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SILVER CASTING METHOD FOR SPARK PLUG ELECTRODES

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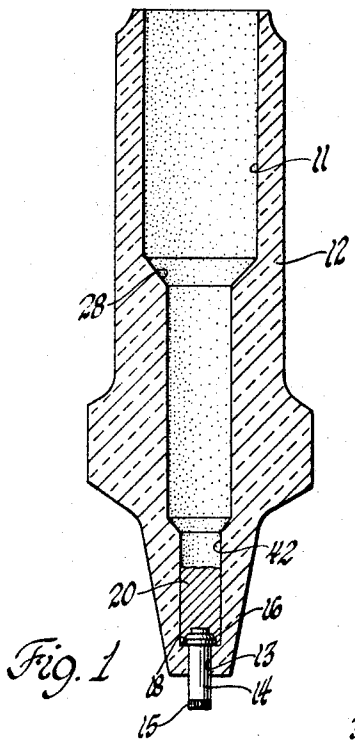



Fig. 1

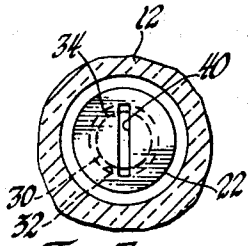



Fig. 3

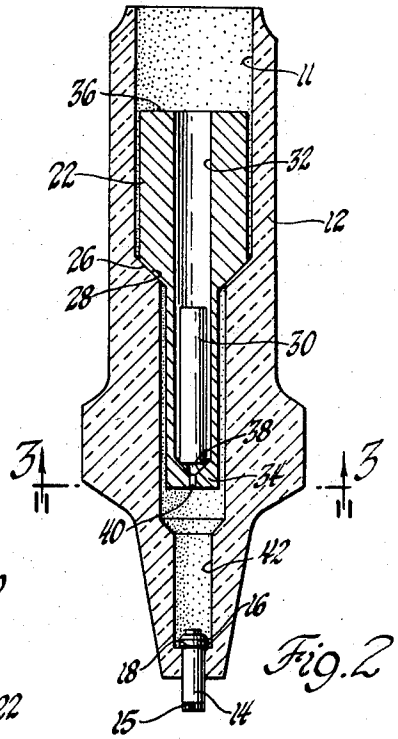



Fig. 2

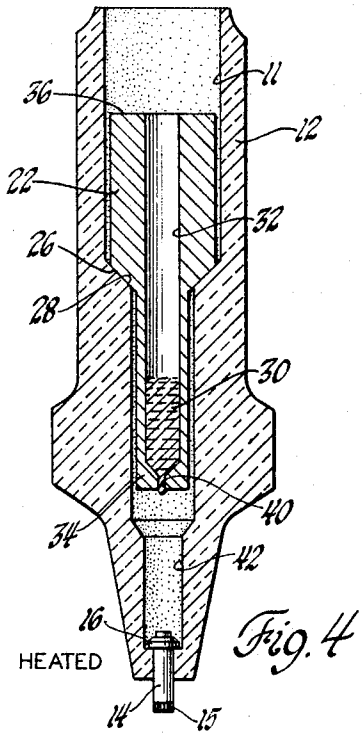



Fig. 4

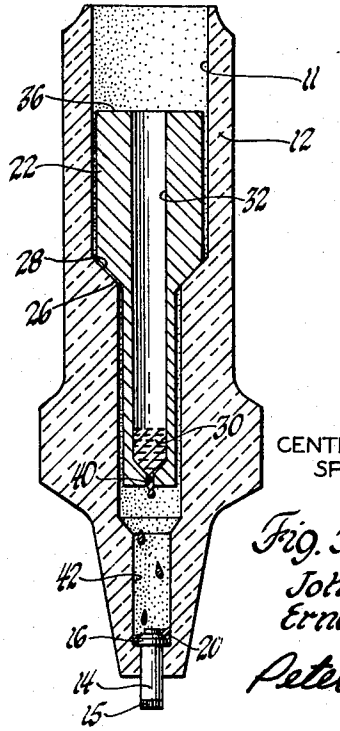



Fig. 5

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# SILVER CASTING METHOD FOR SPARK PLUG ELECTRODES

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## ABSTRACT OF THE DISCLOSURE

