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2,296,033

SPARK PLUG

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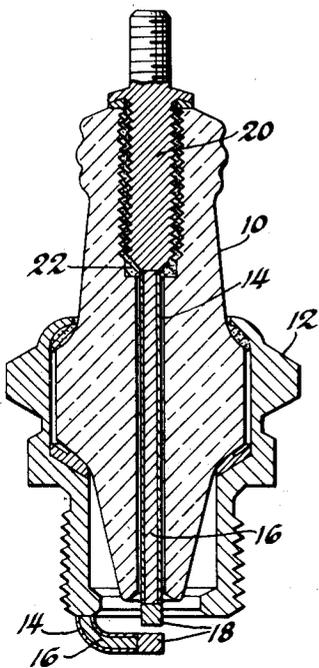


Fig. 1

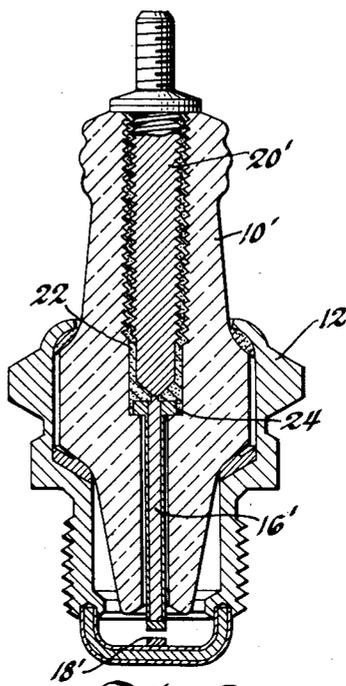


Fig. 2

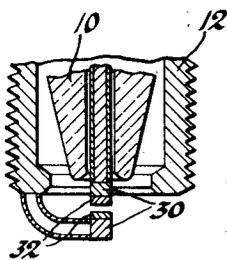


Fig. 3

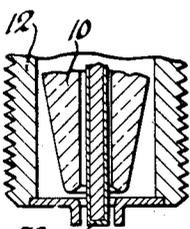


Fig. 5

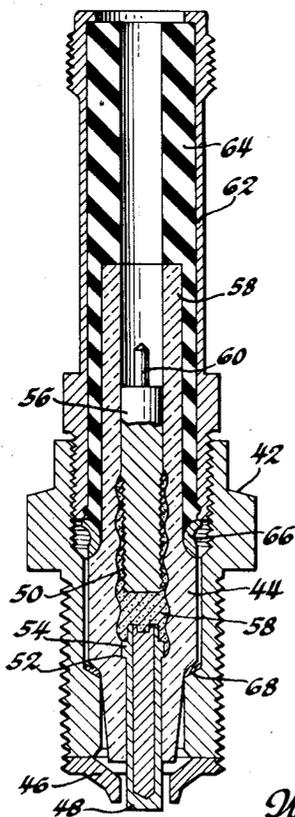


Fig. 7

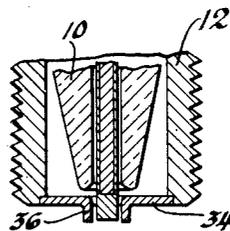


Fig. 4

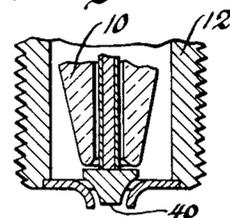


Fig. 6

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SPARK PLUG

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9 Claims. (Cl. 123—169)

This invention has to do with improvements in spark plugs having as their object lengthening of the life of the electrodes and consequently the useful life of the plug.

Spark plug electrodes are subject to wear and deterioration due to erosion and corrosion. Erosion is produced by the action of the spark in mechanically wearing away the metal of the electrode as well as burning the electrode metal and sputtering it as the result of high potential and heat differential. It has been found that the rate of erosion increases with the temperature.

