

June 24, 1941.

J. E. D. McCARTY ET AL

2,246,948

SPARK PLUG AND METHOD OF MAKING SAME

Filed Dec. 12, 1939

Fig.-1

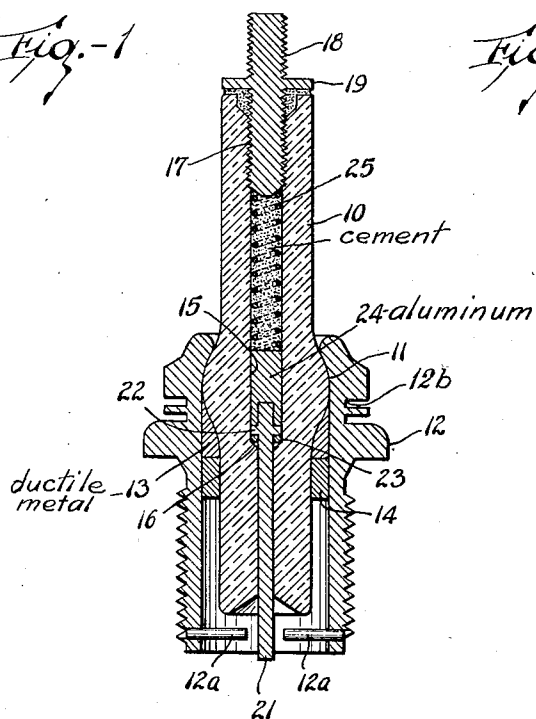


Fig.-2

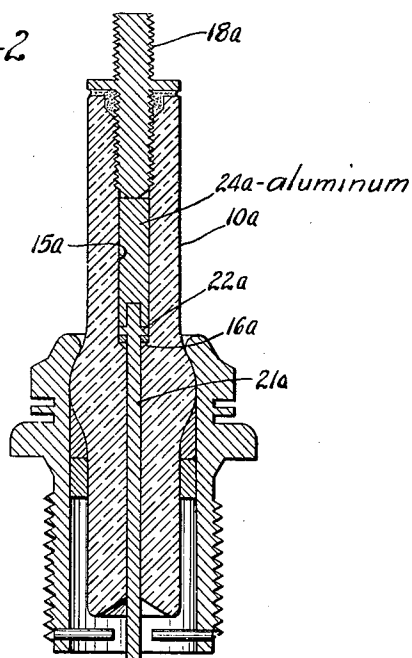
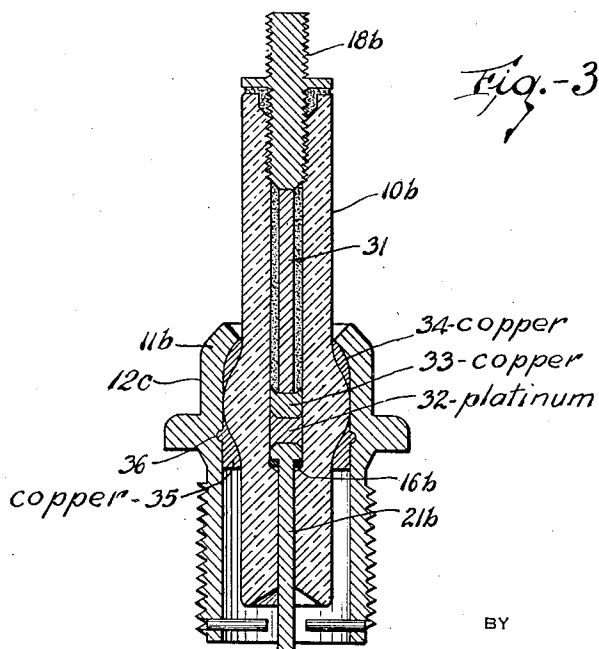


Fig.-3



INVENTORS
JOHN ELLSWORTH D. McCARTY
MELVILLE F. PETERS

BY

William Jones

ATTORNEYS

UNITED STATES PATENT OFFICE

2,246,948

SPARK PLUG AND METHOD OF MAKING
SAMEJohn Ellsworth D. McCarty, Akron, Ohio, and
Melville F. Peters, Beltsville, Md.

