

July 31, 1934.

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1,968,314

SPARK PLUG AND METHOD OF MAKING THE SAME

Filed Jan. 14, 1933

2 Sheets-Sheet 1

**Fig. 1**

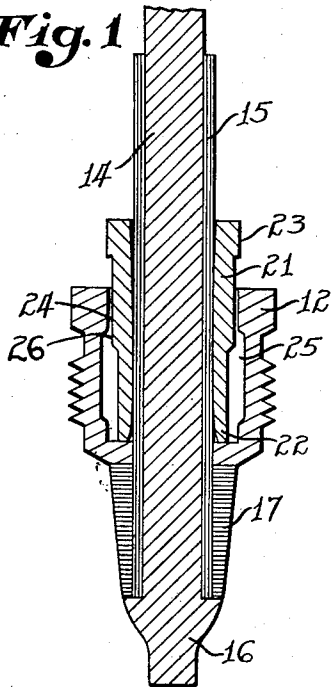


**Fig. 2**

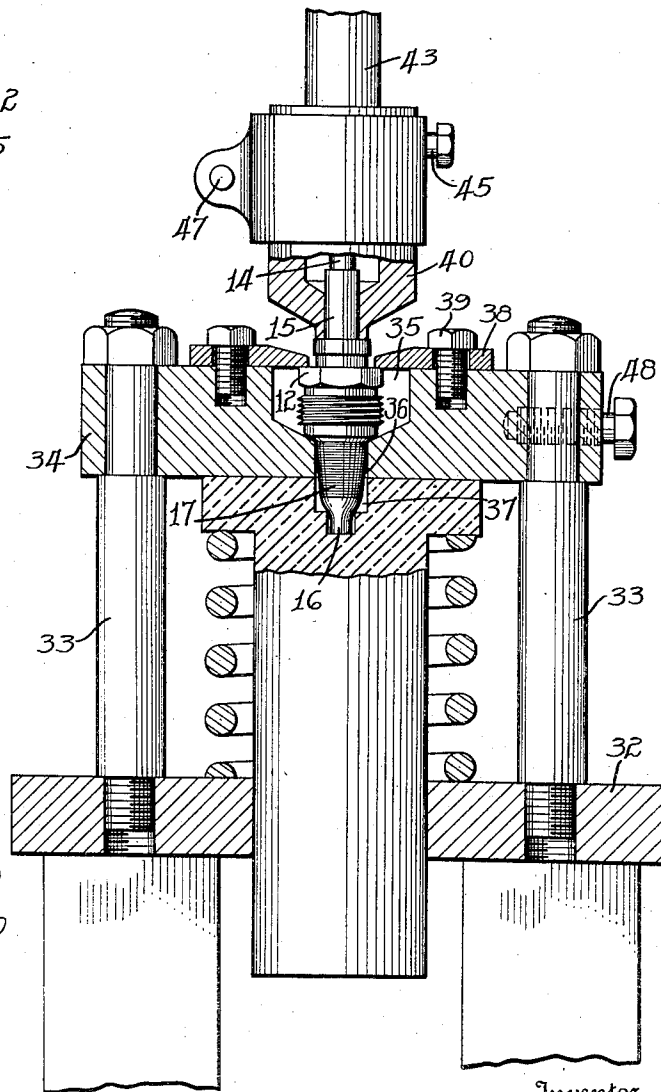
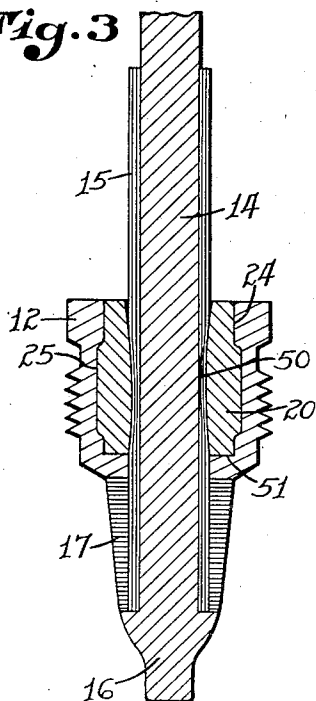


