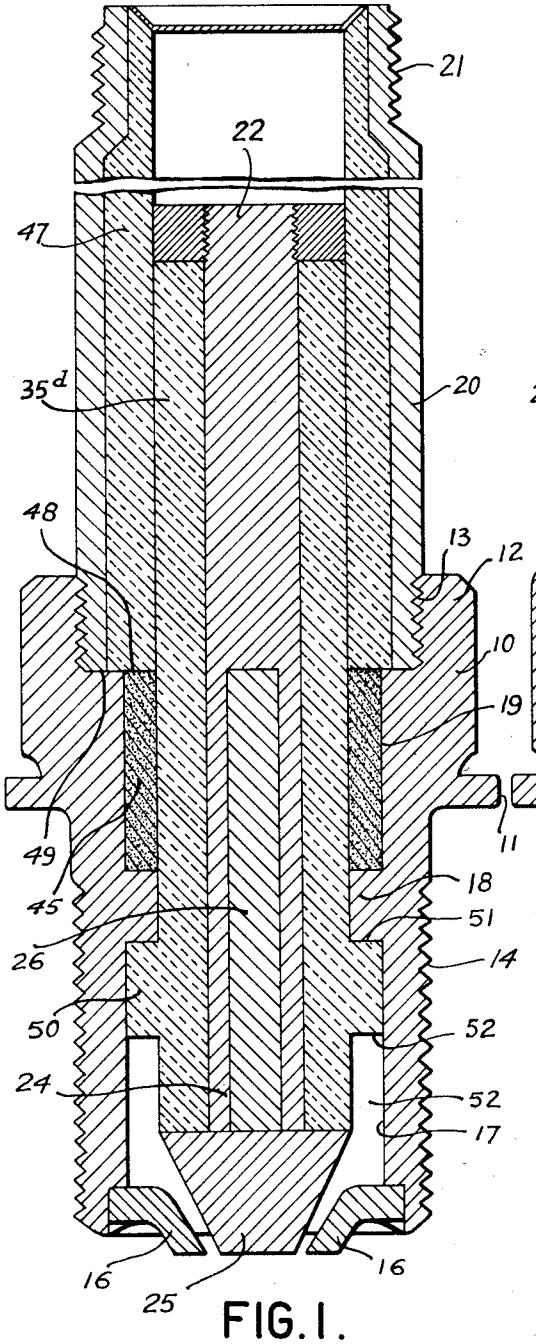


FIG. 1.

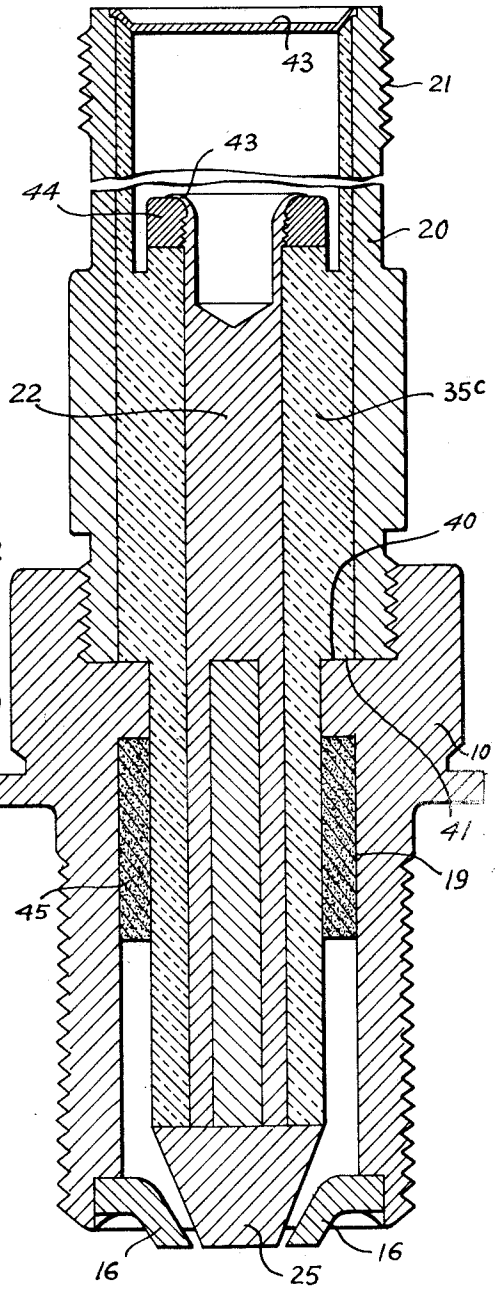


FIG. 2.