A method of casting a mass of silver about the head above a spark plug center electrode is disclosed. A silver mass is melted in a dispenser which is in communication with the spark plug insulator centerbore. The dispenser is positioned at a distance from the center electrode head which will permit the silver mass to progressively fill the insulator centerbore directly around and above the center electrode head. The spark plug assembly including the dispenser is subjected to centrifugal force which causes the silver to pass from the dispenser in a fine stream onto the center electrode head so that the molten silver which first touches and surrounds the center electrode head solidifies sufficiently to act as a seal which prevents the remainder of the molten silver from leaking out around the center electrode.

This invention relates to spark plugs, and more particularly to a method for silver casting the head of a center electrode.

Conventionally, spark plugs in aircraft engines which are subjected to high operating temperatures have a silver mass in the insulator centerbore surrounding the center electrode head for the purpose of conducting heat away from the center electrode thereby improving the performance of the spark plug at these elevated temperatures. A silver casting method commonly used for this purpose involves centrifuging a heated spark plug assembly consisting of the insulator, center electrode, and a molten silver mass, and is fully described in U.S. Patent No. 2,449,403. The method described in this patent is the simplest and most economical method available for silver casting a spark plug center electrode in an insulator centerbore; however, the method has several drawbacks which limit its usefulness. One drawback in this method is that during the centrifuging step, the molten silver tends in some instances to leak out of the insulator by flowing around and below the center electrode head and between the shank of the center electrode and the lower insulator centerbore walls. Spark plug assemblies in which the molten silver has passed down along the center electrode shank and out of the insulator are called silver leakers. Since the quantity of silver above and around the center electrode head in a silver leaker is considerably less than that compared with a properly silver cast center electrode, heat is not conducted away from the center electrode effectively. This heat which is not conducted away reduces the useful life of a spark plug significantly. Another drawback with this prior art method is that the silver casting on top of the center electrode head may contain entrapped air bubbles which cause an inferior casting. The air bubbles are formed in the silver casting during the centrifuging step when the molten silver mass forces the air which was entrapped about the center electrode head up through the molten silver. Although



some of the air escapes the molten silver mass, some of it is still entrapped.

It is a basic object of this invention to provide an improved method for silver casting the center electrode head in a spark plug insulator centerbore which does not leak silver out of the insulator centerbore and which provides an air bubble-free silver casting. It is still another object of this invention to provide a dispenser means which will control the flow of molten silver under centrifugal force to progressively fill the insulator centerbore space surrounding the spark plug center electrode head.

These and other objects of this invention are accomplished by the method of manufacturing a spark plug in which a molten mass of silver is dispensed onto the center electrode head in a controlled manner to progressively fill the insulator centerbore space surrounding the center electrode head. In general, the improved method consists of melting a solid silver mass in a dispenser which is in communication with the insulator centerbore. The dispenser is positioned at a distance from the center electrode head which will permit the silver mass to progressively fill the insulator and centerbore directly around and above the center electrode head. The assembly is then subjected to centrifugal force which causes the silver to pass from a dispenser in a fine stream onto the center electrode head. The first silver mass to hit the center electrode head is cooled sufficiently to cause solidification. The silver mass thus solidified forms a solid seal about the center electrode head and permits the space immediately above the center electrode head to be completely filled with molten silver. None of the molten silver passes out of the insulator tip by the method described above and no air bubbles are entrapped in the molten silver mass.

Other objects and advantages of this invention will be apparent from the following detailed description, reference being made to the the accompanying drawing wherein a preferred embodiment of this invention is shown.