Application December 12, 1939, Serial No. 308,882

15 Claims. (Cl. 123—169)

This invention relates generally to spark plugs, more especially spark plugs subjected to severe temperature changes and high temperatures in operation.

The invention described herein, if patented, may be manufactured and used by and for the Government for governmental purposes without payment to the owner of the patent of any royalty whatsoever.

In manufacturing spark plugs, it is very difficult to secure permanent seals between the outer metal shell and the porcelain insulator, also between the center electrode and the porcelain insulator. In certain instances this problem is aggravated as it is desirable to permit longitudinal movement of the center electrode in the porcelain with temperature changes and the usual sealing methods prevent such movement. It also is important to prevent overheating the upper portion of the electrode to prevent burning the insulation from the high tension wire secured to the electrode terminal of the spark plug. Most of the spark plugs manufactured today do not solve, satisfactorily, one or more of the foregoing points, or else they are objectionable for other reasons. These factors are especially important in spark plugs for use in airplane motors as these motors usually operate at high temperatures for long periods. In fact, airplane spark plugs are ordinarily made by use of mica insulation rather than ordinary porcelain insulation due to the difficult insulating problem presented in that type spark plug. Mica is comparatively expensive while also being difficult to fabricate, so that there is usually quite a high percentage of rejects in mica insulated spark plugs.

The general object of this invention is to overcome the foregoing and other objections to and problems involved in construction of known types of spark plugs and to provide satisfactory, relatively low cost airplane spark plugs using porcelain insulators. Specific objects of the invention are to provide a better seal for the center electrode of a spark plug; to provide a spark plug seal that may become more effective with increases in temperature; to prevent excessive flow of heat from the center electrode to the electrode terminal; and to prevent overheating the firing portion of the center electrode. These and other objects will be manifest from the following specification.

The invention will be described with particular reference to the accompanying drawing in which:

Figure 1 is a vertical sectional elevation of an

assembled spark plug embodying the invention; and

Figures 2 and 3 are vertical sections of modifications of the invention.

Referring specifically to the drawing, a hollow porcelain, or insulator, 10 having an annular boss or flange 11 around it at its mid section is shown received in a metal shell 12 of any suitable design that has ground electrodes 12a carried thereon. The porcelain 10 is retained in the metal shell 12 preferably by means of a ductile metal sleeve 13 which is pressed into engagement between the flange 11 and the bore of the shell 12 and a metal sleeve 14 that is forced against the bottom of the first sleeve. The upper edge of the metal shell 12 is bent inwardly to form a seat for the upper portion of the flange 11, which is snugly received in the bore of the spark plug and which conforms to the contour of the upper end of the shell. This forms a backing for the pressure exerted on the porcelain 10 by the metal sleeve 13. Grooves 12b may be formed in the upper portion of the sleeve 12 to facilitate crimping the upper part of the sleeve inwardly to form a seat for the porcelain 10, if desired, although a standard, preformed shell may be used in most instances.

The porcelain has a bore 15 which has an annular shoulder 16 in it adjacent its lower end at which point the diameter of the lower portion of the bore 15 is reduced. The upper end of the bore 15 is threaded at 17 and engages with an electrode terminal or cap 18 having a flange 19 which bears against the upper end of the porcelain 10 when the terminal is engaged with the threads 17. A center electrode 21 is received snugly in the lower portion of the bore 15 and it has a flange 22 formed on it adjacent its upper end. This flange 22 bears upon a soft metal washer or gasket 23 which in turn engages with the shoulder 16. Then the center electrode is held in position by means of metallic packing 24 that is pressed downwardly over the upper end of the center electrode to force the flange 22 against the gasket and the gasket against the shoulder whereby the electrode is firmly held in place. The metallic packing 24 may be made from any suitable electroconductive material but the use of thin aluminum or other metallic sheet or foil has been found particularly desirable. The metal foil is placed in the bore 15 in the form of a small roll and it then is tamped, hammered, or otherwise forced down around the top of the electrode to form a gas-tight seal for the bore of the porcelain. Sometimes, metal powder may be used with, or in place of, the foil to form the seal.