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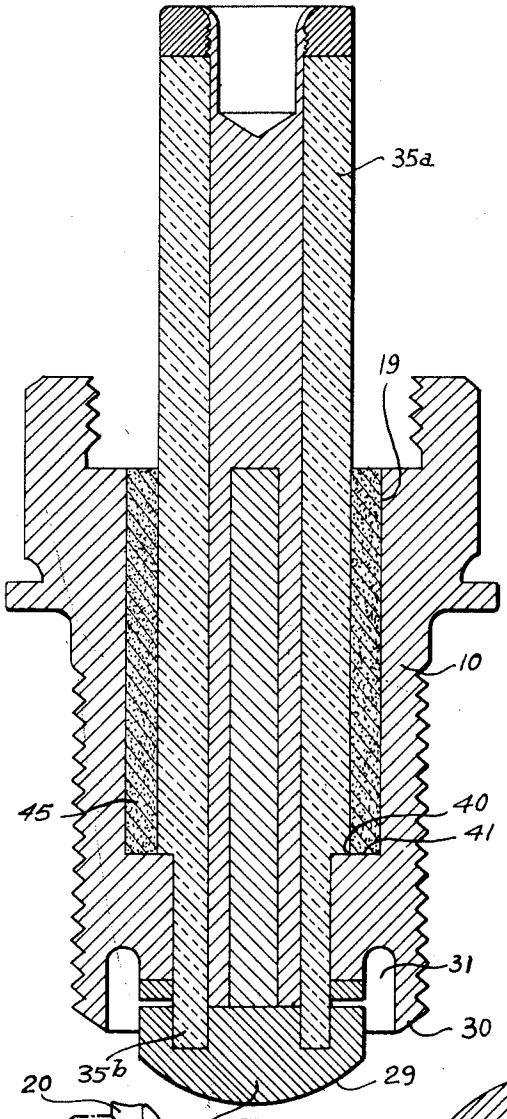


FIG.3.

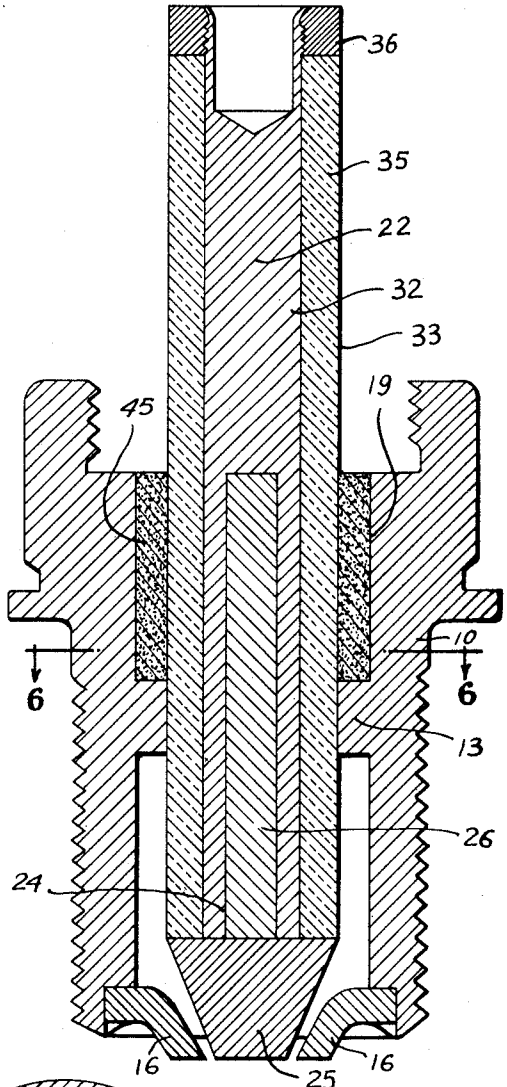


FIG.4.

