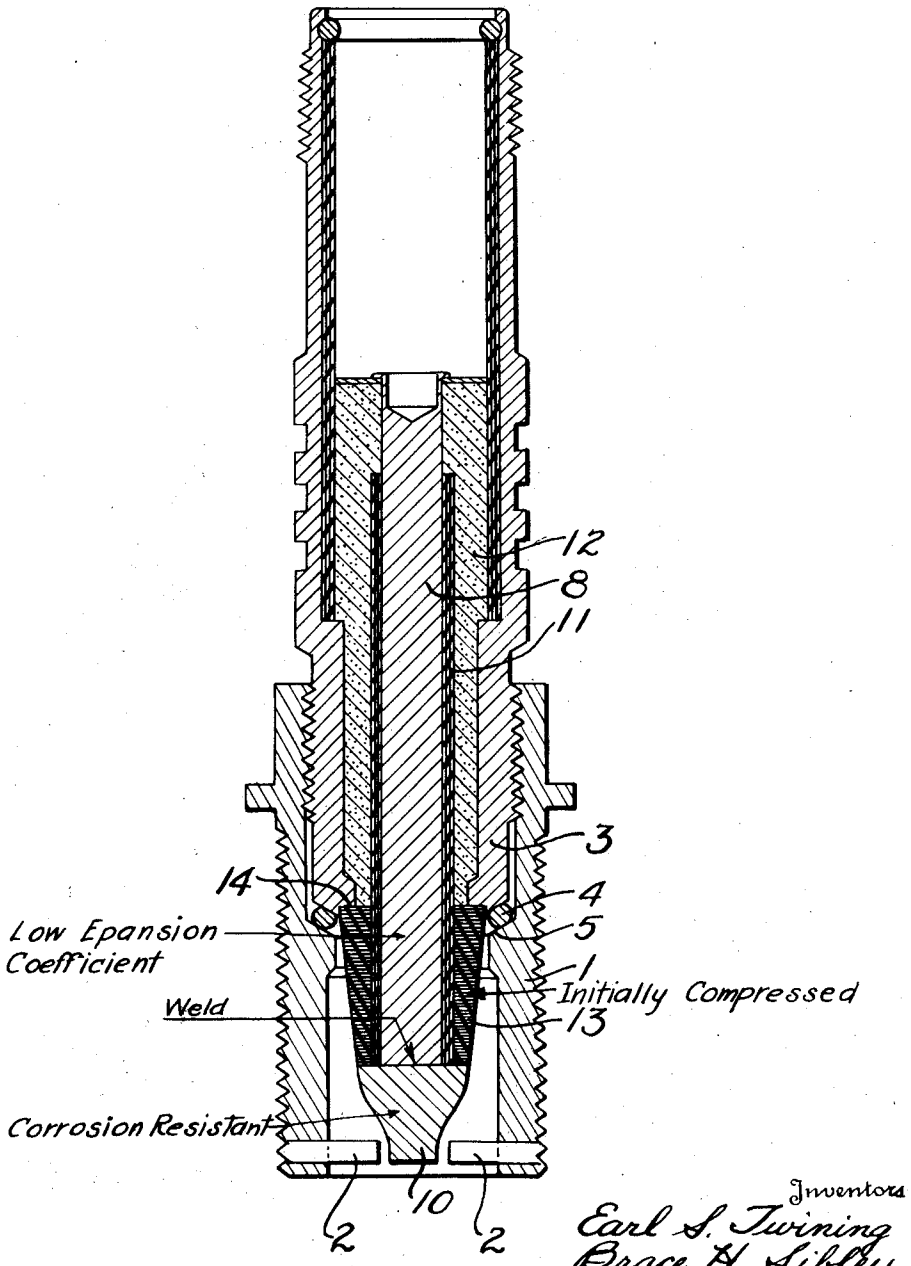
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SPARK PLUG

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SPARK PLUG

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This invention relates to spark plugs and is particularly directed to spark plugs having mica or similar longitudinally compressed insulation.

Mica insulated spark plugs used in aircraft and in other types of extreme service have given considerable trouble due to the fact that the parts of the plug which confine the mica and the mica itself all operate in different temperature ranges and all have different coefficients of thermal expansion. The plugs are, of course, assembled cold and when heated, longitudinal expansion of certain of the parts to an extent greater than the expansion of the mica loosens the latter and causes failure of the plug.

It has heretofore been common in ceramic insulated spark plugs to utilize metal for the spindle selected to have approximately the same coefficient of thermal expansion as the ceramic insulator to reduce cracking of the latter by excessive radial expansion of the spindle. It is also common to provide composite metallic spindles in which each metal serves the purpose for which it is best suited, e. g., heat conduction or corrosion resistance or spark erosion resistance. None of these expedients, however, solves the problem of longitudinal expansion and resulting failure in mica insulated plugs.

The primary object of the present invention is the provision of means to assure substantially constant compression on the insulating parts of a spark plug regardless of the plug temperature.

Other objects and advantages of the invention will become apparent from the following specification, reference being had to the accompanying drawing which shows a central vertical section of a spark plug incorporating the present invention.

Referring to the drawing, a typical spark plug includes a shell 1 adapted to be threaded into an engine in the usual manner and carrying suitable ground electrodes 2 of any desired configuration and material.

In the type used for illustration, a bushing 3 is threaded into the upper end of the shell 1 and has its lower end seated against a gasket 4 which latter bears against a shoulder 5 on the interior of the shell 1. The bushing is thus in heat exchange relationship with the relatively cool running shell 1 and, in addition, is exposed to the air at its upper end and is cooled thereby. It can be expected, therefore, that the bushing 3 will operate at a relatively low temperature.

