July 12, 1955 S. I. JOHNSON ET AL 2,712,685

METHOD OF MANUFACTURING SPARK PLUG SHELL AND GROUND ELECTRODE ASSEMBLIES

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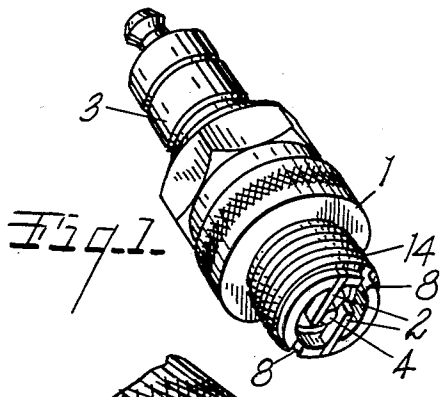


Fig. 1.

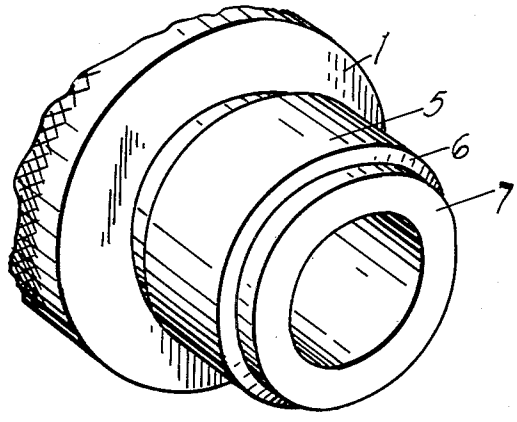


Fig. 2.

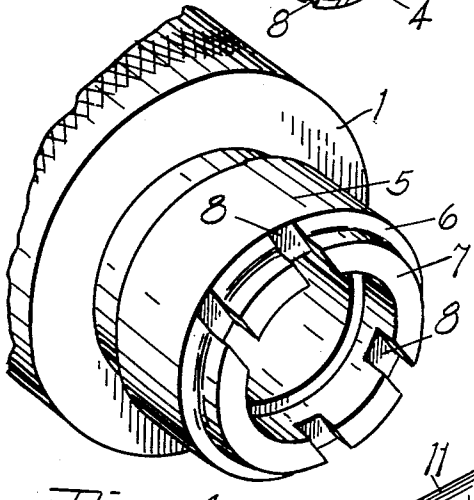


Fig. 4.

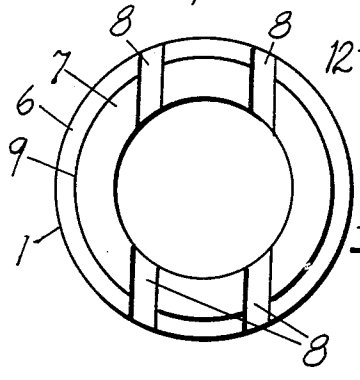


Fig. 3.

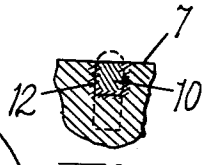


Fig. 10.

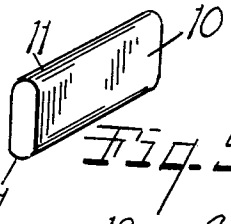


Fig. 5

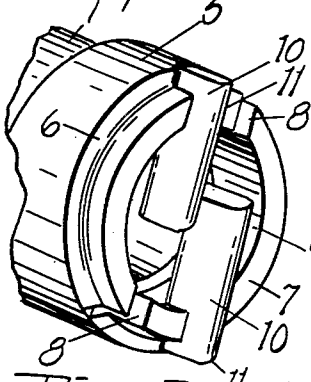


Fig. 6.

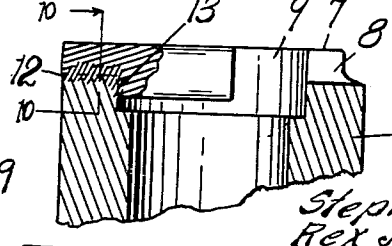


Fig. 9.

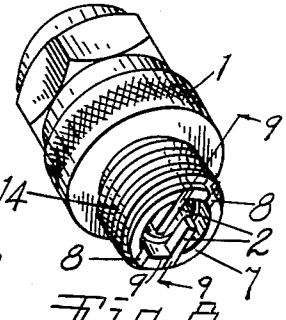


Fig. 8.



Fig. 7.

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METHOD OF MANUFACTURING SPARK PLUG SHELL AND GROUND ELECTRODE ASSEMBLIES

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Application August 6, 1951, Serial No. 240,586

4 Claims. (Cl. 29—25.12)

This invention relates to improvements in method of manufacturing spark plug shell and ground electrode assemblies.

