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L. H. MIDDLETON

2,111,916

SPARK PLUG

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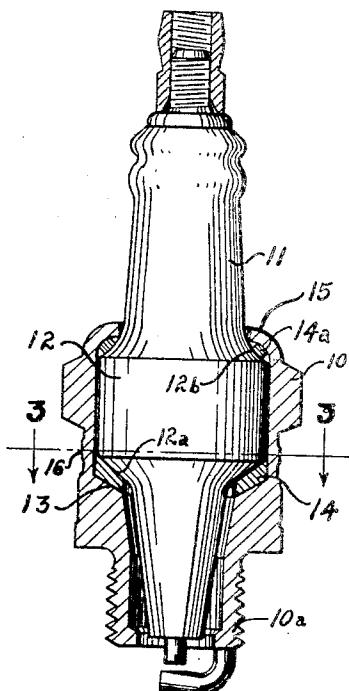


Fig. 1

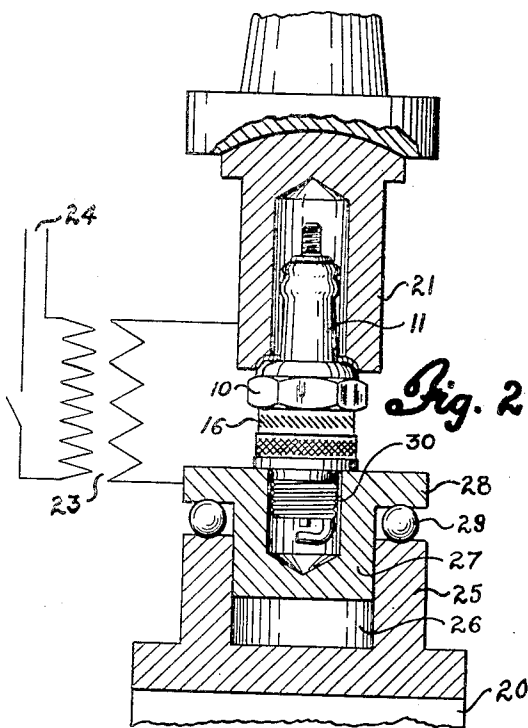


Fig. 2

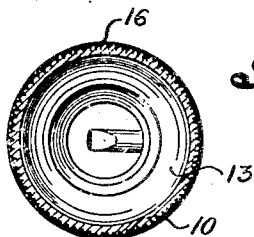


Fig. 3

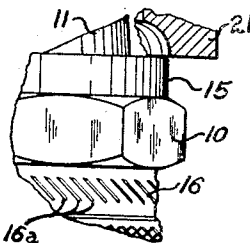


Fig. 4

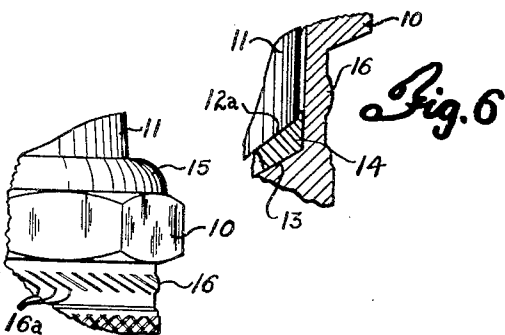


Fig. 5

INVENTOR
Leslie H. Middleton
BY
H. Henry Stollenberg
ATTORNEY

UNITED STATES PATENT OFFICE

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SPARK PLUG

Leslie H. Middleton, Toledo, Ohio, assignor to
The Electric Auto-Lite Company, Toledo,
Ohio, a corporation of Ohio

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6 Claims. (Cl. 123—169)

This invention relates to spark plugs, more particularly to spark plugs wherein the shell portion in which an insulating member is permanently positioned is of one-piece construction.

5 To obtain tight joints between the shell and insulator of a spark plug, provision has been made in this invention whereby the shell, under influence of axial pressure and heating by electric currents, thermoplastically collapses in an annular section with an accompanying grinding action, to seat the gaskets on the insulator to insure a leak-proof joint at normal operating temperatures. There is provided a method whereby the heating by the electric current and the rotative grinding is obtained automatically without appreciably decreasing the mechanical strength of the affected portion.

