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METHOD FOR THE MANUFACTURE OF SPARK PLUGS FOR  
INTERNAL COMBUSTION ENGINES

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2 Sheets-Sheet 1

FIG. 1

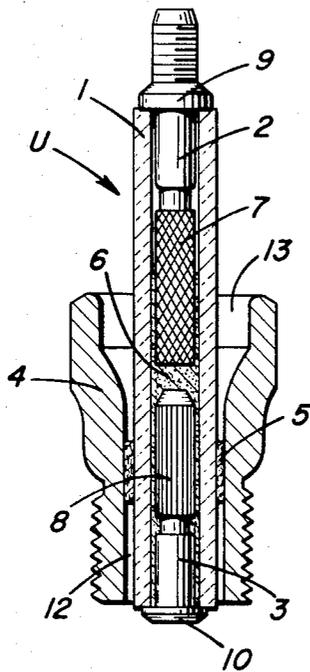
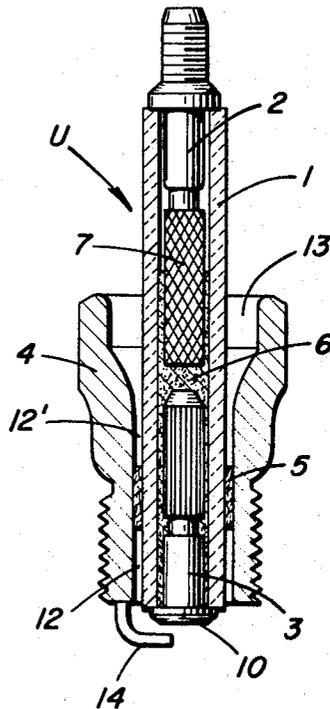


FIG. 2



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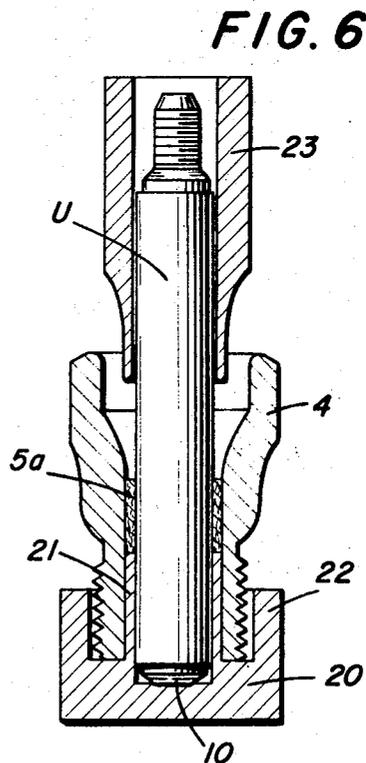
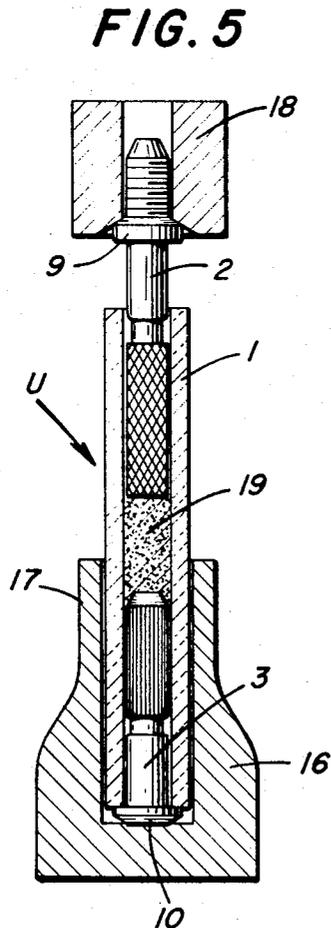
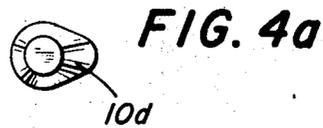
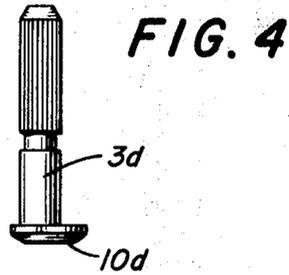
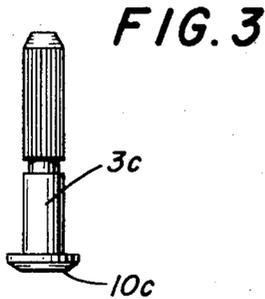
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## METHOD FOR THE MANUFACTURE OF SPARK PLUGS FOR INTERNAL COMBUSTION ENGINES