While any metal foil or powder may be used, a metal or alloy having substantially the same coefficient of expansion as the insulating material is desirable. This aids in maintaining a tight seal around the center electrode regardless of the temperature variation of the spark plug.

It will be observed that the center electrode 21 is secured in the porcelain 10 only adjacent the upper end of the electrode. When the temperature of the spark plug rises with use, the electrode is free for downward longitudinal expansion since it is only secured to the porcelain at its upper end and thus does not strain the porcelain by such movement. Another feature of the construction is that the intimate bond between the metal packing 24 and the center electrode aids in withdrawing heat from the electrode and prevents excessive heating of the ignition portion of the center electrode. The metal packing is in good contact with the porcelain and dissipates heat therethrough to the shell 12. This reduces losses due to pre-ignition which occur when the electrode becomes overheated.

In order to form a current conducting path between the metal packing 24 and the electrode cap 18 without permitting ready conduction of heat therebetween, a light metal spring 25 is positioned and compressed between the lower end of the electrode cap and the upper surface of the metal packing. This spring can be made from any desired electroconductive material and preferably forms a good electrical connection with the surfaces contacted. The small cross-sectional area of the spring 25 prevents excessive flow of heat from the metal packing 24 to the cap. This, of course, prevents the cap from being overheated and in turn prevents any overheating of the high tension wire connected to the electrode cap. Such action is desirable since it prevents the insulation on the high tension wire connecting to the electrode cap from burning due to elevated temperatures of the electrode cap.

It usually is desirable to fill, substantially, the upper part of the bore 15 with a suitable cement, such as a water glass cement, before screwing the terminal 18 into position. This cement fills the space around the spring 25 while also acting, when solidified, to seal the spring and terminal in position. If a film of the cement forms between the ends of the spring and the terminal or packing, it may temporarily act as slight insulation therebetween, but it will be carbonized rapidly by current flow through the spark plug.

A primary feature of the invention is that practice thereof results in securing a positive and uniform gas-tight seal between the center electrode and the porcelain. This is produced by the light weight metal packing which is pressed into position to hold the electrode in engagement with the porcelain and seal it in place. As the temperature of the spark plug changes, the metallic packing tends to expand and produce a still tighter seal, or if the metal has the same expansion as the insulator, the seal retains its initial tightness throughout the entire operating temperature range. Another feature of the construction is that the withdrawal of heat from the center electrode by the metal packing tends to reduce corrosion and wear on the center electrode and increases its life. Thus it should be evident that a novel type of spark plug is provided by the invention

and that the objects of the invention have been achieved.

In the modification of the invention shown in Figure 2, the spring 25 is eliminated. A shoulder 16a is formed in the upper portion of the bore 15a of the porcelain 10a. Metallic packing 24a is pressed against the upper surface of a flange 22a of an electrode 21a received in the bore of the porcelain. Then the lower end of a terminal 18a bears against the upper surface of the packing to form a connection for current flow through the spark plug. A larger volume of metallic packing is used in the spark plug of Figure 2 in comparison with that used in the spark plug of Figure 1 and this aids in removing heat from the center electrode. It may be desirable to place the shoulder 16a at the same relative position as the shoulder 16 to aid in dissipating heat to the metal sleeve.

