May 27, 1952 R. F. DORAN 2,597,978

SPARK PLUG

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FIG. 2

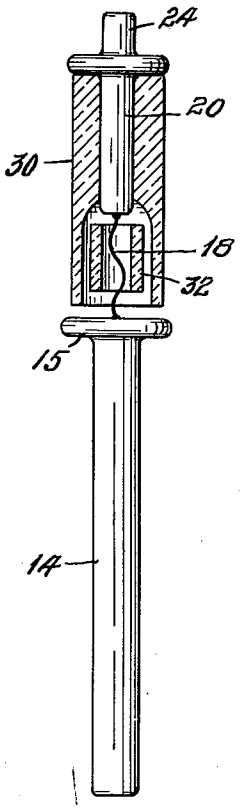
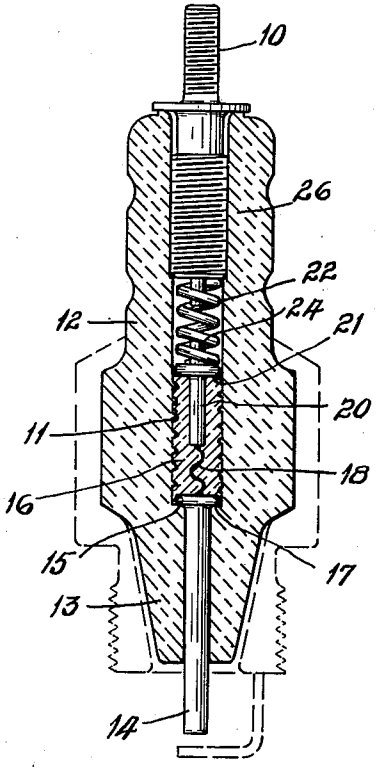


FIG. 1



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SPARK PLUG

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This invention relates to spark plugs and to their methods of manufacture.

Although it is well recognized that porous seals between the electrode and the ceramic body of a spark plug are undesirable, there are no commercially available automobile spark plugs in which the seal is not porous. This is true in spite of the fact that hermetically sealed plugs are being made today for the aviation industry. The present method of manufacturing these plugs for the aviation industry is, however, so slow and time consuming that the sales price of these plugs is necessarily many times higher than could be tolerated in the automobile industry.

In accordance with the present method of making such plugs for the aviation industry, the electrode which is to be hermetically sealed to the ceramic body is first surrounded with a metallic powder which is dipped into the small cylindrical opening by means of a special tool requiring numerous dippings as well as a series of tamping operations between each dipper-full of metal powder. This is followed by the introduction of powdered glass in much the same manner in which the powdered glass is fed into the small cylindrical opening by means of a special tool and successive tamping operations, whereupon a plug of metal powder is inserted on top of the glass powder by means of a similar series of steps. The composite obtained in this manner is subsequently passed through a heating furnace in which the temperature is sufficiently high to fuze the glass and bring about a semi-hermetic porous looking seal between the electrode and the ceramic shell. However, since each of these three filling operations is necessary and since each of these filling operations, when carried on by a skilled operator with the special tools designed for this purpose, can only process approximately 1200 spark plugs per day per team of 4 skilled operators, one can readily understand why this process results in a costly spark plug.

It is an object of this invention to design a spark plug in which the sealed portion is isolated from that portion of the plug which is likely to be subjected to mechanical stresses through the electrode.

Another object of this invention is to design a spark plug which is adapted for manufacture by modern high speed techniques which will enable the production of non-porous plugs at prices which will be attractive in the automobile field.

In accordance with this invention, it has been found that these and other advantages can be attained if that portion of the electrode comprising the sealing material and a current carrying electrode is made into a sub-assembly prior to its introduction into the ceramic body.

In the drawings which illustrate a preferred embodiment containing features of this invention,

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Fig. 1 is a front elevation partly in section showing the component parts of the spark plug in assembled position;

Fig. 2 is a front elevation partly in section of a sub-assembly of the electrode and the sealing material.

Since the normal stresses on electrodes is torsional there is real advantage in isolating these forces from the seal because of the point of loading characteristic of torsional forces on a seal of this particular geometry.

Preferred embodiments of the spark plug of this invention, therefore, have their center current carrying electrode portion made up of a plurality of parts in which the electrode portion 10 extending from the ceramic body 12 at the end projecting from the motor when in use, is not rigidly attached to the sparking point 14 of the electrode which is hermetically sealed to the ceramic body by means of a sealing material such as shown at 16. The sparking point 14 can be kept in good electrical contact with the electrode 10 through the sealing material by means of an electrical conductor 18, a pin 20 and a spring 22.

The sparking point 14 is preferably made of a metal which will stand corrosion at high temperatures in both reducing and oxidizing atmospheres. The essential characteristics are, of course, that its cross-sectional area remain as constant as possible and that its surface remain free of contaminants which would interfere with its current carrying capacity. The wire 18 shown in the preferred embodiment illustrated in the drawing is preferably one which can carry a substantial current at a high temperature and which is relatively flexible and not easily broken even when drawn into a relatively thin wire. In preferred embodiments of the spark plug of this invention, molybdenum wire is used for this purpose. The pin 20 is preferably but not necessarily made of a metal suitable for making good glass-to-metal seals. The spring 22 serves a dual function to provide the necessary resistance within the plug as well as to provide for any relative expansion between the electrode 10 and the sparking point 14.