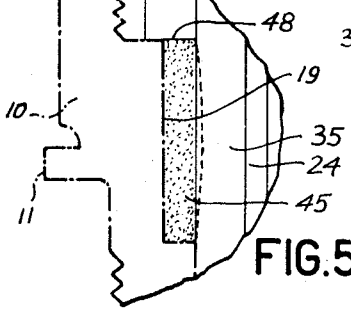


FIG.5.

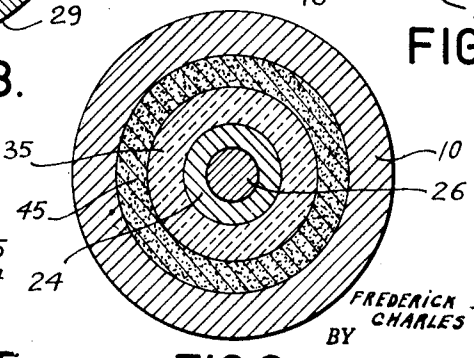


FIG.6.

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SPARK PLUG

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3 Claims. (Cl. 123—169)

This invention relates to spark plugs, and more particularly to the type in which ceramic portions are utilized. In spark plugs of this type there has been found in the use thereof, a great deal of difficulty in that the ceramic structure would, due to its inherent strains and stresses, be subject to breakage during the use of the spark plug, particularly in such cases where cone-shaped washers are utilized for the purpose of securing a tight fit, which tight fit has for its object to prevent leakage of gases from the cylinder.

The object of this invention is to provide an improved spark plug which may be constructed from ceramic material of such a shape as to be free from harmful internal strains and stresses at the point where the locking action is provided to prevent the leakage as aforesaid. The simplest form of ceramic member is a plain hollow cylinder in that all of the strains and stresses in the concentric inner and outer walls are equalized. A more refined form of such a ceramic member is to provide shoulders upon such cylindrical member, which shoulders have the purpose of functioning with the steel shells of the spark plug to limit the position of the ceramic member. Also, such an improved cylindrical ceramic member may be used to determine the amount of space desirable for the spark or arcing. Here again, when such locking portions are of a cylindrical shape the internal strains and stresses resulting from the use of the same are neutralized or balanced and the ceramic portion of the spark plug is then not subject to harmful strains tending toward breakage as heretofore.

In order to avoid such breakage at that portion of the ceramic member which is subjected to a sealing action to prevent leakage, this invention contemplates the combination with the aforesaid ceramic member of a compression member which is made from powdered copper or any other suitable kind of powder material or materials which when subjected to a high pressure brings about the coherence of the particles of the powder into a single solid mass. This mass has a large surface area compared to devices heretofore in use and the compression forces passing through this solid mass and acting upon the cylindrical exterior of the ceramic member divide the action of the forces equally upon the unit area so as to distribute the force and will bring about an absolutely secure holding and sealing action.

For this purpose my invention consists of a spark plug in which there is a cylindrical ceramic member surrounded by a chamber in which powdered material is supplied and which powdered material after it has been subjected to a very high pressure, enters the solid state and thereby causes the compression forces to exert themselves upon the longitudinal wall of the outer chamber and upon the wall opposite thereto, namely, the exterior cylindrical part of the ceramic member. While such powdered material is under such applied pressure it acts like a fluid and enters the interstices of the outer wall of the ceramic member, and upon the release of the pressure, it becomes a solid mass.

The invention also consists in providing this cylindrical member of ceramic material with cylindrical shoulder portions to limit the movement of the cylindrical ceramic member in respect to the other parts of the spark plug, and in the further contemplated invention said cylindrical shoulders serve the further function of limiting the amount of space necessary for the sparking action. In certain cases the shoulder of the ceramic member may serve to insure a balanced heat distribution between the positive spindle and the negative lower shell. Among other things a prevention of fouling results.

This invention will be more fully described hereinafter, embodiments thereof shown in the drawings, and the invention will be finally pointed out in the claims.