A further modification of the invention is shown in Figure 3. Here the spring 25 is also eliminated, but in this case an electrical conductor 31 of any suitable composition is substituted therefor. The conductor 31 is welded or otherwise secured to the electrode cap 18b before the cap is inserted into the porcelain 10b. In this form of the invention, the electrode 21b has a flat head against which is pressed metallic packing 32. This packing 32 preferably is formed as a thin foil and tamped into place to hold the electrode against the shoulder 16b formed in the porcelain. Preferably the metal packing 32 is made from a high melting metal having a low coefficient of expansion and platinum has been found to be one metal suitable for this purpose, although other low expansion non-corrosive metals would be suitable. After the electrode is sealed in place by the packing 32, further high melting, conductive, metallic packing 33, such as copper, is pressed against the upper surface thereof to aid in drawing heat from the electrode.

In this construction, the porcelain is secured in the metal shell in a different manner. Thus copper gaskets or sealing rings 34 and 35 are placed around the upper and lower portions of the boss 11b on the porcelain, with the gasket 35 being pressed into place to position the porcelain. Note that a groove or recess 36 is formed on the inner surface of the metal shell 12c. The lower copper gasket 35 is pressed into this groove 36 in order to lock the gasket against downward movement. This eliminates the use of additional sealing gaskets on the under portion of the plug. The remaining portions and construction of the spark plug shown in Figure 3 are similar to those forming the spark plug shown in Figure 1.

According to the invention, the upper end of the metal shell is heavier than in ordinary metal spark plug shells and it is preformed to engage with the boss on the porcelain, which is inserted through the lower end of the metal sleeve. This is desirable, since the high pressures in the cylinders tend to blow the porcelain out of the metal shell. The pressure exerted on the sleeves 13, 14 or 35 forces the porcelain to seat in the shell before distorting the sleeves to seal the porcelain in the metal shell. Obviously the spark plug of the invention could be made by using a standard metal shell which has a shoulder formed in its lower portion to seat the porcelain and which has its upper edge crimped down around the porcelain to retain it in the shell. This construction, however, does not form quite as good an upper seat for the porcelain as does practice of

the preferred method of inserting the porcelains into a preformed upper seat in the metal shell.

While a written description and illustration of several embodiments of the invention are disclosed herein, it will be understood that various other modifications can be made without departing from the scope of the invention as defined in the appended claims.

What is claimed is:

1. In a spark plug, a hollow porcelain, a center electrode received in and extending only partially through the bore of said porcelain, means at the top of said electrode securing same in said porcelain whereby downward expansion of said electrode relative to said porcelain is permitted on increase in temperature.

2. In a spark plug, a hollow porcelain, a center electrode received in said porcelain, and metal packing pressed downwardly against said electrode to retain it in place and seal said electrode in said porcelain, said seal becoming tighter with increase in temperature.

3. A spark plug comprising an insulator, an electrode terminal secured in the top of said insulator, an electrode received in the base of said insulator, metallic packing of an electroconductive material pressed around said electrode at its upper end to seal same in said insulator, and a spring compressed between adjacent surfaces of said electrode terminal and said metallic packing to form a current conductor therebetween whereby conduction of heat from said electrode to said electrode terminal is prevented.

4. That method of sealing a center electrode of a spark plug in the bore of a porcelain which comprises the steps of inserting an electrode into the bore, placing metal foil adjacent the top of the electrode, holding the electrode against downward movement, and pressing the metal foil tightly around the entire upper end of the electrode to seal same in the porcelain.

5. In a spark plug, a hollow porcelain, a center electrode received in only the lower portion of said porcelain, and metal packing pressed downwardly against said electrode to retain it in place and seal said electrode in said porcelain, said metal packing having substantially the same coefficient of expansion as the insulator so that said seal remains of substantially the same tightness throughout the temperature range at which the spark plug operates.

6. In a spark plug, a hollow insulator having a bore of reduced diameter at the lower end thereof and a shoulder formed therein at the point of reduction of diameter thereof, an electrode having a flange thereon received in said bore, said flange engaging with said shoulder, metallic packing sealing said flange against said shoulder, a terminal at the upper end of said porcelain, a conductor extending between said metallic packing and said terminal, and sealing means securing said conductor and said terminal in position.