Corrosion of the electrodes is produced by the combustion gases H_2 and carbon monoxide and the oxidizing gases, oxygen, steam and carbon dioxide. The principal corrosive acids present in the combustion chamber are sulphur compounds and lead compounds. As in the case of erosion, corrosion increases directly as the temperature. It is the object of the present invention to provide a spark plug electrode construction by which the electrode will be maintained at lower temperature and hence corrosion and erosion will be reduced and the life of the plug will be lengthened.

In the drawing:

Figure 1 is a vertical section through a spark plug embodying my invention.

Figure 2 is a similar view showing a modified form of the invention.

Figure 3 is a fragmentary view showing a slight modification of the invention shown in Figure 1.

Figures 4, 5 and 6 are similar views showing modifications.

Figure 7 is the vertical section through another form of my invention, the spark plug being illustrated as provided with a radio shield.

In all of the forms of the invention illustrated the center electrodes and, if desired, the side electrodes as well, are in the form of hollow tubes of material resistant to heat and corrosion filled with material of very good heat conductivity. The tubular electrodes are preferably closed at the sparking ends by tips made of material resistant to erosion caused by sparking as well as to corrosion.

I have found that the tubular electrode as well as the tip may be made of nickel, nickel alloys, tungsten, stainless steels or similar materials. An especially desirable alloy is one consisting of approximately 2% manganese, $3\frac{1}{2}\%$ chromium, .02% barium and the balance nickel; this alloy being described and claimed in Randolph Patent No. 1,976,295, issued October 9, 1934.

The most desirable material for the good heat conducting filler is copper although other materials having good heat conductivity, such as silver, may be used.

In case of most severe service it may be desirable to employ tips of material more resistant to corrosion than the material used for the tubular electrode, such as platinum or platinum alloys including platinum-rhodium, platinum-iridium, and platinum-rubidium alloys.

Referring now to the form shown in Figure 1, 10 indicates the insulator which may be either of the sintered oxide or porcelain type. The insulator is mounted in the usual shell indicated at 12. Both the center and side electrodes comprise a tubular shell 14 made of the described heat and corrosion resistant materials filled with good heat conducting material indicated at 16, preferably copper. To the ends of the electrodes are secured tips 18 of material resistant to spark erosion as well as corrosion. This latter material may be the same as the material of the tubular portion or may consist of platinum or platinum alloys as previously mentioned.

The upper end of the central electrode is indicated as in contact with the enlarged upper portion 20 having a projecting terminal for engagement with the spark plug lead. The portion 20 may be welded or otherwise secured to the lower portion of the electrode but is preferably simply in contact with it.

The electrode assembly is secured in the insulator 10 preferably by means of a conducting seal 22 of the type described and claimed in Schwartzwalder and Kirk Patent 2,106,578, granted January 25, 1938, as improved in accordance with the invention described and claimed in Schwartzwalder and Rulka application Serial No. 343,808, filed July 3, 1940. The seal 22 consists essentially of a mixture of glass and powdered metal, for example, copper, iron, cobalt, nickel, tungsten or molybdenum. Of these copper is to be preferred. As described in said applications the parts are assembled with the sealing material in place. In the form illustrated in Figure 1 the sealing material is introduced in the form of an annular pellet. Thereafter the assembly is heated to fuse the glass and while the glass is still soft the electrode is advanced to the position shown in Figure 1. The sealing material on cooling forms an excellent gas-tight bond between the electrode and the insulator. The metal included in the sealing material assists in

conducting the heat away from the center electrode.

The tubular electrode as shown in Figure 1 may be made in various ways. Thus a copper filled rod or bar may be swaged or rolled down to the desired diameter and cut to length and the tip may then be welded to one end. I have found it particularly advantageous when welding the tip to the tubular electrode to use the so-called percussion method of welding which consists essentially in employing a welding circuit including a condenser which is arranged to discharge while the tip and the head of the electrode are close together and after the discharge the parts are engaged thereby forming a good weld without the application of sufficient heat to cause the copper filling to flash through the joint thereby exposing it to corrosion.