**Fig. 3**



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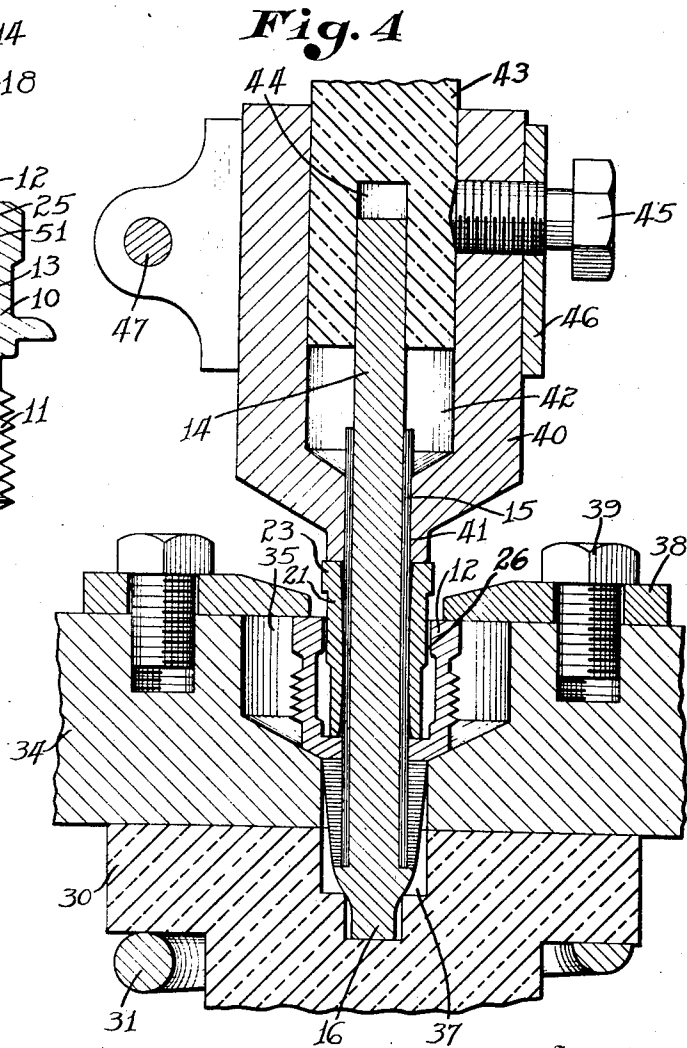
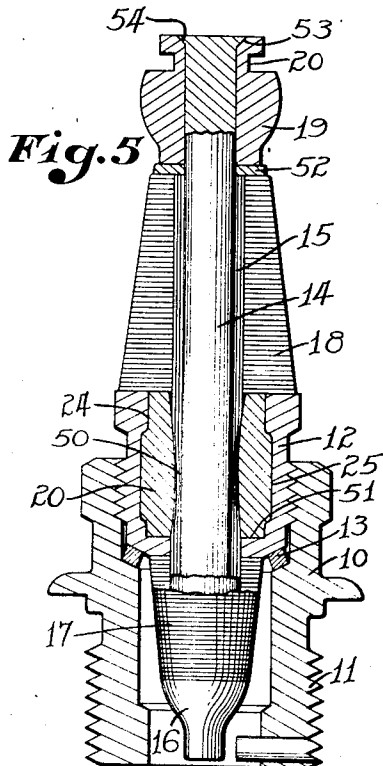
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SPARK PLUG AND METHOD OF MAKING THE SAME

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2 Sheets-Sheet 2



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## UNITED STATES PATENT OFFICE

1,968,314

SPARK PLUG AND METHOD OF MAKING  
THE SAMEOtto C. Rohde, Toledo, Ohio, assignor to Cham-  
pion Spark Plug Company, Toledo, Ohio, a cor-  
poration of Delaware

Application January 14, 1933, Serial No. 651,781

13 Claims. (Cl. 29—155.51)

This invention relates to a spark plug and a method of making the same. More particularly it relates to the formation of a gas-tight joint between the mica insulation of the spark plug and the electrode on one side and the shell on the other side. Details and minor objects of the invention will appear as the description proceeds.