7. In a spark plug, a hollow insulator having a bore of reduced diameter at the lower end thereof and a shoulder formed therein at the point of reduction of diameter thereof, an electrode having a flange thereon received in said bore, said flange engaging with said shoulder, metallic packing sealing said flange against said shoulder, a terminal at the upper end of said porcelain, and a spring compressed between said metallic packing and said terminal.

8. In a spark plug, a hollow insulator, an electrode received in the lower portion of said insulator, the bore of said insulator being of reduced

diameter at the lower portion thereof and having a shoulder formed therein at the upper extremity of its reduced diameter portion, said electrode having a flange thereon bearing against said shoulder, conductive means sealing said electrode in said bore, and a terminal received in the upper end of said porcelain and bearing upon said conductive means.

9. In a spark plug, a hollow insulator, a center electrode positioned in the lower portion of said insulator, a terminal cap carried by the upper portion of said insulator and spaced from said center electrode, conductive means extending between said terminal cap and center electrode, and means filling the remaining space between said terminal cap and center electrode and sealing said terminal cap, center electrode, and conductive means in position.

10. In a spark plug, a metal shell having an annular groove formed in its inner surface adjacent the upper end thereof, a porcelain having an annular boss formed thereon snugly received in the bore of said metal shell, said boss being adjacent said groove, and a metal sealing ring between said porcelain and said metal sleeve and engaging with the lower portion of said boss, said sealing ring extending into said groove to be held against downward movement thereby.

11. In a spark plug, a hollow insulator, a center electrode positioned in the lower portion of said insulator, a terminal cap carried by the upper portion of said insulator and spaced from said center electrode, metallic packing forced around the top of said center electrode to seal same in said insulator, further metallic packing forced into said insulator to aid in removing heat from said center electrode, and conducting means secured to said terminal cap and extending to said metallic packing.

12. That method of making a spark plug from a hollow metal shell and a porcelain insert having a flange therearound comprising the steps of forming the hollow metal shell with a bore which terminates in an upper portion that is adapted to engage with the flange on the porcelain, inserting the porcelain from the bottom of the metal shell, placing a metal sleeve against the lower portion of the flange, and forcing the metal sleeve against the porcelain to seat it in the upper portion of the metal shell and to seal the porcelain in the metal shell.

13. In a spark plug, a hollow metal shell, a porcelain having an integral rounded boss formed thereon positioned in said metal shell, a ductile metal sleeve wedged between said metal shell and said porcelain and bearing against the lower portion of said boss to aid in positioning said porcelain, and a second metal sleeve bearing on the lower edge of said first sleeve and being wedged between said porcelain and said shell to reinforce said first sleeve.

14. In a spark plug, a hollow insulator, an electrode received in the lower portion of said insulator, the bore of said insulator being of reduced diameter at the lower portion thereof and having a shoulder formed therein at the upper extremity of its reduced diameter portion, said electrode having a flange at its upper end seated on said shoulder, conductive means sealing said electrode in said bore, and a terminal received in the upper end of said porcelain and electrically connected to said conductive means.

15. That method of making a spark plug comprising the steps of forming a metal shell adapted to have a porcelain having a boss thereon in-

served from the bottom of the metal shell and having an annular groove formed in its inner periphery, inserting a porcelain having a boss thereon into the metal sleeve from the lower end thereof, and pressing a ductile metal sleeve against the lower portion of the boss on the porcelain to wedge the metal sleeve between the

5 porcelain and metal shell to seat the porcelain in the metal shell, the metal sleeve being forced into the annular recess by the pressure applied thereto to retain it against downward movement in the metal shell.

JOHN ELLSWORTH D. McCARTY.
MELVILLE F. PETERS.