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Original application Jan. 30, 1967, Ser. No. 612,550, now Patent No. 3,449,613, dated Jan. 10, 1969. Divided and this application Dec. 6, 1968, Ser. No. 798,534  
Claims priority, application Italy, Jan. 31, 1966,

14,014/66

Int. Cl. F23q 3/70; H01t 13/00

U.S. Cl. 29—25.12

7 Claims

### ABSTRACT OF THE DISCLOSURE

A method for making spark plugs for internal combustion engines and comprising the steps of: cementing first and second electrodes within an insulating tube in an air tight manner; positioning said tube within a body portion; positioning a bushing intermediate said tube and said body portion and compressing said bushing to thereby seal said tube to said body portion. There are also disclosed several embodiments of spark plugs constructed in accordance with the above method.

This application is a division of my copending application Ser. No. 612,550, filed Jan. 30, 1967, now Pat. No. 3,449,613.

This invention relates to an ignition spark plug for internal combustion engines and more specifically a high voltage spark plug in which the spark must effect at least one jump across an air gap to reach the ground (spark plug) electrode.

An object of the invention is to provide an ignition spark plug apt to consent a wide range of temperature degrees and a considerable index of heat expansion and compensation.

Another object of the invention is to provide a spark plug which is suitable to produce either a discharge (spark) of the conventional type i.e. with spark jump in air gap only or a semi surface discharge i.e. also with the spark running on the insulator with subsequent spark jump in air gap and lastly, a mixed type discharge with the formation of two sparks. A further object of the invention is to provide a spark plug of the standard type, of simple workmanship and assembly and requiring a minimum number of components, being at the same time the least cumbersome possible, of low cost and long life.

The above objectives are achieved with a spark plug in which the ceramic portion is secured air-tight to the metal body of the spark plug with the aid of a soft metal bushing which is axially compressible between the walls of said ceramic insulator and said metal body, after having been freely inserted from either end of the spark plug and arranged in the axial position desired.

The walls of the insulating body and the metal body form an annular chamber of a certain length which makes it possible to vary, within certain limits, the locking position of the bushing and consequently the thermal index of the spark plug.

Moreover, the ignition electrode terminates with a head which consents to obtain three different types of electrical discharge, depending upon its size, in addition to increasing the spark plug's life, thanks to reduced wear of the electrode.

In one of the embodiments of the spark plug forming the object of this invention, the insulator consists of a tube whose inner and outer diameters are constant, thereby simplifying fabrication to a great extent.

A further object of the invention pertains to the method and procedure for fabricating the spark plug.

Further advantages and characteristics of the invention will become evident from the following description taken in conjunction with the attached drawings, which refer, by way of example only and without any limitation to an ignition spark plug having a tube shaped insulator for the central electrode, consisting of two separate sections secured air-tight to said insulator by means of a conductive cement.

FIG. 1 is a longitudinal cross-section of an ignition spark plug according to the invention.

FIG. 2 is another version of the spark plug shown in FIG. 1.

FIGS. 3 and 4 show two different embodiments of the central electrode.

FIG. 5 is an illustration, in longitudinal cross-section of a suitable jig for assembling the central electrode to the insulating body.

FIG. 6 is a longitudinal cross-section of a jig for securing the insulator in air-tight relationship to the ground body.

In FIG. 1 of the attached drawings No. 1 identifies the insulator, consisting of a ceramic material cannule or tube of constant inner and outer diameters, Nos. 2 and 3 show the current lead-in connected to the high voltage conductor and the central or ignition electrode proper; No. 4 shows the metal ground body; No. 5 an annular metal element locking the insulating tube in air-tight relationship to the ground body 4.