15 It is, therefore, an object of this invention to provide a spark plug having leak-proof joints in which the thermal activity of an electric current acting on the metal shell will be made effective without materially decreasing the mechanical strength thereof, so that the shell may be collapsed in an annular section by axial pressure during the plastic stage of the heated metal forming the shell.

25 It is a further object of this invention to provide a method of sealing the joints of a spark plug by the thermoplastic compression of an annular section of the shell under the influence of an electric current and axial compression, the annular section being contorted to effectuate a rotative torque under axial compression and to increase its relative electrical resistance for a thermal change under influence of a flow of electricity.

30 It is a further object of this invention to provide a method of forming leak-proof joints for spark plugs whereby the component parts of the joint are ground into sealing relation when the shell is being thermoplastically collapsed under the influence of axial pressure.

45 Other objects and advantages of this invention relating to the arrangement, operation and function of the related elements of the structure, to various details of construction, to combinations of parts, and to economies of manufacture, will be apparent to those skilled in the art upon consideration of the following description and appended claims, reference being had to the accompanying drawing forming a part of this specification wherein like reference characters designate corresponding parts in the several views.

55 Figure 1 is a sectional elevation of the plug showing the relations between the insulator and the shell of the plug.

60 Figure 2 is a sectional elevation of machine parts wherewith an electric current may be passed through the metallic shell and wherewith a constricting force is applied thereto.

Figure 3 is a sectional plan of the shell, taken along the line 3—3 of Figure 1, the insulator being removed.

Figure 4 is an elevational view prior to the turning-in operation of the holding flange.

Figure 5 is an elevational view of the plug, showing the relation of the parts of the shell after the holding flange has been turned in and the shell constricted.

Figure 6 is a sectional elevation, showing the effect of the constricting force upon the collapsed section of the shell.

Referring to Figure 1, there is shown a preferred embodiment of the invention wherein the hollow metallic shell 10 encloses an insulator 11, the shell 10 and the insulator 11 having electrodes at their lower ends in close cooperation to form their sparking points. The lower portion of the shell 10 is provided with a standard threaded section 10a which is adapted to fit into the cylinder wall of an automotive engine. The insulator 11 has an annular raised section 12, whose lower shoulder 12a cooperates with a ledge 13 through a soft metal gasket 14, made of copper or the like. The upper shoulder 12b cooperates with an inturned flange 15 through another soft gasket 14a.

The flange 15 is shown in its upstanding position in Figure 4, which allows easy entry of the insulator 11 into the cavity in the shell 10. The flange is preferably cold rolled from the position shown in Figure 4 to that shown in Figure 5. This rolling in of the flange permanently holds the insulator shell and gaskets in position.

The cold rolling process, however, fails to give leak-proof joints between the shell and the insulator, particularly when the temperature of the plug is raised to operating temperatures, inasmuch as the coefficient of expansion of the metal shell is greater than that of the insulator. With an increase in temperature, the joints progressively open and, therefore, are poorer from the point of efficiency. It is, therefore, essential that the shell be thermoplastically collapsed at temperatures substantially higher than the normal operating temperatures.

To attain this end, an electric current is employed to heat an annular section 16 of the shell at some point intermediate the supporting ledge 13 and the inturned flange 15 by giving the annular section 16 a higher electrical resistance than the balance of the shell, but at the same time retaining substantially its mechanical strength. It has been found that this may best be attained through the use of fluting in the annular section 16 as clearly shown in Figure 4.

The fluting, as shown in Figure 4, is preferably formed with parallel indentations 16a sloping at an angle of approximately 45 degrees with the central longitudinal axis of the plug. This

formation displaces or contorts the metal in the section so as to increase the relative resistance thereof and when an electric current of proper quantity is caused to flow axially of the shell, this increased resistance will cause the annular section 16 to heat more rapidly and approach a plastic state with greater rapidity than the adjacent portions of the shell which remain comparatively cool. Then axial pressure is applied.

10 The electric current and the axial pressure are applied to the shell by the machine shown in Figure 2, to be described hereinafter.

When the axial compression is applied with the metal in the annular section in plastic state, the two component parts of the shell, as divided by the plastic section, are driven together under the compression which is maintained during the plastic stage. This forces the inwardly turned flange 15 closer to the supporting ledge 13 and tends to conform the soft metal gaskets 14 and 14a to the contour of the juxtaposed surfaces on the shell and insulator to form a gas-tight joint. The temperature of the annular section is high at the plastic point of the metal so that as it cools, a contraction results which further tends to pull the ledge and flange together and places tension on the metal between them. As the operating temperature of the plug is much lower, this tension is never relaxed by expansion, hence the joints will remain tight at all operating temperatures.

