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SPARK PLUG

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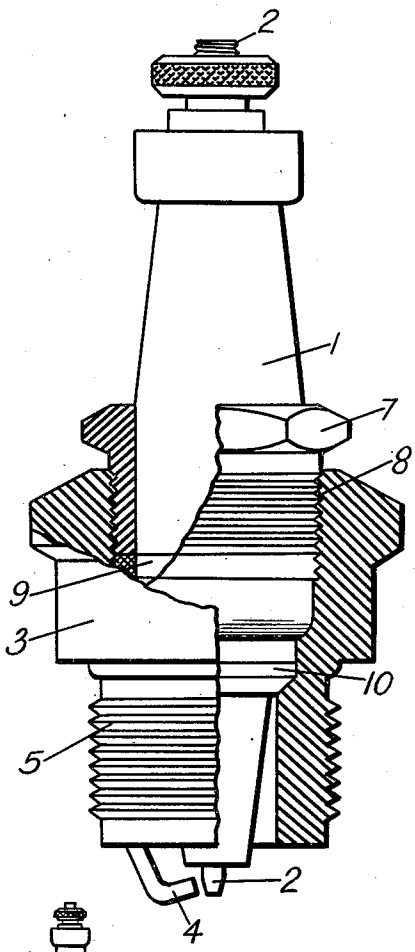


Fig. 1

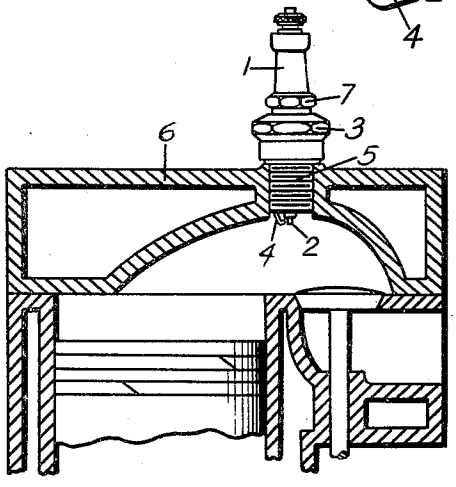


Fig. 2

INVENTOR.
Ernest R. Darby.
BY Corbett & Mahoney
ATTORNEYS.

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SPARK PLUG

Ernest R. Darby, Detroit, Mich., assignor to Federal-Mogul Corporation, Detroit, Mich., a corporation of Michigan

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7 Claims. (Cl. 123—169)

My invention relates to spark plugs. It has to do, more particularly, with a spark plug for internal combustion engines which is of novel construction and through the use of which improved engine performance is acquired.

In internal combustion engines, the spark plug is the part which provides for the ignition of the explosive charge which has been drawn into the cylinder. The plug is located, in most instances, in the cylinder head in such a manner that a portion of it is exposed in a suitable position to the combustion chamber. At a proper time with respect to the cycle of the engine, a high voltage electric current passes through the plug, producing a spark at the exposed end whereby the explosive charge is ignited.

The ordinary spark plug embodies a central member made of porcelain, mica, or other material of a highly insulating nature through which an electrode extends for the purpose of conducting the high voltage electric current. A body member enclosing this insulator is provided with an electrode which is positioned to give a definite space or gap between it and the electrode carried by the central insulating member. The end of the body member is threaded so that the plug may be screwed into the cylinder head exposing the two spaced electrodes to the explosive gases of the cylinder. The insulator and the electrode carried thereby are held tightly together by a gland nut which is threaded into the upper end of the body member. In the conventional spark plug, the body member and the gland nut are made of steel or other similar ferrous material.