In the accompanying drawings forming a part of this specification, Fig. 1 is a sectional view of an initial assembly in making one form of a spark plug embodying my invention;

Fig. 2 is a view of assembled mechanism for performing the next step in the making of the plug after that shown in Fig. 1;

Fig. 3 is a longitudinal section of a spark plug in the stage after it has been treated by the mechanism in Fig. 2;

Fig. 4 is an enlarged section of the plug and immediately associated mechanism shown in Fig. 2;

Fig. 5 is a longitudinal section of a completed plug formed in accordance with Figs. 1 to 4.

The completed spark plug shown in Fig. 5 will be described first. In this view there is shown the usual shell 10 having the screw threads 11 adapted to be screwed into the cylinder wall of an internal combustion engine. Within the top of the shell there is threaded a bushing 12 seated upon a gasket 13. The central electrode 14 has wound about its central portion mica sheets 15 forming an insulating sleeve. Between the lower end 16 of the electrode and the lower end of bushing 12 there is insulation 17 formed by mica discs 17 while a similar series of mica discs 18 is provided above the bushing and below the attachment member 19, which has a groove therein 20 for reception of a terminal.

In the making of the plug, the sleeve 15 is first wound upon electrode 14 and then mica discs 17 are placed in position. Thereafter bushing 12 is placed around sleeve 15 above the discs 17 and a filler sleeve 21 is inserted between the bushing and sleeve 15. In the form shown, filler sleeve 21 has a somewhat reduced lower end 22 and a slightly thickened upper end 23 which is designed to just fit within the upper bore 24 of bushing 12. Below the upper end, the bore of bushing 12 is enlarged as at 25. In the form shown, sleeve 21 is thinner above beveled end 22 to shoulder 26 than thereabove to upper end 23. A low-manganese steel containing one or two per cent manganese, for example, is suitable material for the sleeve. The steel bushing is preferably given the usual black finish, inside

and out, this finish having some insulating properties. The finish may be removed from the inner end of the counter bore in bushing 12 where it is contacted by beveled end 22 of sleeve 21, and from the shoulder immediately opposite this point.

With the parts thus assembled, they are placed in the device shown in Figs. 2 and 4. This comprises an abutment member 30 supported by a strong spring 31 upon a support 32. Rods 33 extend upward from support 32 and have fastened to their upper end a cross piece 34 which has therein a socket 35 adapted to receive bushing 12. Below socket 35 there is an opening 36 to receive the insulation 17. The upper end of abutment 30 has a socket 37 adapted to receive the lower end 16 of the electrode and surrounding insulation. Bushing 12 is held in socket 35 by clamping members 38 fastened in place by screws 39.

A plunger head 40 has an opening 41 therein to receive the electrode 14 and sleeve 15. The upper portion of this opening is enlarged at 42 to receive a plunger stem 43 which has in its lower end a socket 44 to receive the upper end of electrode 14. Head 40 is held in adjusted position upon member 43 by a screw 45 or other means. A ring 46 is clamped about head 40 by means of a member 47.

Cross-head 34 is insulated from other portions of the mechanism and abutment 30 is preferably of non-conducting material. Cross-head 34 may be connected to a source of electricity by a terminal at 48, while another terminal is attached at 45. Thereupon with the parts in position as shown in Fig. 4, electric current passes from cross-head 34 through bushing 12 into the lower end of filler sleeve 21 and thence through plunger head 40. It will be understood that spring 31 is sufficiently strong to insure proper compression of insulation 17 so that the bushing 12 is held in proper relation to electrode 14 and sleeve 15.

Sufficient current is employed to melt the lower end of the filler sleeve, first at its lower beveled end, then progressively along the thin portion to shoulder 26, then along the thicker portion to upper end 23. Enough pressure is exerted on the upper end of filler sleeve 21 to insure the pressing down of its upper end as its lower end melts, and the current is regulated so that upper end 23 remains hard. This hard ring is pressed down preferably until it is flush with or slightly below the top of the surrounding bushing, and forces the molten metal against the bushing and mica. Pressure is continued while the metal sets.