During the compression of the shell at the plastic stage of the annular section 16, the angular relation between the indentations 16a and the longitudinal axis of the plug is changed as shown by a comparison of Figures 4 and 5. Figure 4 shows the initial position of the indentations while Figure 5 shows the final position. The angle of displacement has approached nearer the perpendicular relation in the final position. This flattening out of the section 16 causes relative rotation of the component parts of the shell 10 as defined by the plastic section during the compressive stage. This relative rotation causes a grinding action on the gaskets 14 and 14a and tends to give them a better seating relation with the cooperating shell and insulator surfaces between which they are positioned.

In Figure 2 there is shown a mechanism whereby the electric current may be applied to the shell and the proper compression obtained after the shell has attained a plastic state in the annular section 16. It comprises generally a base portion 20, and a moving die portion 21, having the shell 10 of the plug positioned therebetween. An electric current of any suitable kind as, for example, alternating current is supplied, having the die 21 as one electrode and the base 20 for the other electrode as shown. A step-down transformer 23 may be used to change the voltage from a line source 24 to a proper value.

The base portion 20 may be provided with an annular boss 25 having an aperture 26, in which the bushing 27 is positioned. The bushing 27 may have a flange 28 in juxtaposition with the boss 25, an antifriction means as, for example, ball bearings 29 may be positioned therebetween so that the bushing 27 may rotate freely in the aperture 26. The bushing is provided with an aperture 30 into which the threaded portion 10a of the plug will fit loosely. The antifriction means mentioned above allows free relative movement of the lower portion of the plug so that it may be readily influenced by the ro-

tative effort supplied during the compression period by the fluting on the annular section as described above.

It is to be understood that the above detailed description of the present invention is intended to disclose an embodiment thereof to those skilled in the art, but that the invention is not to be construed as limited in its application to the details of construction and arrangement of parts illustrated in the accompanying drawing, since the invention is capable of being practiced and carried out in various ways without departing from the spirit of the invention. The language used in the specification relating to the operation and function of the elements of the invention is employed for purposes of description and not of limitation, and it is not intended to limit the scope of the following claims beyond the requirements of the prior art.

I claim:

1. The method of making a spark plug having a hollow metallic shell, of providing an internal supporting ledge, and a rib on the upper end of the shell; placing the insulator in position in the shell, and turning the rib inwardly into holding engagement with the insulator, and then applying heat and pressure to the shell for thermoplastically collapsing a shell section between the inwardly turned rib and the internal supporting ledge and during the plastic period of the shell section applying a torque to a shell portion to cause relative rotation of the parts of the shell in the plastic section.

2. The method of thermoplastically collapsing the shell of a one-piece spark plug comprising applying heat and pressure to the shell for longitudinally collapsing a plastic shell section and applying a torque to a portion of the shell to rotate portions of the shell relatively about the plastic section.

3. In a one-piece spark plug, an insulator, a metal shell permanently positioned about the insulator, gaskets to form a seal between the insulator and the shell, a section of the metal of the shell disposed to increase the electrical resistance thereof, said section having a heater portion and a portion to provide torque when the shell is thermoplastically collapsed by application of pressure and an electric current.

4. In a thermoplastically collapsed shell of a one-piece spark plug, a plastic section formed by application of an electric current and pressure, the plastic section comprising a supporting portion and a torque-producing portion, whereby the adjacent parts of the shell are relatively rotated under compression of the plastic section.

5. The method of thermoplastically collapsing the shell of a one-piece spark plug comprising, disposing the metal in the plastic section of the shell which creates a relative rotation of the parts of the shell about the plastic section during collapse and applying heat and pressure for longitudinally collapsing the plastic section to create said relative rotation.

6. The method of thermoplastically collapsing the shell of a one-piece spark plug comprising, conforming a section of the shell by an oblique fluting, and applying heat and pressure to the shell for longitudinally collapsing the shell at the fluting, whereby the collapse of the fluting creates a turning action on a portion of the shell to rotate the same relative to the other portion.

LESLIE H. MIDDLETON.