In the drawings:

FIGURE 1 is a cross sectional side view of an insulator assembly having a silver casted center electrode head;

FIGURE 2 is a cross sectional side view of the insulator assembly containing a dispenser having a silver slug therein;

FIGURE 3 is an enlarged end view of the dispenser;

FIGURE 4 is a cross sectional side view of an insulator assembly containing a dispenser having molten silver therein; and

FIGURE 5 is a cross sectional side view of the insulator assembly containing a dispenser with a portion of the molten silver remaining therein.

Referring to FIGURE 1 of the drawings, the spark plug assembly formed by the method described in this invention comprises a conventional insulator **12** with a centerbore **11** having a lower portion **13** of relatively small diameter. A center electrode **14** is positioned in the lower portion **13** of the insulator centerbore, the serrated lower end **15** thereof projecting beyond the lower tip of the insulator **12**. The center electrode head **16** rests on the insulator shoulder **18** which is connected to the lower portion **13** of the insulator centerbore **11**. The silver casting **20** is positioned above and around the center electrode head **16**.

The invention will now be described in detail in terms of a method for silver casting a spark plug center electrode. As shown in FIGURE 2, the spark plug center electrode **14** is inserted in the insulator centerbore **11** so

that the center electrode head **16** is positioned on the insulator ledge **18**. A dispenser **22** is inserted in the insulator centerbore **11** so that the dispenser side **26** is supported on the insulator ledge **28**. A dispenser made of alumina is preferred although any material melting above 1900° F. may be used. A silver slug **30** is inserted in the dispenser centerbore **32** and is supported by the lower portion **34** of the dispenser **22**. The dispenser centerbore **32** has a uniform diameter from the top edge **36** until it reaches the sloped centerbore sides **38** which taper into the opening **40**. The opening **40** should be at a distance from the center electrode head **16** which is at least as great as the height above the center electrode head **16** which will be occupied by the solid silver mass in the insulator centerbore after the center electrode head has been silver cast. The diameter of the dispenser centerbore **32** has a direct relationship with the size of the opening **40** at the bottom of the dispenser **22**. For example, the wider the dispenser diameter, the larger the opening **40**, since the downward pressure exerted by a given silver slug will be less when the diameter of the centerbore **32** is wider. The sloping sides **38** of the dispenser centerbore **32** form an angle of 45° with a line drawn perpendicular to the longitudinal axis of the dispenser in the preferred embodiment. This angle is not critical although it has been found that this angle facilitates the flow of molten silver through the slot opening **40**. The opening **40**, as shown in FIGURE 3, is in the form of a slot. The shape of the opening **40** is not critical and may take the form of a round hole, or a square or a rectangular opening. The dimensions of the opening are governed by the retaining surface tension force of the molten silver and the downward force exerted by the molten silver. The downward force depends on the weight of the silver, the diameter of the dispenser centerbore; and the speed of the centrifuge. The opening must facilitate the flow of molten silver at a rate which is fast enough to accomplish the silver casting in a reasonable time and yet at the same time do it at a slow enough rate to permit the first droplets to harden sufficiently at the base electrode head to retain the molten silver as will be hereinafter described. In the preferred embodiment, the opening **40** is in the form of a rectangular slot having a width of 0.020 inch. The width of the slot may vary from 0.015 to 0.025 inch. When the opening **40** is in the form of a rectangular slot, the width of the slot is the critical dimension when considering the retaining force of the surface tension of silver. In other words, when silver is used in a dispenser having a rectangular slot, the length of the slot is not critical. It has been observed that a width of 0.020 inch has worked satisfactorily for silver slugs varying in weight from 0.013 to 0.040 ounce when the diameter of the dispenser center bore was 0.120 inch. The diameter of the dispenser centerbore may vary from 0.100 to 0.140 inch. A silver slug weighing 0.030 ounce is preferred.