It has been found that a spark plug having the body portion thereof and the gland nut made of ferrous material has certain disadvantages. In engine operation the portions of the conventional type of spark plug which are exposed to the combustion chamber get very hot and the body of the plug, being made of a ferrous material with relatively low thermal conductivity, obstructs the flow of heat from these exposed parts into the cylinder head and atmosphere. This creates a hot spot in the combustion chamber which causes detonation or pinging. Furthermore, because of the fact that the body member of the plug is made of low conductivity material, this permits the building up of extreme temperatures in the spaced electrodes and the adjacent portions of the insulator, shortening their life and detracting from their performance. Also, the extreme temperature gradient between the portions of the body member of the plug exposed to combustion gases and that portion exposed to the air, which may be as much as 1200° F., affects the life of the insulator with respect to cracking and leakage. This extreme temperature gradient is due to the fact that the body member is made of material having a low thermal conductivity.

It has been found also that reduction of body area exposed to combustion flame through the reduction of the diameter thereof to thereby establish a more desirable ratio of such area to the entire body mass as a means of relieving detonation and pre-ignition through more favorable body temperatures is not generally satisfactory. Such reduction in diameter and area results in necessarily greatly restricted chambers between body and insulator, which are definitely more susceptible to frequent fouling and consequent short-circuiting. It also necessitates a greatly reduced cross-sectional area of the insulator, leading to greater fragility and shorter life thereof.

Another condition which obtains with conventional spark plugs is the formation of a hard carbon deposit on the metal surfaces of the plug which are exposed in the combustion chamber. This carbon deposit frequently becomes incandescent from the heat of the combustion gases causing pre-ignition and detonation. This condition, together with the others previously related, becomes more pronounced with the use of the high-compression high-temperature engines in the automobile, air craft, and industrial fields of the present time.

I have found that by constructing the body member and the gland nut of the spark plug of a copper alloy, with comparatively high strength and hardness and a high thermal conductivity, greatly improved engine performance will result and the disadvantages pointed out above will not be present.

In the accompanying drawing I have illustrated a spark plug made in accordance with my invention. In this drawing, like characters of reference designate corresponding parts and:

Figure 1 is a vertical section of the spark plug.

Figure 2 is a view showing the spark plug screwed into position in a cylinder head.

As shown in Figure 1, the spark plug embodies a central member 1 made of porcelain, mica or other material of a highly insulating nature through which an electrode 2 extends for the purpose of conducting the high-voltage electric current. A body member 3 enclosing this insulator is provided with an electrode 4 which

is positioned to give a definite space or gap between it and the lower end of the electrode 2 which projects from the lower end of the insulator 1. The extreme lower end of the body member 3 is threaded at 5, so that the plug may be screwed into a cylinder head, such as the cylinder head 6 in Figure 2, exposing the electrodes 2 and 4 to the explosive gases of the cylinder. The insulator 1 and the member 2 are held tightly together by a gland nut 7 which is threaded into the extreme upper end of the body member 3, as indicated at 8. The whole unit is protected against leakage of gases by gaskets 9 and 10 which may be made of soft copper.

In the conventional spark plug the members 3 and 7 are made of steel or other similar ferrous material of low thermal conductivity. I have found that by making the body member 3 and the gland nut 7 of the spark plug of a copper alloy with comparatively high strength and hardness and with a thermal conductivity preferably over 60 per cent that of pure copper, greatly improved engine performance will result. I have found that even with compression ratios of 8 to 1 detonation or pinging is greatly reduced over that observed when a conventional type spark plug of like dimensions is employed. I have also found that in the use of a plug made according to the principles of my invention, the carbon deposit on the surfaces of the electrode 4 and on the extreme lower edge of the body member 3 is very much less and that the small amount of carbon which is deposited does not get sufficiently hot to cause pre-ignition or spark knocking.

In addition, I have discovered that because of the even distribution of heat over the body of member 3 of the plug, the gap between the electrodes 2 and 4 remains more nearly constant even after prolonged use than is the case with the conventional type of spark plug. This indicates longer life for electrodes and for the insulator 1. The plug 3, being made of copper alloy, readily conducts the heat into the cylinder head and to the atmosphere and the heat is evenly distributed in the body member 3 and the gland nut 7.