In the accompanying drawings:

Fig. 1 is a longitudinal central section of a spark plug presenting one embodiment of this invention;

Fig. 2 is a longitudinal vertical section of another embodiment of this invention;

Fig. 3 is a longitudinal vertical section of still another embodiment;

Fig. 4 is a longitudinal vertical section of another embodiment;

Fig. 5 is a fragmentary enlarged portion of parts of the structure shown in Fig. 4 showing the functioning of the parts therein shown, and

Fig. 6 is a horizontal section taken on line 6—6 of Fig. 4.

Similar characters of reference indicate corresponding parts throughout the various views.

Referring to the drawings, and more particularly to Fig. 1, which will be described first in regard to the known parts which are generally common to all of the embodiments shown in Figs. 1 to 4, and then in regard to the improved parts forming the basis of this present invention.

In the known spark plug a casing 10 has a shoulder 11 and an extension 12 with an internal screw thread 13. This member 10 has an ex-

ternal screw thread 14 and upon the lowermost free end of this exteriorly screw threaded portion 15, one of the sparking members 16 is suitably secured thereto, preferably welded. The member 15 has a bore 17, and an internally extending shoulder 18 which has a sub-calibered bore to the bore 17. About the shoulder 18 the member 10 has a bore 19 of substantially the same diameter as the bore 17. Into the internal threads 13 of the extension 12 another metallic cylindrical hollow member 20 with external threads is fitted and this member 20 has at its free upper end external threads 21. Within the member 20 at its central portion is a central member 22 which extends downwardly and is of electrically conducting material and has at its lowermost end 24 a spark head 25, which embodiment is frusto-conical in shape and enables this member 25 to be in spacial relationship to the other sparking member 16 which is circularly disposed around the member 25, and it is over the air-gap therebetween that the sparking takes place. The arc member 25 is suitably secured to the steel member 22 by welding and this member 22 has a bore which is filled with a copper rod 26. With the exception of the cylindrical bore 19, the parts described are known and are common to all of the embodiments shown with the exception of the embodiment of Fig. 3 in which the spark member 28 is of an extension type with a curved surface 29 in the nature of a button, the peripheral portions of which cooperate with the ends 30 for the passage of the spark over the air-gap portion 31. This latter construction is also known.

The improvement consists in surrounding the central member 22 with a cylindrical ceramic member having a bore 32 which is concentric with the externally cylindrical surface 33, and the bore 32 and the externally cylindrical surface 33 are co-extensive throughout the length of this ceramic member 35. This ceramic member 35 of Fig. 4 extends from the washer end 36 to the spark end 25 and huggingly engages the central member 22 and at the same time the shoulder portion 18 of the casing, the casing itself having the interior bore 19 of larger diameter than the diameter of the exterior surface of the ceramic member 35. The space then formed between the outer surface 33 of the ceramic member 35 and the bore 19 of the casing and the upper surface of the shoulder portion 18 is then filled with a copper powder and when so filled is subjected first to a tamping action more or less generally applied and thereafter to a stronger pressure, in fact to a very high compression action so as to convert these particles of the powder after acting like a fluid into a solid member in a manner well known with the cooperation of heat as in powder metallurgy. Instead of copper powder some other powder of suitable material may be used. The importance here is a secure fit against any possible leakage of gases, oil, etc., which may affect the operation of the spark plug. The combination of this kind of a sealing action with the ceramic member of cylindrical shape has the advantage that the compression forces are distributed over a large area instead of being applied to a small area whereby breakages of the ceramic member take place. The distribution of such compression forces over the external portion of a cylinder has the further advantage that due to the inherent resiliency of a hollow cylindrical ceramic member a portion thereof may be very slightly bent by such high pressure and thereby the internal bore of the cylindrical ceramic member forced tightly against the internal member 22. An exaggerated view of this is shown in Fig. 5. It is believed also that such a distribution of compression forces probably have an effect upon the molecular construction of the ceramic member under such pressure whereby a greater compactness of the ceramic member is obtained, again acting as a sealing action or breaking action against any forces tending to bring about leakage.