The assembly just described is then placed in a tray which is loaded into an oven (not shown) heated to a temperature of approximately 1800° F. The assembly is held at this temperature until the silver **30** has melted and has completely filled the lower portion of the dispenser centerbore **32** as shown in FIGURE 4. The tray is then removed from the oven and placed immediately into a centrifuge (not shown). The centrifuge is then turned on for 2 minutes including acceleration time up to a maximum speed of 880 r.p.m. during which time the centrifugal force causes the molten silver **30** shown in FIGURE 5 to flow out of the dispenser opening **40** dropwise. The first molten silver mass that surrounds the center electrode head **16** solidifies to form a seal thereby enabling the remaining silver molten mass to fill up the insulator centerbore portion **42** as desired and as shown in FIGURE 1.

There are several reasons why the silver casting



method described in this invention is superior to the prior art methods. The primary reason is that this method does not yield a silver leaker. The first molten silver mass which hits the base of the center electrode head **16** partially solidifies. This partially solidified silver mass forms a barrier or seal around the lower portion of the center electrode head **16** preventing the flow of molten silver between the insulator centerbore and the center electrode **14**. There is sufficient heat transfer away from the center electrode head **16** during the centrifuging step as a result of the normal cooling of the lower end of the center electrode **14** and from the lower portion of the insulator **12** to cause the first silver mass which hits the center electrode head **16** to solidify because the mass of the first silver mass is small in comparison with the total silver mass. The heat transfer lowers the temperature of the first silver mass below the solidification temperature or melting point of silver thereby causing this silver mass to solidify, especially on the outer surface thereof. The subsequent molten silver mass which covers the solidified mass would have a tendency to transfer heat to the solidified silver mass. However, the quantity of heat transferred to the solidified mass which is not transferred away by center electrode **14** is not sufficient to remelt the solidified mass. In contrast, the former method had a large mass of molten silver in contact with the center electrode head. The heat transfer away from the molten silver mass during the centrifuging step by means of the center electrode and the lower portion of the insulator **12** was not sufficient to cool the entire molten mass sufficiently to cause the molten silver around the lower portion of the center electrode head to solidify and thereby prevent passage of the molten silver through the insulator centerbore surrounding the center electrode **14**. The mass of the silver in the prior art method would transfer heat to that portion of the silver mass in contact with the center electrode head as fast as the center electrode head would transfer the heat away. This heat transfer relationship prevented the required amount of solidification of the silver in the prior art method during the centrifuging step necessary to prevent silver leakers.

Another reason why the improved method described in this invention is superior to the prior art methods is that there are no air bubbles entrapped by the silver since the air has an opportunity to flow upward as the molten silver is being deposited progressively on the center electrode head. In contrast, in the prior art methods during the centrifuging step the entire molten silver mass moved when filling the space above the center electrode head. This molten silver mass trapped air which had previously filled the space around the bottom of the center electrode head now occupied by the silver. Some of the air that was trapped bubbled up all the way through the molten silver mass whereas the remainder of the air was trapped as air bubbles within the molten silver mass. The entrapped air bubbles of the prior art methods causes an inferior seal whereas the method described in this invention provides a air bubble-free silver casting superior to that obtained by the prior art methods.

While the invention has been described in terms of a preferred embodiment, it is to be understood that the scope of the invention is not limited thereby except as defined in the following claims.

What is claimed is:

**1.** In the manufacture of a spark plug having a silver mass which surrounds the head of the center electrode and completely fills that portion of the insulator centerbore surrounding said head, the method of forming said silver mass comprising the steps of melting a solid mass of silver in a dispenser which is in communication with said insulator centerbore and positioned at a distance away from said head which is at least as great as the height above said head in said insulator centerbore which will be occupied by said mass, and subjecting the spark plug

to centrifugal force whereby said molten silver is dispensed through the opening at the bottom of the dispenser onto and about the head of the center electrode to progressively fill the insulator centerbore portion so that said molten silver which first touches and surrounds said head solidifies sufficiently to act as a seal.

2. A method as defined in claim 1 wherein the weight of the solid mass of silver ranges from 0.013 to 0.040 ounce.

3. A method as defined in claim 1 wherein the opening at the bottom of the dispenser is in the form of a rectangular slot.



4. A method as described in claim 3 wherein the rectangular slot has a width of 0.015 to 0.025 inch.

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