This application is a continuation in part of our application for Letters Patent filed April 28, 1950, for Method of Manufacturing Spark Plugs, which application was a division of our application for Letters Patent filed August 1, 1949, Serial No. 107,876, Patent No. 2,614,548, issued October 21, 1952, for Spark Plugs and Method of Making Spark Plugs.

The main objects of this invention are:

First, to provide a method of manufacturing spark plug shell and electrode assemblies which when assembled in a spark plug maintain their efficiency during long periods of time.

Second, to provide a method of manufacturing spark plug shell and ground electrode assemblies which are well adapted for so-called "heavy duty" use and use under severe working conditions, one in which the electrodes are effectively protected against erosion and against accidental injury in handling, both in the assembly with other parts of a spark plug and in use, and one in which the ground electrodes can be easily and quickly "gapped" or adjusted without the aid of special tools and without likelihood of breaking the electrodes.

Third, to provide a method of producing spark plug shell and ground electrode assemblies in which the likelihood of becoming excessively or injuriously heated in use is minimized and one in which there is an effective current and heat transfer joint between the shell and the electrodes.

Fourth, to provide a method having these several advantages which enables rapid and economical production with great uniformity.

Objects relating to details and economies of the method will appear from the description to follow. The invention is defined and pointed out in the claims.

A completed spark plug comprising our invention and a complete shell and ground electrode assembly and certain of the steps in producing the same are illustrated in the accompanying drawing, in which:

Fig. 1 is a perspective view of a spark plug embodying the shell and ground electrode assemblies produced by our method.

Fig. 2 is an enlarged fragmentary perspective view illustrating one of the steps and certain details of the shell as produced on a screw machine.

Fig. 3 is an inner end view, the inner end only of the shell being shown with pairs of slots milled or cut therein.

Fig. 4 is a fragmentary perspective view corresponding to that of Fig. 2 with the slots milled in the inner end of the shell.

Fig. 5 is a perspective view of the blank or piece of ground electrode element stock.

Fig. 6 is a fragmentary perspective view corresponding generally to that of Fig. 4 with a pair of the electrodes inserted in a diagonally opposed pair of slots preparatory to the welding step.

Fig. 7 is a fragmentary side elevational view with an electrode element assembled in the shell as in Fig. 6.

Fig. 8 is a perspective view of the plug shell and ground electrode assembly after the electrodes have been welded to the shell.

Fig. 9 is an enlarged fragmentary view on a line corresponding to line 9—9 of Fig. 8 showing the electrode and a portion of its welded connection to the shell.

Fig. 10 is a detailed fragmentary view on a line corresponding to line 10—10 of Fig. 9 showing further details of the welded connections for the ground electrodes to the shell and their relation thereto.

It should be understood that all of these views are considerably enlarged, this being done in the interest of clearness and convenience in illustration; however, spark plugs are made in different sizes.

In Fig. 1 we illustrate a complete spark plug embodying a shell and ground electrode assembly produced by our method. The spark plug comprises the shell designated by the numeral 1 and having a pair of ground electrodes 2. The insulator 3 is adapted to receive the shell, the insulated electrode 4 being carried and insulated by the insulator.

In the practice of our method the shell 1 is desirably formed on a screw machine. The shell is provided with a cylindrical inner portion 5 shouldered at 6 to provide the end edge portion 7 of reduced diameter. Opposed pairs of slots 8 are then milled or cut through the inner end edge of the shell. The planes of these slots are parallel and laterally spaced on opposite sides and in laterally spaced relation to the axial center of the shell. The positioning of these slots with their planes in parallel spaced relation and in spaced relation to the axial center of the shell is clearly shown in Fig. 3. After the slots 8 are cut, the inner end of the shell is counterbored as shown at 9 in Fig. 4.

In Fig. 5 we illustrate one of the electrode elements 10 which are of flat section and have rounded edges 11. These electrode elements are inserted in diagonally opposite slots 8 and are preferably fitted into the slots with some pressure with the bottom curved edges thereof resting on the bottoms of the slots as shown in Fig. 7. The inner ends of the electrode elements are spaced from the opposite slots of the pairs and their inner ends are in laterally spaced overlapping relation. The next step is to weld the electrodes to the shell. This is done by simultaneously applying welding current and pressure which results in a welded joint indicated at 12 in Figs. 9 and 10, the weld being on both the bottom and sides of the electrodes.

It will be noted that the width of the electrode elements 10 exceeds the depth of the slots 8 and when the electrodes are heated they are pressed into the slots, forming a very effective heat and electrical transfer contact with the walls of the slots. The inner portions of the electrode elements are pressed into the counterbore 9 as indicated at 13 in Fig. 9.