In the modification shown in Figure 2 the side electrode is of U-shape and is provided with a tip 13' welded to the side thereof. The upper end of the lower part of the central electrode is provided with a flange 24 resting on a shoulder provided in the bore of the insulator 10'. The lower end of the upper part 20' of the center electrode is in contact with the good heat conducting filler 16' of the lower part of the center electrode. The electrode assembly is secured in place by means of the heat conducting seal 22 as previously described.

The modification shown in Figure 3 is the same as that shown in Figure 1 except that the ends of the tubular electrode sections are closed by means of tips 30 of the same material as the tubular portions of the electrodes, and these tips are in turn provided with tips 32 of the more resistant material such as platinum or platinum alloys.

The modification shown in Figure 4 is the same as that described in Figure 1 except that the side electrode takes the form of a disc 34 suitably secured in the bottom of the shell and having down-turned portions 36 which cooperate with the center electrode. Similar side electrodes are shown in Figures 5 and 6. In all these forms of the invention the filling of good heat conducting material is omitted from the side electrodes. This is permissible in some instances because since the side electrode is provided with a good heat conducting path through the spark plug shell there is less need for cooling.

In the modification shown in Figure 5 the center electrode 38 is provided with an integral sheath of material resistant to erosion and corrosion. Such center electrodes may be manufactured by drilling a central passage in the electrode and filling it with good heat conducting metal.

In the modification shown in Figure 6 the lower end of the central electrode is provided with an enlarged tip 40 welded to the copper filled tubular shank as described in connection with Figure 1.

There is illustrated in Figure 7 a further modification which has proven to be especially good after extensive tests in airplane engines. Here 42 indicates the shell in which is secured insulator 44 preferably composed chiefly of sintered oxides such as aluminum oxide. To the lower end of the shell is welded the electrode 46 which may be made of stainless steel, nickel or nickel alloys. The center electrode comprises a lower portion 48 made of erosion and corrosion-resistant material, preferably the nickel-manganese-barium-chromium alloy disclosed in the said

Randolph patent. This electrode section is drilled out and filled with copper or other good heat conducting material. The copper may be cast in or fused in place or, if desired, the copper insert in the form of a wire may be secured in place by silver solder using any suitable flux in the customary manner. It will be noted that the interior of the bore 50 of the insulator is provided with a wavy thread as shown or other irregular contour and with a shoulder 52 on which seats flange 54 formed at the upper end of electrode section 48. 56 indicates the upper electrode section and 58 the conducting glass seal. The parts are assembled in the manner previously described; that is the conducting glass seal preferably consisting of a mixture of copper and Pyrex glass as described in the said Schwartzwalder and Rulka application is made in the form of pellets and placed in the bore after the lower electrode section has been positioned as shown. Thereafter the insulator is heated to melt the glass and the upper electrode section 56 is then forced into the desired position causing the molten sealing material to surround and grip the threads on the upper electrode section and at the same time engage the threads provided in the bore in the insulator, thus locking the electrode assembly against displacement.

Insulator 44 is provided with an extension 53 of considerable length protruding beyond the upper electrode section 56. The upper electrode section 56 is provided with an extension 60 adapted to be connected in any suitable manner with the spark plug lead.

In this view the plug is illustrated as provided with radio shielding consisting of metal sleeve 62 having threaded engagement with shell 42 and lined with insulating material 64. A C-shaped insulator 66 is engaged between the bottom of shield 62 and the top of the shoulder on the insulator to hold it in position in the shell. The usual copper gasket is provided at 68 to receive the lower part of the shoulder of the insulator.

Spark plugs of the construction shown in Figure 7 have been successfully tested in modern high speed aircraft engines and have performed exceptionally well. The electrodes have had unusually long life and this improvement is to be attributed largely to the good conducting path for dissipation of heat provided by the copper-filled center electrode and the conducting glass seal. It will be understood that the insulator employed in the construction shown in Figure 7 and consisting largely of aluminum oxide contributes substantially to the dissipation of heat since it possesses high heat conductivity.