From the simplest form of cylindrical ceramic member with an internal bore concentric with its exterior as in Figure 3, this cylindrical member 35a may be provided with a shoulder portion 40 resting upon the upper surface 41 of the internal shoulder of the casing 10 such as shown in Fig. 3. Thereby a limitation of movement of the cylindrical ceramic member 35a in Fig. 3 is brought about. In this embodiment of Fig. 3 the ceramic cylindrical member 35a has an extension 35b which enters into the spark button 28. The spark button or sparking member 28 has a member recess into which this extension enters, and the insulating member 35a extending from said recess beyond the spark gap acts as an insulating barrier behind the spark gap, and electrically separates the casing 10 from the conducting member of the sparking member. In the embodiment of Fig. 3 the internal bore 19 is longitudinally longer than that shown in Fig. 4 and the feeding of the powdered material is from the top, as is also the case in the embodiment of Fig. 4.

In the embodiment of Fig. 2 the cylindrical ceramic member 35c has an extension 42 which has a larger size bore than the bore of the member 35c. This member 45 extends to the extreme upper end of the casing 20 and is suitably secured thereto by an internal washer 43 or the like. The upper end of the central member 22 is suitably secured to the ceramic member 45 by upsetting the member 22 as shown by 43 after a screw threaded washer 44 has been applied to the external screw threaded portion of the member 22. This ceramic member 35c has a shoulder portion 46 which again is seated upon the shoulder portion 41 of the casing 10 and thereby the movement of the ceramic member 35c is controlled. The ceramic member 35c then extends with its externally subcalibered portion downwardly to contact with the sparking end 25 which is of frustro-conical shape as in Fig. 1. In this embodiment the filling of the material takes place from the bottom up instead of from the top down as in the other embodiments. For this purpose the internal bore wall 19 is provided in the casing 10 and the extended annulus of compacted powder forced into a solid as indicated by 45, is provided. As stated, instead of copper powder, any other suitable powder which has certain special qualifications and which will compact itself into a solid may be used. Of course in providing a copper filling in Figure 2, this is done before the sparking member 16 is affixed to the casing as by welding or the like, and after the filling 45 has been completed this sparking member is applied. In Figure 2, the ceramic is one piece from the sparking tip to the washer at the top of the upper shell, and the upper shell is not secured to the ceramic, except by the fastening at the end.

Referring now to Fig. 1, in which the ceramic member 35d has a cylindrical bore and acts with an externally cylindrical portion 47 which is made part of the shell 20 and which extends to the

uppermost end of the shell and downwardly to form one wall 48 of the filling chamber and has a thickness of wall so as to rest upon a shoulder 49 of the casing 10. The ceramic member 35d below the copper filling 45 has a cylindrical collar portion 50 which on the one hand acts against the cylindrical shoulder 51 of the casing 10, and on the other hand at 52 provides a shoulder forming with the cylindrical portion of the ceramic member a space 52. This collar 50 is utilized to distribute heat so as to bring about a substantial uniformity of heat between the positive spindle and the negative lower shell during the sparking action. It will be noted that the cylindrical annulus or collar 50 of the ceramic member 35d at the shoulder portion 51 serves to lock the ceramic member 35d against any upward movement, and the shoulder portion 49 of the shell acts to lock the cylindrical ceramic member 35d against a movement in the opposite direction. Thus the ceramic member is so shaped as to lock into a substantially unmovable position. It is subjected due to the compression forces of the filling member 45 to a sealing action of such a kind as before described as to prevent any leakage. The shell 20 may be unsecured with the enclosed ceramic lining member 42 while the ceramic extension is part of the shell and may be removed therewith. The two ceramic cylinders 35d and 47 can be cemented together. In such a case, as also with the embodiment of Fig. 2, a weather proof spark plug results due to its complete sealing from moisture or other weather conditions. This eliminates the possibility of any interior deterioration in the upper shell compartment particularly preventing electrical leakage due to the moisture. In Fig. 2 the ceramic member 35c is integral from end to end of the shell.

The parts are assembled as described, and in view of their respective coefficients of expansion, the steel central member 22 has a tolerance space with the bore of the porcelain member surrounding it, and the exterior of the porcelain has a tolerance with the bore of the member 10, so that on expansion of the respective parts these tolerances are taken up. In respect to the expansion of the filling material 45, this is taken up by the porcelain in the manner indicated by Fig. 5, in the dotted curved line there shown.