The tube or cannule 1 may be obtained by extrusion and may be utilized without requiring any additional workmanship, except for butting-in, which may be obtained also when the tube is cut from the barstock. The use of the tube greatly facilitates the assembly of the spark plug in that its positioning, as well as the introduction of the electrode or parts thereof may be effected from either end.

A minimum requirement of ceramic material is ensured by the absence of any shaping and minimum transversal.

The current lead-in 2 and the central electrode 3 consist of two cylindrical rods, secured air-tight to each other and to the insulator by a conductive glass cement 6; the rods have, on the side of their external periphery a knurling 7 or channeling 8 to consent the introduction of the cement and better securement of the electrode parts to the insulator 1 in the assembly or fabrication phase.

The solidification of the cement in the channeling 8 of the electrode 3 ensures improved heat transmission from said electrode to the exterior.

Externally, the lead-in 2 and electrode 3 have respective flanges 9 and 10; flange 10 forms the striking surface for the spark in the electrode 3. Said flange rests on the front surface of tube or cannule 1 and may form a single body with the electrode 3 itself in this case the flange is preferably punched out in the general form of a nail head.

By varying the form and dimensions of said head 10 it is possible to provide, as it will be described further on, a spark plug of the conventional discharge, semi surface discharge or mixed discharge type.

The flange head 10, by forming a massive end of electrode 3, guarantees a considerably long life for the spark plug, as far as wear is concerned.

This arrangement makes it possible to employ a central electrode of non precious material, for example steel of the usual type. Furthermore, as the electrode 3 and the lead-in 2 are made of a cylindrical rod of the same diameter, these parts may be obtained from a round metal of the same material thus affording evident advantages from the viewpoints of simplicity, workmanship and economy.

The diameter of flange head 10 of electrode 3 is considerably greater as compared to the points of conventional types electrodes, and its radial flared section im-

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proves screening of that insulator portion which is most subject to accumulation of dirt, with consequent and evident improvement of the spark plug's overall electrical efficiency.

The insulating tube or cannule 1, with its lead-in 2 and electrode 3 locked air-tight therein, form an assembly "U" which is secured air-tight to the ground body 4 by means of a bushing 5 of soft metal, for example, copper, which is a good heat conductor. Instead of a metal bushing, a braid of copper wires may be conveniently employed.

The inner surface of the ground body 4 has a constant diameter adjacent to the location of the bushing, so as to form an annular chamber 12 of uniform width in conjunction with the insulator 1 and which extends axially for a certain length; said internal forms a wide surface chamber opening upwardly, starting said chamber in the connecting end of the spark plug, so as to insure efficient cooling of the body.

The above mentioned chamber is preferably flared towards the upper portion of the spark plug, as illustrated in FIGS. 1 and 2.

The external profile of the ground body being substantially cylindrical in shape affords a considerable saving in material for manufacture, as compared to the conventional type of ground bodies; moreover, due to the simplicity in design of the inner end outer shaping, and particularly in view of the total absence of a channel to hold the conventional insulator sealing gasket, the body may be more easily fabricated, for example by pressing, from a semi machined metal of reduced dimensions.

The insulator 1 and ground body 4 are connected to each other exclusively by bushing 5 which may be inserted into chamber 12 surrounding the insulator, from either end of assembly "U" and that is, both from the electrical connection end and from the ignition head of the spark plug. Bushing 5, which may be slid freely along chamber 12 is set in the locking position and subjected to axial compression, by holding one of its ends firm against a lodging and acting on the other end by means of a suitable punch, so as to cause the bushing to adhere to the walls of tube or cannule 1 and to the ground body 4. Once the compression operation is completed, the only connecting piece between ground body 4 and tube or cannule 1 is represented by bushing 5 which guarantees a gas tight seal in addition to mechanically locking the parts together, as well as providing heat transfer from assembly "U" to the ground body 4.

