Nov. 18, 1941. H. K. KING 2,262,769

SPARK PLUG

Filed Feb. 19, 1941 2 Sheets-Sheet 1

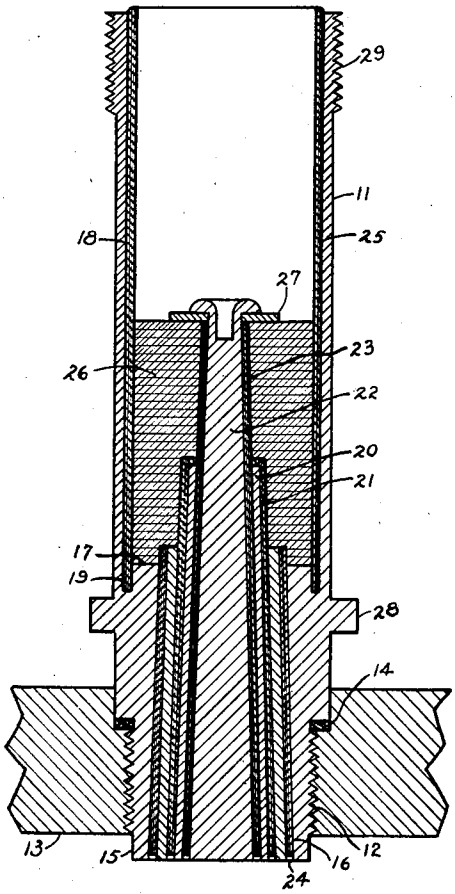


FIG. 1

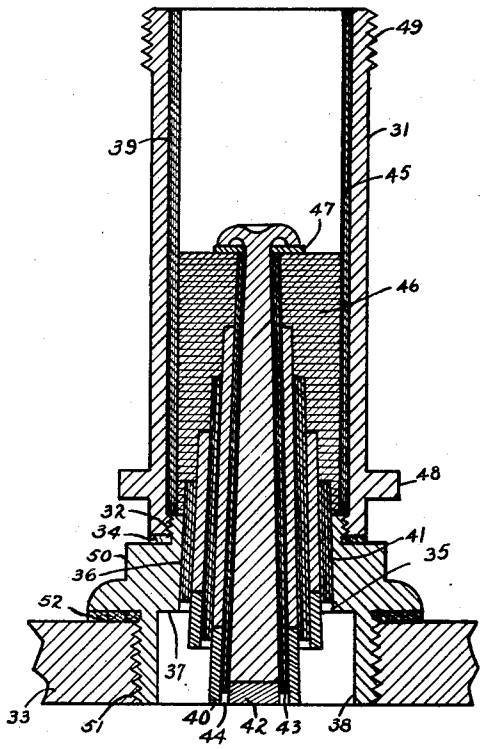


FIG. 2

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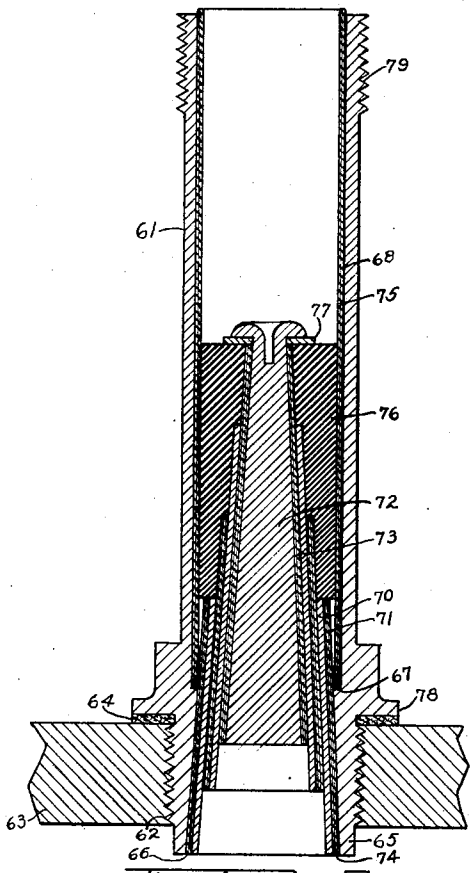