From the foregoing it therefore appears that the invention consists of the combined action of an externally cylindrical internally cylindrically bored ceramic member extending substantially from the sparking end to the other end of a spark plug thus insuring insulating qualities throughout combined with a pocket in which a sealing action is provided by providing such a pocket with powdered material and subjecting this powdered material to high pressures to transform it into a solid. And the invention also consists in the particular shape of such a cylindrical member whereby such a ceramic member is locked in position against any displacement movement.

It will have noted that this invention deals with several patterns of ceramic insulations adaptable to certain styles of spark plug shells using pressed powders as a method of sealing any or all of the particular patterns to the shells themselves.

The various styles of ceramic patterns have been planned so as to afford maximum heat deliverance from those portions of the plug which normally become too hot. They are also designed so that with the use of pressed powder they become mechanically rigid and lose none of their electrical or thermal qualities.

Having thus described our invention and the embodiments thereof, we do not wish to be limited to the particularities thereof, and desire to include such changes as may be made without departing from the spirit of our invention as defined in the appended claims.

What we claim is:

1. In a spark plug consisting of a metallic casing having external attaching means and an internal circumferential shoulder forming cylindrical bores within the casing, and a central cylindrical conducting member having a sparking end and extending from that end to the other end of the spark plug; a hollow cylindrical ceramic sleeve member with inner and outer cylindrical surfaces extending from the sparking end of the central member to said other end of the spark plug, the internal diameter of the bore of said ceramic member being equal to the external diameter of said conducting member, and the external diameter of the ceramic member being equal to one of the bores of said casing, the external diameter of the ceramic member being substantially the same throughout its length, said casing having walls adjacent said shoulder portions spaced from said ceramic member to form a filling chamber, said conducting member extending above and below said chamber, and metallic material formed of compressed powder in said filling chamber having inherent compression forces to prevent leakage between said filling material and the walls of the casing and the external walls of the ceramic member, respectively, such forces resulting from converting the powder into a solid under pressure, and such forces being distributed over an area along the external cylindrical part of said ceramic member between the ends thereof and pressing it radially inwardly preventing the axial movement of the ceramic member.

2. In a spark plug consisting of a metallic casing having external attaching means and an internal circumferential shoulder forming cylindrical bores within the casing, and a central cylindrical conducting member having a sparking end and extending from that end to the other end of the spark plug; a hollow cylindrical ceramic sleeve member with inner and outer cylindrical surfaces extending from the sparking end of the central member to said other end of the spark plug, the internal diameter of the bore of said ceramic member being equal to the external diameter of said conducting member, and the external diameter of the ceramic member being equal to one of the bores of said casing, the external diameter of the ceramic member being substantially the same throughout its length, said casing having walls adjacent said shoulder portions spaced from said ceramic member to form a filling chamber, said conducting member extending above and below said chamber, metallic material formed of compressed powder in said filling chamber having inherent compression forces to prevent leakage between said filling material and the walls of the casing and the external walls of the ceramic member, respectively, such forces resulting from converting the powder into a solid under pressure, and such forces being distributed over an area along the external cylindrical part of said ceramic member between the ends thereof and pressing it radially inwardly preventing the axial movement of the ceramic member, and an external

shoulder portion on said ceramic member of cylindrical shape and of a diameter slightly larger than that of the cylindrical ceramic member, coacting with the shoulder of the casing to prevent the movement of the ceramic member in one direction of the casing.

3. In a spark plug having a casing, a cylindrical insulating sleeve member in said casing having a cylindrical bore, said insulating member extending from end to end of the spark plug in an integral piece, with an outer configuration of cylindrical shape concentric with its bore, a cylindrical conducting member of an external diameter equal to the internal diameter of the insulating member and extending into the bore of said insulating member, and a sparking member on said conducting member and spaced from said casing to form a spark gap, and having a circular cylindrical recess for engaging one end of said cylindrical insulating member, said insulating member extending from said recess beyond said spark gap and acting as an insulating barrier behind the spark gap, and electrically separating the casing from the conducting member.

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