The bushing dimensions, before being locked in position, as well as its axial locking position in chamber 12, may be varied depending on the specific type of spark plug which it is desired to build. It is obvious however, that by varying the axial position of a given bushing in the said chamber, it is possible to change the thermal degree of the spark plug. By locking bushing 5 in the zone nearest to the ignition point of the spark plug (head 10) it is possible to obtain spark plugs with a high thermic degree; this because the spark plug chamber 12 is of minimum size or nonexistent (i.e. the chamber formed between the metal body 4 and insulating tube 1, and which is struck by the combustion gases), and also in view of maximum heat transmission by bushing 5 located in higher heat zone of the spark plug, the latter being cold.

Conversely, by locking bushing 5 at a distance from the ignition point of the spark plug the size of chamber 12 is increased, with reduced heat transmission across bushing 5; in this case the spark plug has a low heat coefficient (hot spark plug). It is clearly understood therefore, that the tube or cannule 1 with the lead-in 2 and electrode assembled or joined together as well as the ground body 4, make up two unified assemblies which may be employed for spark plugs covering a wide range of thermal degrees said assemblies which may be employed for spark plugs covering a wide range of thermal

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degrees said assemblies in fact, do not contribute to the variation of the thermal degree of the spark plug, which, on the other hand is influenced as above stated, only by the position of the bushing 5 along chamber 12. From the above it is evident, that the component parts of unit "U" are also standardized.

The spark plug illustrated in FIG. 2 is identical to that of FIG. 1, except for the different locking position of the bushing in chamber 12 and the presence of a protruding ground electrode 14 carried by ground body 4. In both types of spark plug, head 10 of the central electrode does not extend beyond the outer perimeter of tube or cannule 1; therefore, in the spark plug of FIG. 1, the discharge is of the surface type, i.e. the spark, after leaving head 10 reaches ground body 4 after having run along the edge portion of tube or cannule 1 and accomplished the spark jumps across annular chamber 12; on the other hand, in the spark plug of FIG. 2 the discharge is of the conventional or of the mixed type; i.e. of the semi-surface type as in the case of FIG. 1, but with spark jump across head 10 and mass electrode 14.

In the spark plug shown in FIG. 2 the protruding type electrode 14 is secured in the correct position opposite head 10 after having locked the ground body 4 to assembly "U."

In particular, if electrode 14 is carried by ground body 4, the former is bent over head 10 after being secured to said body 4. On the other hand if electrode 14 is to be applied to ground body 4, this operation is carried out subsequent to securing the ground body to the assembly "U."

FIGS. 3 and 4 show two different types of central electrodes. In FIG. 3, the central electrode 3c has a knurled head 10c for the purpose of increasing the sparking (discharge) efficiency and thus provide uniform wear along the entire periphery of the head itself.

In FIGS. 4 and 4a head 10d of the central electrode 3d has on one side a flared radial or lobe portion which is conveniently sized. In this case, the discharge takes place with a spark jump between the end of the flared portion or lobe and the ground body, and by a semi-surface discharge on the remaining portion of the head.

Generally speaking, in the case of semi-surface discharge type spark plugs, the presence of head 10 extending radially, makes it possible to shorten the distance between said head and the ground body 4; this, in turn makes it possible to obtain ground bodies 4 of a simplified form, and that is, cylindrical shaped or substantially so, which affords the advantage of inserting bushing 5 from either end of the spark plug.

The use of this specific type of spark plug is particularly advantageous for engines in which the conventional type of spark is most suitable for starting up.

From the above description, the advantages of the spark plug forming the object of this invention, may be summarized as follows:

The possibility of obtaining, with a single component of the spark plug, a thermal degree which may vary over a wide range.

Because of the reduced ceramic mass (tube 1), with respect to the metal mass, the spark plug affords a considerable thermal expansion index, which is further increased by the large surface of the bushing which is much greater than that of the sealing gaskets in conventional spark plugs.

The transversal dimensions are much reduced and the spark plug is therefore suitable for all applications in which limited mass and space requirements have to be met with.

The spark plug affords extreme simplicity of construction and assembly, with a minimum number of component parts.