FIG. 3

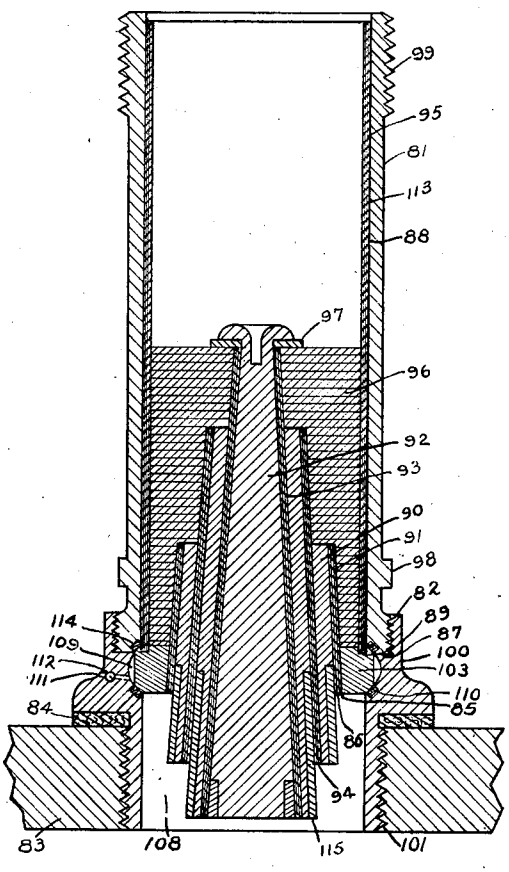


FIG. 4

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Patented Nov. 18, 1941 2,262,769

UNITED STATES PATENT OFFICE

2,262,769

SPARK PLUG

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Application February 19, 1941, Serial No. 379,600

17 Claims. (Cl. 123—169)

(Granted under the act of March 3, 1883, as amended April 30, 1928; 370 O. G. 757)

My invention relates to spark plugs and provides a new and novel type of construction and arrangement of parts whereby certain difficulties inherent in present types of plugs are minimized or obviated and also certain new advantages are realized, as will presently appear.

One object of my invention is to provide a plug, the joints between the insulation of which will become tighter with increase of temperature during operation.

Another object is to reduce the possibility of leakage of current or electrical breakdown of the insulation.

A further object is to provide a plug of small overall diameter.

A still further object is to provide a plug which can be easily cleaned without disassembly.

A still further object is to provide a plug, the electrode of which will undergo minimized wear or erosion during long service.

An additional object is to provide a plug with self-cleaning gaps.

A still further object is to provide a plug in which those parts that are most subject to wear or damage can be readily replaced.

A still further object is to provide a plug having an improved thermal path for the conduction of heat away from the electrodes.

A still further object is to provide a plug with readily replaceable parts in which the possibility of escape of gas through necessary gaskets with damage to insulation is reduced to a minimum.

These and other objects will appear more fully in the detailed description of the invention which follows. Although four embodiments of the present invention are illustrated in the accompanying drawings, it is to be expressly understood that these drawings are for the purpose of illustration only and are not to be construed as a limitation of the scope of the invention, reference being had primarily for this purpose to the appended claims.

In the drawings illustrating different embodiments of my invention,

Fig 1 is a longitudinal sectional view of a spark plug adapted for use where very small overall diameter is desired.

Fig. 2 illustrates a modification of the design of Fig. 1, permitting the use of two-piece construction, and allowing greater heat flow away from the central electrode.

Fig. 3 illustrates a modification of the design of Fig. 1, permitting greater heat flow away from the central electrode.

Fig. 4 illustrates a modification of the design of Fig. 1, permitting the use of a three-piece construction with a readily removable core, and a vent to minimize possibility of entrance of gas into the upper barrel.

My first object, that of providing increased tightness of the joints between insulating members, is attained by the use of a conical inner electrode, and conical sleeves for intermediate electrodes, all placed in a conical recess in the outer electrode. These electrodes are separated by conical sleeves of insulating material. As heating occurs with operation the greatest proportionate expansion will occur at the base of the inner electrode because a higher temperature is found there than at the upper portion of the inner electrode or at the bases of the remaining electrodes, and further because a larger volume of metal is located at the base of the inner electrode than at the other places mentioned. Thus, the inner electrode will be gripped by the innermost intermediate electrode more tightly at its base than elsewhere. The bases of the intermediate electrodes will also expand in a similar way, each against the next outer one, but to a lesser degree than the one within it, so as a result all electrodes, and the insulating sleeves, which are stretched by them, are more tightly held at their bases than elsewhere.

The metal electrodes will expand longitudinally in a greater amount than the insulating sleeves, having a higher coefficient of expansion. As the electrode-insulating sleeve assembly is held more tightly at its base, this longitudinal expansion will cause the conical electrodes to wedge tightly into the enveloping conical insulating sleeves instead of sliding through them as would occur if the electrodes were cylindrical, and tightening of the joints will occur with the heat of expansion. Control of tightening of seal at the base with heat of use may be obtained by choosing material for electrodes which will have a coefficient of expansion so related to coefficients of expansion of insulating material that desired degree of tightening will occur. Electrodes may be of two metals, one forming a plated coating on the other or being a distinct sleeve appropriately joined.