I have found in the case of an 8-cylinder engine of popular make, which in operation with new plugs of the conventional type showed very pronounced detonation, that when operated with plugs constructed according to my invention but similar in general structure and of the same dimensions as the conventional plugs previously used in the engine, detonation was practically eliminated and much better acceleration and power was obtained. After prolonged use, an examination of the plugs, made according to my invention, disclosed that much less carbon had deposited upon the exposed surfaces and that the electrodes and insulators were in much better condition than was the case with the conventional plugs after a like period of use. In fact, they were practically unharmed, while the conventional plugs showed marked erosion of electrodes and considerable carbon on exposed plug surfaces.

Although I do not wish to be confined to any particular alloy composition, as any copper base material meeting the requirements of conductivity, strength and hardness can be used, without departing from the spirit of my invention, I have found as a result of my experiments with various materials that a precipitation-hardened copper-chromium alloy containing 98 per cent or more copper is suitable for this purpose. The body member 3 and the gland nut 7 may be cast or otherwise formed from this alloy. The chromium of the alloy serves to harden the copper. The precipitation-hardening is preferably carried out after the members are shaped therefrom. This precipitation-hardening improves the physical properties of the alloy and increases the thermal conductivity thereof. I may employ any copper-rich alloy which is relatively soft when initially formed but which is capable of being precipitation-hardened for improving its physical properties and for increasing the thermal conductivity thereof. The chromium may be in part replaced by such elements as: silicon, cobalt, cadmium, beryllium, zirconium, silver, zinc or phosphorus or these elements may be used in addition to the chromium, so long as their effect is not harmful to conductivity, strength and hardness.

I have also found that argentiferous copper, preferably containing silver in an amount of about 30 ounces per ton, is suitable for use in making the body member and the gland nut of the spark plug. This argentiferous copper is preferably cold-worked.

It is desirable to use a spark plug made according to my invention with an engine head which is also made of copper or copper alloy in order to obtain the best engine performance. Thus, in Figure 2, the spark plug is shown mounted in an engine head 6 which is also made of copper or copper alloy. However, when my spark plug is mounted in a cylinder head made of cast iron or aluminum, greatly improved engine performance will result.

It will be apparent that satisfactory results may be obtained if the body member 3 is made of the copper alloy but the gland nut 7 is not. However, it is preferable to make both of such members of the copper alloy. It is to be understood that in the claims where I refer to the "body member" as being made of copper alloy, I intend to cover a spark plug where the member corresponding to the member 3 is made of copper alloy and the member corresponding to gland nut 7 may or may not be made of copper alloy.

Having thus described by invention, what I claim is:

1. A spark plug having a body member made of a copper base alloy having a thermal conductivity at least 60 per cent as great as that of pure copper, and having high strength and hardness.

2. A spark plug having a body member made of a copper base alloy having a thermal conductivity at least 60 per cent as great as that of pure copper, and having high strength and hardness, said alloy containing at least one element selected from the class consisting of chromium, silicon, cobalt, cadmium, beryllium, zirconium, silver, zinc and phosphorus.

3. A spark plug having a body member made of argentiferous copper having a conductivity at least 60 per cent as great as that of pure copper, and having high strength and hardness.

4. A spark plug having a body member made of cold worked argentiferous copper, having a conductivity at least 60 per cent as great as that of pure copper, and having high strength and hardness.

5. A spark plug having a body member made of a precipitation hardened copper base alloy having a thermal conductivity at least 60 per cent as great as that of pure copper, and having high strength and hardness.

6. A spark plug having a body member made of a precipitation hardened copper base alloy containing chromium, and having a thermal con-

ductivity at least 60 per cent as great as that of pure copper, and having high strength and hardness.

7. A spark plug having a body member made of a precipitation hardened copper base alloy containing at least 98 per cent copper and containing chromium and at least one other constituent selected from the group consisting of silicon, cobalt, cadmium, beryllium, zirconium, silver, zinc and phosphorus.

ERNEST R. DARBY.