The cost of the spark plug is 40% lower as compared to the conventional types.

By varying the dimensions and shape of the electrode

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head, it is possible to obtain a spark plug for different types of discharge.

FIG. 5 shows schematically, cross-sectional views of assembly "U" in its phase of assembly with lead-in 2 and central electrode 3 as well as the relevant assembling jig including a fixed base 16 provided with a guiding collar 17 and a movable punch 18.

The central electrode 3 is inserted into the guiding collar 17 so that head 10 may rest on the bottom of the base 16 the tube or cannule 1 being inserted successively, until it comes to rest against said head 10. The cement 19 is then introduced from the opposite end of the tube and subsequently the power lead-in 2. The assembly is then heated up to softening of the cement and an axial pressure is exerted on head 9 of lead-in 2 by means of the bored movable punch 18. The pressure is released once head 9 of lead-in 2 comes into contact with the edge tube or cannule 1.

FIG. 6 shows spark plug assembly "U" and a schematic longitudinal cross-section of the jig which consents controlled locking of bushing 5 to ground body 4 of the spark plug in accordance with FIG. 1. A fixed mounting base 20, as shown, is equipped with 2 annular guide collars 21 and 22 to receive respectively assembly "U" and ground body 4.

The assembly "U" rests with its head 10 on the bottom of the base whilst the ground body 4 rests with its lower end upon the same base whilst the axial position of bushing 5a is determined by the height of guide collar 21 with the upper edge of which the bushing is engaged. It is obvious, as previously stated, that bushing 5 may be inserted over assembly "U" and into chamber 12 from either end of these parts, thereby simplifying the assembly of the spark plug to a great extent, especially if automatic assembly is involved.

After having arranged the parts under consideration in base 22, it is necessary to act on the upper edge of bushing 5a with a movable annular punch 23, so as to compress said bushing axially, so that its lateral edges will be caused to adhere tightly to the walls of assembly "U" and ground body 4.

At this stage, the fabricating procedure for the spark plug can be considered completed.

The spark plug and the production process of the same have been described and illustrated by way of example, with reference to a plug the insulator of which is formed of a small tube

It is obvious that the shape of the insulator can be different; for instance, the outer diameter of the same can be larger than the locking portion of the bush. In any case, the surfaces of the insulator and of the metal body designed to cooperate for the locking action of the bush, must have a certain axial length, in order to lock the bush in a wide range of different positions.

In the invention consideration is given also to the case in which the central electrode consists of one single rod,

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whereas the anchorage of one part, or of the parts of the electrode in the hole of the insulator, can be carried out by means of any appropriate system.

I claim:

1. A method for making spark plugs for internal combustion engines and comprising the steps of: cementing first and second electrodes within a tubular insulating member in a gas tight manner; positioning said tubular member within a main body portion; locating a sealing member intermediate said tubular member and said main body portion, in such a manner that the thermal degree of the spark plug is set at a predetermined value; and compressing said sealing member to effect a gas tight seal between said tubular member and said main body portion.

2. The method as recited in claim 1, wherein said first and second electrodes each have a head portion associated therewith and wherein said step of cementing comprises: inserting said first electrode into one end of said tubular member; introducing cement to the opposite end of said tubular member; inserting the second electrode into said opposite end of the tubular member; and positioning said first and second electrodes within said tubular member so that the respective heads of said electrodes lie at substantially the ends of the tubular member.

3. The method as recited in claim 2 and further comprising the step of: heating the assembly to soften the cement.

4. The method as recited in claim 1, wherein said sealing member is compressed by maintaining one end thereof in a fixed position and by exerting a compressive force on the opposite end thereof.

5. The method as outlined in claim 1, wherein said sealing member is made of a thermally conductive material.

6. The method as described in claim 1 and further comprising the step of: appending to the main body portion a third electrode adjacent said first electrode, said third electrode extending from said main body portion towards said first electrode in order to form a gap there-between.

7. The method as defined in claim 1 and further comprising the step of: maintaining a gap between said tubular member and said main body portion, except in the region of said sealing member.

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