The second object, that of reducing the possibility of leakage of current or electrical breakdown of insulation, is obtained by means of the use of sleeves or cigarettes of insulating material rather than stacks of washers.

With the mica washer type of design, nonhomogeneity of adjacent rings, formations of carbon, oil or other foreign material at joints or on abutting surfaces, or air between abutting poorly fitted or loosened surfaces may occur. Such loosening frequently occurs due to spindle shank elongation in service. These occurrences will cause displacement of the dielectric flux field and may cause local concentrations of sufficient flux density to result in breakdown of the insulation at such points. With the insulation consisting of homogenous cigarettes such excessive flux densities are much less likely to occur.

One modification shown in Fig. 1 is especially

adapted to plug construction where very small overall diameter is desired, thus attaining the third object. In this modification the faces of all electrodes are in the same transverse plane, and the faces of the cigarettes of insulating material which separate these electrodes are in a transverse plane nearly the same as the plane of the electrode faces. Thus, the end of the plug being very nearly a plane, the insulator surfaces are exposed and readily accessible for cleaning, as desired in the fourth object.

The use of electrodes consisting of annular rings provides a large surface over which wear and erosion are distributed. For these reasons, therefore, wear or erosion is minimized during long service, as desired in the fifth object.

The sixth object, to provide a self-cleaning gap, is obtained by the use of multiple series gaps. When one gap is fouled the remaining gaps will still permit a spark to be formed, and the heat of the resulting combustion will act to destroy the deposit and clean the fouled gap. Furthermore, when a spark occurs across the remaining gap of the circuit the first momentary surge of current is extremely high. This current, passing through the high resistance of the fouled gap, generates a high temperature, which also will tend to oxidize the fouling substance and clean the gap. As a thermal gradient will exist between the inner and outer electrodes, conditions to cause fouling of all gaps simultaneously are unlikely to occur. Proper design, in the embodiments shown in Figs. 2, 3 and 4, of the axial distance between the gaps, will permit placing these gaps so that when at operating temperature one or more will be outside the temperature ranges within which lead fouling and carbon fouling occur.

The seventh object, to provide for replacement of the barrel, plug and other parts which are most subject to wear or damage, is attained in embodiments shown in Figs. 2 and 4 by two-piece and three-piece construction, dividing the barrel of embodiment shown in Fig. 1 into an upper barrel and a plug in embodiment shown in Fig. 2, and into an upper barrel, plug and inner electrode in the form of a core in embodiment shown in Fig. 4.

The eighth object, to provide an improved thermal path for removal of heat by conduction is attained in the embodiment shown in Fig. 2 by using electrode assemblies in which the electrode proper consists of metal chosen for its non-corrosive properties, while the electrode shank is of metal chosen for its high thermal conductivity. This object also is attained in the embodiment shown in Fig. 3 by using material of high thermal conductivity and placing the inner electrode, the hottest part of the plug, within the interior of the plug so that a relatively short path is provided to the exterior radiating surfaces of the plug.

The ninth object, to reduce, in a plug with readily replaceable parts, the possibility of escape of gas through gaskets with damage to insulating material, is attained in the embodiment shown in Fig. 4. In this three-piece design we have the outer electrode in the form of an annular core containing the remaining electrodes. This core is placed within the barrel-base plug assembly, making contact at the edges of the two flat surfaces through gas-tight washers. Between the outer cylindrical surface of the core and the plug there is left a void space; a vent passage equipped with a check valve leads to the atmosphere from this annular void space. Thus, if the washer on the cylinder side fails at any point gas will escape through the void space and vent. Thus, there is almost no possibility of gas causing failure of the outer gasket, entering the upper barrel and causing damage to the insulating material there, during the interval between failure of the inner gasket and an opportunity to replace same.

Referring in detail to Fig. 1, the spark plug barrel **11**, of conductive material, is adapted to be secured by screw threads **12** into the engine cylinder wall **13**, gasket **14** making a gas-tight joint. The base of barrel **11** projects into the cylinder and forms the outer electrode **15**. Barrel **11** is hollow, a truncated conical recess **16** being formed commencing at outer electrode **15** and progressing with decreasing diameter a portion of the length until meeting at shoulder **17** a cylindrical recess **18** formed commencing at the external end of barrel **11**. The face of shoulder **17** is normal to the longitudinal axis of barrel **11**, and its greatest diameter is less than that of cylindrical recess **18**, so that cylindrical slot **19** is formed at the innermost portion of cylindrical recess **18**.