After the electrodes are welded into the shell, the inner end of the shell is externally machined or "hollow milled" to remove any projecting ends of the electrodes and to chew up any distortions which may result from the welding operation. The threads 14 are then formed on the cylindrical portion 5 of the shell, preferably by a rolling operation. The rolling of the thread extending across the outer ends of the electrodes further acts to hold them in place.

The curved or rounded edge 11 is a feature of advantage, particularly in resistance welding. We desire to point out, however, that there are other types of welding such, for example, as the condenser capacity discharges which are not so dependent upon the resistance between the two elements being welded together. The counterbore

provides a relatively thin wall at the inner end of the shell which is also of advantage, particularly in resistance welding and it is of further advantage in that it provides more space in which to move the electrodes for adjustment permitting a relatively large amount of gases in the combustion chamber to circulate around the sparking point and thereby serves to secure better and more positive firing.

The opposed slots are open to permit adjustment of the free inner ends of the electrode as by means of a screw driver engaged in the open slot aligned with the electrode to be adjusted. This permits the accurate adjustment to and from the insulated electrode 4. In addition to this feature of advantage in adjustment, the edges of the open slots form reaming edges for cleaning the threads of the plug receiving bore of the combustion chamber.

Our method has the further advantage in that it enables large quantity production with uniformity of products. The ground electrodes lie within the shell and are protected to a very substantial extent from the flame flow across the inner end of the plug and consequent erosion.

The spark plug shell and ground electrode assemblies produced by our method are highly efficient and highly durable in use. We have illustrated the steps of our method which we believe will enable those skilled in the art to practice the same in a practical manner.

Having thus described our invention, what we claim as new and desire to secure by Letters Patent is:

1. The method of making spark plug shell and ground electrode assemblies comprising the steps of forming a tubular metal spark plug shell, cutting opposed pairs of aligned slots through the inner end edge thereof with the planes of the pairs of slots parallel and laterally spaced and on opposite sides of and in laterally spaced relation to the axial center of the shell, pressure inserting electrode elements of flat section and having a rounded edge edgewise into diagonally opposite slots with their rounded edges contacting the bottoms of the slots and with their inner ends in spaced relation to the opposed aligned slot and projecting beyond and in laterally outward spaced relation to the axial center of the shell, applying pressure to the outer edges of the electrode elements and simultaneously therewith applying welding current to produce a welded heat and current conducting joint between the electrode elements and the shell with the electrode elements lying within the plane of the inner end of the shell, the axially inner edges of the electrode elements being deformed by said pressure axially inwardly of the shell along the radially inner ends of the slots in which they are received into heat conducting contact with the inner surface of the shell.

2. The method of making spark plug shell and ground electrode assemblies comprising the steps of forming a tubular metal spark plug shell with a generally cylindrical inner portion, cutting opposed pairs of aligned slots through the inner end edge thereof with the planes of the pairs of slots parallel and laterally spaced and on opposite sides of and in laterally spaced relation to the axial center of the shell, inserting electrode elements into diagonally opposite slots with their inner ends in spaced relation to the opposed aligned slot and in laterally outward spaced relation to the axial center of the shell, applying pressure to the electrode elements and simultaneously therewith applying welding current to produce a welded heat and current conducting joint between the electrode elements and the shell with the electrode elements lying within the plane of the inner end of the shell, and threading the said cylindrical portion of the shell.

3. The method of making spark plug shell and ground electrode assemblies comprising the steps of forming a tubular metal spark plug shell, cutting opposed pairs of aligned slots through the inner end edge thereof with the planes of the pairs of slots parallel and laterally spaced and on opposite sides of and in laterally spaced relation to the axial center of the shell, inserting electrode elements into diagonally opposite slots with their inner ends in spaced relation to the opposed aligned slot and in laterally outward spaced relation to the axial center of the shell, applying pressure to the electrode elements and simultaneously therewith applying welding current to produce a welded heat and current conducting joint between the electrode elements and the shell with the electrode elements lying within the plane of the inner end of the shell, the axially inner edge of the electrode being deformed by said pressure axially inwardly of the shell along the radially inner end of the slot in which it is received into heat conducting contact with the inner surface of the shell.

4. The method of making spark plug shell and ground electrode assemblies comprising the steps of providing a metal shell, forming opposed pairs of slots in the end edge thereof with the corresponding slots of the pairs in alignment, the aligned slots being in parallel planes and spaced laterally relative to the center of the shell, inserting electrodes in diagonally opposed slots, and welding them into the slots with the electrodes within the plane of the end of the shell.

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