The ring 23 forms a close fit with the top of the surrounding bushing, but preferably does not make good electric contact therewith during its insertion therein, as a good electric contact at this point tends to shunt the circuit around the lower part of the sleeve that is being progressively melted. A very slight clearance, especially when aided by a black finish or similar slight coat, is sufficient to prevent detrimental shunting.

After the pressing operation, the cooling of the heated metal about sleeve 15 further compresses that sleeve so that a thoroughly gas-tight joint is produced at 50, (see Fig. 3). Since the metal of filler sleeve 21 is seated in the bushing while molten, the fit is so close as to be gas-tight under ordinary circumstances but, if desired, there is a welded union of the reduced lower end 22 of sleeve 21 with the bushing, as indicated at 51 on Fig. 3. This welded union is not ordinarily necessary to make a gas-tight joint, but may be provided, if desired, for purposes of safety.

Upper ring 23 fits closely around sleeve 15, but is not shrunk thereon like the molten metal below, and consequently there is no sharp upper shoulder cutting into the mica. Likewise, the bevel 22 at the bottom not only aids in localizing the initial heat so as to start melting at that point, but also results in less pressure on the mica at this point, so that the inner surface of the filler sleeve is somewhat convex in the finished plug, as shown in Fig. 3, and provides compression over a considerable length of the mica sleeve without any sharp shoulder at any point that is likely to break or injure the mica.

Since the metal is molten while being fitted into the counter bore of the bushing, it is pressed in every direction by the applied pressure, and conforms exactly to any irregularities in the contour of the space, even such slight irregularities as result from the beginning and terminations of the laminae of mica making up sleeve 15. The pressure exerted by ring 23 is sufficient to insure this accurate fit, but need not approach that necessary to deform solid metal. The slight expansion of the steel during solidification may assist in the close fit which it is found to have within the shell even after cooling to the temperature of the shell.

After the parts are thus assembled, as shown in Fig. 3, the insulating members 18 are placed in position after which a washer 52 is placed thereon and upper terminal member 19 is pressed down upon insulating washers. The upper end of the bore in member 19 is flared at 53 and the top of the electrode is upset at 54 so as to rivet the parts in assembled relation. The bushing 12 is then screwed into sleeve 10 to form the completed plug shown in Fig. 5.

By the above described arrangement it will be seen that there is provided a permanent gas-tight joint between the insulating member and the surrounding metallic member by which the spark plug is mounted.

While one construction has been shown in considerable detail, it will be understood that changes in the details of the method and plug may be made within the scope of the appended claims, wherein the term "shell" is intended to cover bushing 12 or any other member surrounding the insulating tube.

What I claim is:—

1. In making a spark plug, the method of sealing a shell onto a non-vitreous insulating tube surrounding an electrode which consists in ex-

erting pressure upon molten metal in the space between the shell and tube, and maintaining the pressure until the metal solidifies, the solidified metal as it cools shrinking onto the tube.

2. In making a spark plug, the method of sealing a shell onto a non-vitreous insulating sleeve surrounding an electrode, which consists in exerting pressure upon molten metal in the space between the shell and tube, and maintaining the pressure while the metal sets in interlocking engagement with the shell and in intimate contact with the tube, the solidified metal as it cools shrinking onto the tube.

3. In making a spark plug, the method which consists in winding thin mica sheets about an electrode and thereby forming an insulating tube, surrounding the tube with a shell, exerting pressure upon molten metal in the space between the shell and tube, and maintaining the pressure while the metal sets in intimate contact with the shell and tube, the solidified metal as it cools shrinking onto the tube, thereby pressing the tube against the electrode.

4. In making a spark plug, the method which consists in winding thin sheets of mica around an electrode to form an insulating tube, surrounding the tube with a shell having an undercut counter bore, exerting pressure upon molten metal in the counter bore and maintaining the pressure while the molten metal solidifies in intimate contact with the tube and with the undercut portion of the counter bore, the solidified metal as it cools shrinking onto the tube.