The center electrode, or spindle of the spark plug, is formed in two parts including an upper section 8 and a lower exposed section 10 which is subject to the corrosive effects of the engine combustion as well as the erosion of the electrical discharge. The tip of the section 10 cooperates with the ground electrode 2 to form the spark gap. The two sections 8 and 10 are welded together preferably along the line indicated by the arrow, although the joint may be made at some other point should circumstances require.

The upper section of the spindle is wrapped in a mica "cigarette" 11 and is for the greater portion of its length surrounded by a compressed holding and insulating material 12 in the form of a powder. The insulation is shown merely by way of illustration and forms no part of this invention. The upper end portion of the upper spindle part 8 may thus be considered as anchored with respect to the bushing 3 against relative axial displacement.

Where the spindle section 8 projects from the bushing 3 it is surrounded not only by the mica cigarette, but by a stack of mica washers 13 seated on the head of the spindle section 10 and compressed between it and a recessed shoulder 14 of the bushing 3. As stated, these washers are initially compressed and serve as heat insulation and, to a degree, as electrical insulation. If the washers become loose and separated even minutely, failure at this point is likely, the lines of failure being between the separated washers.

The spindle of the spark plug runs at a very high temperature at its tip, probably close to 1100° F. or 1200° F. because its inner end is exposed to the combustion and the heat must travel up the spindle to be dissipated through the insulation surrounding it to the shell and bushing. The spindle is, therefore, subject to considerable longitudinal thermal expansion if made of the usual metals, and the expansion is downwardly from the bushing 3 since the part of the spindle which projects from the bushing is free to move.

The fact that the bushing 3 operates at a relatively low temperature and is in addition relatively well held against displacement while the spindle is free to expand longitudinally has resulted in a loosening of the mica washers 13. This loosening has frequently been responsible for failure of the spark plug. In order to maintain the compression originally placed on the stack of washers the present invention coordinates the expansion characteristics of the spindle with the remaining plug parts. Since the spindle operates at the highest temperature, it must have the lowest coefficient of thermal expansion, at least throughout the major portion of its length. For this reason, an alloy having

a low coefficient of expansion is chosen, such, for example, as Ascoloy #55, an alloy containing iron—70.90%, chromium—27.42%, nickel—.48%, manganese—.80%, silicon—.25%, carbon—.15%. This material, and others of similar nature are, however, unsuitable for the tip portion 18 as it is subject to rapid corrosion and erosion. The lower section 18 is, therefore, made from an alloy containing a high percentage of nickel or other metal which will resist gap wear and the effects of combustion.

By utilizing a metal which has a low coefficient of expansion for a portion of the center spindle, it is possible to maintain a substantially even compression on the stack of mica washers or similar compressed insulating material throughout the entire operating range of the spark plug. The dangerous possibility of loosening of the insulation is thereby eliminated and the reliability of the plug greatly increased.

While the invention has been described in connection with a "two piece" type of spark plug, it will be readily apparent that it is equally applicable to any spark plug having longitudinally compressed insulating material held between an outer metallic part which operates at relatively low temperature and an inner spindle which runs at relatively high temperature.

What we claim is:

1. A spark plug for an internal combustion engine including a relatively cool running outer metallic part, an inner metallic spindle, and insulating material initially compressed in a direction longitudinally of the spindle between a portion of each of said outer part and said spindle, said spindle having its major portion formed from an alloy of low coefficient of thermal expansion whereby when the spark plug is heated in use the compression on said insulation is substantially maintained.

2. A spark plug for an internal combustion engine including a relatively cool running outer metallic part, laminated insulating material initially compressed against a portion of said outer part, an inner metallic spindle holding said insulating material under longitudinal compression and having a portion free for longitudinal expansion, said spindle being for the greater part of its length formed from an alloy of low coefficient of thermal expansion whereby when the spark plug is heated in use the compression on said laminated insulating material is substantially maintained.

3. A spark plug for an internal combustion engine including a relatively cool running outer metallic part substantially restrained against longitudinal displacement, an inner metallic spindle carried within said outer part in a manner such that at least a portion thereof is free for longitudinal expansion under heat, and insulating material initially compressed longitudinally between a part of each of said spindle and said cool running outer part, said spindle having its major portion formed from an alloy of low coefficient of thermal expansion whereby the longitudinal displacement of the spindle and outer parts when heated in use are substantially similar and the compression on the insulation is substantially maintained.

4. A spark plug for an internal combustion engine including a relatively cool running outer metallic part, an inwardly facing shoulder form in said part, an inner metallic spindle having an enlarged head axially displaced from the shoulder of said outer part, laminated insulating material surrounding said spindle and compressed between the head thereof and said shoulder, said head being formed of a material resistant to gas corrosion and erosion by sparking, and the remainder of said spindle being formed of an alloy having a low coefficient of thermal expansion whereby the compression on said insulating material is substantially maintained.

5. A spark plug for an internal combustion engine including a shell, a relatively cool running bushing threaded into the shell, laminated insulating material initially compressed against a portion of said bushing, an inner metallic spindle holding said insulating materal under longitudinal compression and having a portion free for longitudinal expansion, said spindle being for the greater part of its length formed from an alloy of low coefficient of thermal expansion whereby when the spark plug is heated in use the compression on said laminated insulating material is substantially maintained.

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