In accordance with the method of this invention which lends itself to high speed manufacturing techniques of the type used successfully in the radio industry the sparking point 14 and the sealing material which is preferably made of glass in the form of a glass bead or tubing, is made up into a sub-assembly in order to take advantage of a forming technique. Inasmuch as such forming technique or operation usually consists of the pressing of the softened seal material between mold faces which act as the supporting medium for the more rigid portion of the composite, it has been found advisable to leave a portion of the forming mold in the body. This is particularly necessary and desirable in the spark plug because of the excessive heating of

the forming mold and because of the necessity of heating the glass through the rather thick wall of the plug body, this type of indirect heating would not make it possible to obtain the concentrated localized heating of the glass which is normally used in the sealing art. For this reason the sub-assembly is also provided with the upset pin 20 which is in electrical contact with the sparking point 14 through the wire 18 welded to each of the two aforementioned parts.

In making the sub-assembly in accordance with the preferred embodiments of this invention, illustrated in the drawings, it is preferable to start out with the upset pin 20 and weld thereto a length of wire 18. A determined length of glass tubing 30 is then slipped over the wire and prong portion of the upset pin and sealed thereon in order to insure the best possible seal. An auxiliary piece of glass tubing 32 may be telescoped into the larger tubing as needed. The free end of the wire 18 is then welded to the end of the sparking point at the end provided with the shoulder 15. This completes the sub-assembly which is now ready for insertion into the ceramic body. This is accomplished by dropping it into the ceramic body in such a manner that the contact point protrudes from the end 13 of the ceramic body with its offset portion properly seated on ledge 17 provided therefor within the ceramic portion 12 and pulled down in order to seat properly on the offset portion 15 of the contact pin. As so assembled, the plug body may then be placed in a sealing spindle preferably on a high speed index machine where the heat can be introduced to the body in an amount sufficient to render the glass very soft. A prepress operation in the amount of approximately 10 to 55 pounds per square inch may then be made by introducing a pressure ram down against the top of the pin 20. The composite may be heated further and a final pressing operation of approximately 60 to 80 pounds a square inch can then be applied. This pressure is sufficient to introduce the sealing glass into a groove 11, provided on the inside surface of the ceramic body 12 and to insure a good gas tight type of seal made of a dense clear glass. The amount of glass used can be so chosen that at the time of the final press, the upset pin will locate on the offset 21 provided therefor in the interior of the ceramic body.

After the composite has been properly cooled, a spring 22 may be dropped in to seat on the flat top pin 20 or to locate about a small tit 24 which extends from the top of pin 20 as shown.

The contact portion of the electrode may then be properly threaded into the cement containing threaded section 26 and a pressure contact made through the spring 22 with the contact pin 20.

When a pre-assembly technique of the type described is used, all the steps in the fabrication of the spark plug are such as are adapted to high speed manufacturing techniques in which manual operation can be kept to a minimum. Furthermore, by using such sub-assembly techniques it is possible to pre-inspect a portion of the seal and thereby obtain a better control of the completed unit. Furthermore, the particular construction shown and described herein permits the use of a considerable amount of heat and molding pressure thus insuring good seals, without, however, giving rise to danger of glass sticking to the molds. At the same time the design provides for the isolation of the sealed

portion from mechanical stresses which are likely to be transmitted through the contact portion of the electrodes. This portion in normal service is subjected to torsional stresses in view of the point loading characteristics of the torsional forces on a seal of this particular geometry. It is essential for the best operating characteristics that the gas-tight seal is not subjected to such forces.

While the above description and drawings submitted herewith disclose preferred and practical embodiments of this invention, it will be understood by those skilled in the art that the specific details of construction and arrangement of parts as shown and described are by way of illustration and are not to be construed as limiting the invention.

What is claimed is:

1. A sub-assembly suitable for use in the manufacture of spark plugs by high speed techniques comprising a sparking electrode, a pin having an upset head, a wire connecting said electrode to said pin, a solid glass sleeve surrounding a portion of said pin and said wire, said glass body having a diameter not substantially greater than said head of said pin.

2. A sub-assembly suitable for use in the manufacture of spark plugs by high speed techniques comprising a sparking electrode, a pin having an upset head, a wire connecting said electrode to said pin, a glass sleeve surrounding a portion of said pin and an auxiliary glass sleeve surrounding said wire, said auxiliary glass sleeve also being surrounded by said first mentioned glass sleeve.

3. A sub-assembly suitable for use in the manufacture of spark plugs by high speed techniques comprising a sparking electrode, a pin having an upset head, a wire connecting said electrode to said pin, a solid glass sleeve sealed to and surrounding a portion of said pin and said wire.

4. A sub-assembly suitable for use in the manufacture of spark plugs by high speed techniques comprising a sparking electrode, a pin having an upset head, a wire connecting said electrode to said pin, a glass sleeve sealed to and surrounding a portion of said pin, and an auxiliary glass sleeve surrounding said wire, said auxiliary glass sleeve also being surrounded by said first mentioned glass sleeve.

5. In the method of making spark plugs the steps comprising welding wire to a pin, slipping a glass sleeve over the wire and pin, sealing said sleeve to said pin, welding the free end of said wire to a sparking electrode, inserting the composite of pin, wire, glass sleeve and sparking electrode into a ceramic body and sealing said glass sleeve to said ceramic body by heat and pressure means.

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