5. In making a spark plug, the method of sealing a shell onto a non-vitreous insulating tube surrounding an electrode, which consists in introducing between the shell and tube a metal sleeve while melting the sleeve progressively, beginning at its inner end, and pressing the molten metal thereby formed between the shell and tube by continued pressure on the unmolten outer end of the sleeve, the metal as it cools shrinking onto the tube.

6. In making a spark plug, the method of sealing a shell onto a non-vitreous insulating tube surrounding an electrode, which consists in introducing between the shell and tube a metal sleeve having less electrical resistance at its outer than at its inner end, passing an electric current through the sleeve and thereby progressively melting the inner end, pressing the outer unmolten end into the space between the shell and tube and thereby forcing the molten metal into close contact with the shell and tube, and solidifying the molten metal while it is in such close contact, the metal as it cools shrinking onto the tube.

7. In making a spark plug, the method which consists in winding thin mica sheets about an electrode and thereby forming an insulating tube, surrounding the tube with a shell having a grooved counter bore around the tube, inserting a metal sleeve into said counter bore, melting the inner end of the sleeve progressively while it is being inserted, and continuing to press the unmolten outer end of the sleeve into the counter bore while allowing the molten metal to solidify in interlocking engagement with said groove and in intimate contact with said tube, the solidified metal shrinking onto the tube as it cools, thereby compressing the tube against the electrode.

8. In making a spark plug, the method which consists in placing a metal shell around a non-vitreous insulating tube surrounding an electrode, introducing a steel sleeve into the space between

the shell and tube, forcing the inner end of the sleeve into contact with the shell, passing an electric current through a portion of the shell and through the sleeve and thereby melting the sleeve

5 progressively from its inner end towards its outer end, but leaving the outer end unmelted, pressing the unmelted outer end of the sleeve into said space and thereby bringing the molten metal into intimate contact with the shell and tube, and  
10 solidifying and cooling the steel and thereby sealing the shell to the tube and compressing the tube onto the electrode.

9. In making a spark plug, the method which consists in placing a shell around a non-vitreous  
15 insulating tube surrounding an electrode, introducing a manganese steel sleeve into the space between the shell and tube, passing an electric current through the sleeve to melt the inner end thereof, and pressing the unmolten outer  
20 end of the sleeve against the molten metal and solidifying the molten metal under pressure, the solidified metal as it cools shrinking onto the tube.

10. In making a spark plug, the method which  
25 consists in winding thin sheets of mica around an electrode to form an insulating tube, surrounding the tube with a metal shell having a counter bore affording a space between the shell and tube, inserting a manganese steel sleeve into  
30 the said space, making an electric contact between the shell and inner end of the sleeve and passing an electric current through the shell and sleeve through said contact and thereby melt-

ing the inner end of the sleeve, and pressing the molten metal into said space while it solidifies, the solidified metal shrinking onto the tube by cooling.

11. A spark plug comprising a central electrode, a non-vitreous insulating tube surrounding the electrode, a shell surrounding the sleeve, and a metal seal between the shell and tube, said seal being fitted in place while molten and under pressure and thereby exactly fitting all irregularities in contour of the interior of the shell and exterior of the tube, and shrunk onto the tube and pressing the tube into sealing contact with the electrode. 80 85

12. A spark plug comprising a central electrode, a mica tube around the electrode, a shell around the tube, and a steel seal, pressed into place while molten, between the shell and tube, and thereby fitting exactly the contour of the interior of the shell and exterior of the tube and being shrunk onto the tube and pressing it into sealing contact with the electrode. 90 95

13. In making a spark plug, the method of sealing a shell onto a non-vitreous insulating tube surrounding an electrode, which consists in exerting pressure upon molten metal in the space between the shell and tube and maintaining the pressure until the metal solidifies, said metal when cooling having its degree of shrinkage gradually reduced at its outer end to avoid a sharp shoulder in impingement with the insulating tube. 100 105

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