I claim:

1. A spark plug comprising an insulator having a passage therein, an electrode in said passage comprising a tubular sheath having its exposed end closed, said sheath being made of corrosion-resistant metal and filled with metal of high heat conductivity, and means for securing and sealing the electrode in the insulator, said sealing means enveloping the open end of the sheath and the exposed portion of the metal of high heat conductivity so as to protect it from contact with corrosive gases and conduct heat away from the electrode.

2. A spark plug comprising an insulator having a passage therein, an electrode in said passage comprising a tubular sheath having its exposed end closed, said sheath being made of corrosion-resistant metal and filled with metal of high heat conductivity, a conducting seal comprising ce-

ramic material bonded to the interior of the passage and securing the electrode therein, said seal enveloping the open end of the sheath and the exposed portion of the metal of high conductivity so as to protect the latter from contact with corrosive gases, and conduct heat away from the electrode.

3. A spark plug comprising an insulator having a passage therein, an electrode in said passage comprising a tubular sheath having its exposed end closed, said sheath being made of corrosion-resistant metal and filled with metal of high heat conductivity, and a conducting seal comprising a mixture of ceramic material and good heat conducting material, the ceramic material being bonded to the interior of the passage and securing the electrode therein, said seal enveloping the open end of the sheath and the exposed portion of the metal of high conductivity so as to protect the latter from contact with corrosive gases and conduct heat away from the electrode.

4. A spark plug comprising an insulator and an electrode in the insulator comprising a sheath of corrosion-resistant metal filled with metal of high heat conductivity secured and sealed in the passage by sealing material of high heat conductivity, said sheath having its exposed electrode end closed to prevent the corrosive combustion gases from attacking the metal of high heat conductivity.

5. A spark plug comprising an insulator having a passage therethrough and an electrode mounted in the passage comprising an upper section and a lower section, the latter comprising a tubular sheath having its exposed end closed, said sheath being made of corrosion-resistant metal and filled with metal of high heat conductivity, and a seal having good heat conductivity fused therein connecting said sections and securing them in place.

6. A spark plug comprising an insulator having a passage therethrough and an electrode mounted in the passage comprising an upper section and a lower section, the latter comprising a tubular sheath having its exposed end closed, said

sheath being made of corrosion-resistant metal and filled with metal of high heat conductivity, a seal having good heat conductivity fused therein connecting said sections and securing them in place and said seal comprising a mixture of glass and metal.

7. A spark plug comprising an insulator having a passage therein, an electrode in said passage comprising a tubular sheath having its exposed end closed, said sheath being made of corrosion-resistant metal and filled with metal of high heat conductivity, and means for securing and sealing the electrode in the insulator, said sealing means being in good thermal contact with the open end of the sheath and the exposed portion of the metal of high heat conductivity so as to protect it from contact with corrosive gases and conduct heat away from the electrode.

8. A spark plug comprising an insulator having a bore therethrough, an electrode in said bore comprising a tubular sheath having its exposed electrode end closed, said sheath being made of corrosion-resistant metal and filled with material of high heat conductivity, and means for securing and sealing the electrode in the insular bore, said sealing means surrounding the said sheath and being in intimate contact therewith and with the wall of the bore so as to prevent passage of corrosive gases therethrough.

9. A spark plug comprising an insulator having a bore therethrough, an electrode in said bore comprising a tubular sheath having its exposed electrode end closed, said sheath being made of corrosion-resistant metal and filled with material of high heat conductivity, and means for securing and sealing the electrode in the insulator bore, said sealing means surrounding the said sheath and being in intimate contact therewith and with the wall of the bore so as to prevent passage of corrosive gases therethrough, said sealing means possessing relatively high heat conductivity so as to assist in conducting heat away from the electrode.

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