Within conical recess **16** are inserted several intermediate electrodes **20**, two of which are shown in the present embodiment. These electrodes **20** consist of sleeves of conductive material, of truncated conical shape, and of successively greater length so that the innermost is the longest. The electrodes **20** are placed within truncated conical sleeves of insulating material **21**, each one of length somewhat less than the electrode within it. Within the innermost of the intermediate electrodes **20** is placed the inner electrode **22**, a solid truncated cone of conductive material longer than the innermost of the intermediate electrodes **20**, surrounded by an insulating sleeve **23** similar to sleeves **21**.

The bases of the electrodes **20** and **22** lie in the same plane as that of outer electrode **15**; the base of insulating sleeves **21** and **23** lie in a plane parallel to this plane but transposed from it into the conical recess **16** a slight amount so that the series spark gaps **24** are formed between electrodes **15**, **20** and **22**.

A cylindrical sleeve **25** of insulating material is inserted in cylindrical recess **18**, resting in slot **19**. A stack of discs **26** of insulating material, of varying internal diameters, fills the space between cylindrical sleeve **25** and the conical insulating sleeves **21** and **23**, the innermost disc resting on shoulder **17** and the outermost disc held by washer **27** which, along with suitable means for connecting ignition wiring, is suitably secured to the small end of inner electrode **22** so that the assembly is tightly held.

Nut **28** is made integral with barrel **11** or attached thereto by suitable means, and is adapted to fit a wrench for convenience in installing the barrel **11** in the cylinder wall **13**. Barrel **11** has external threads **29** at its outer end adapted to receive the shielding harness connection.

Referring in detail to Fig. 2, the spark plug barrel **31**, of conductive material, is adapted to be secured by screw threads **32** into hollow base plug **50**, also of conductive material, gasket **34** making a gas tight joint. Plug **50** has its upper portion internally threaded to receive barrel **31**, and is adapted to be secured by screw threads **51** into the engine cylinder wall **33**, gasket **52** making a gas tight joint.

The outer end of plug **50** is adapted to fit a wrench for convenience in installing the plug **50** in the cylinder wall **33**.

The outer end of plug 50 forms the outer electrode 35. Plug 50 is hollow, a truncated conical recess 36 being formed commencing at the outer end and progressing with increasing diameter a portion of the length and meeting at shoulder 37 a cylindrical recess 38 formed commencing at the inner end of plug 50. Barrel 31 has a cylindrical bore 39 of diameter equal to the outer face of plug 50.

Within conical recess 36 are inserted several intermediate electrode assemblies 40, two of which are shown in the present embodiment. These electrode assemblies 40 consist of sleeves of conductive material, of truncated conical shape, and of successively greater length so that the innermost is the longest. Each electrode assembly 40 consists of two sleeves of conductive material of truncated conical shape, permanently joined by suitable means, one being an extension of the other. The portion having the largest diameter of base is made of material chosen for its non-corrosive properties and forms the electrode proper. The other portion is made of material chosen for its high thermal conductive properties. The plane of junction is slightly within the surrounding insulating sleeve. The electrode assemblies 40 are placed within truncated conical sleeves of insulating material 41, each one of length somewhat less than the electrode within it. Within the innermost of the intermediate electrode assemblies 40 is placed the inner electrode assembly 42, a solid truncated cone of conductive material longer than the innermost of the intermediate electrode assemblies 40, surrounded by an insulating sleeve 43 similar to sleeves 41.

The inner electrode assembly 42 consists of two truncated cones of conductive material permanently joined by suitable means, one being an extension of the other. The portion having the largest diameter of base is made of material chosen for its non-corrosive properties and forms the electrode proper. The other portion is made of material chosen for its high thermal conductive properties. The plane of junction is slightly within the surrounding insulating sleeve.

The bases of the insulating sleeves 41 and 43 by a slight amount fail to extend to the bases of the corresponding electrodes 35, 40 and 42, so that the series spark gaps 44 are formed between electrodes 35, 40 and 42. The inner electrode 42 and intermediate electrodes 40 are so placed with reference to the outer electrode 35 that each extends progressively further into the cylinder.

A cylindrical sleeve 45 of insulating material is inserted in cylindrical bore 39 resting on the outer face of plug 50. A stack of discs 46 of insulating material, of varying internal diameters, fills the space between cylindrical sleeve 45 and the conical insulating sleeves 41 and 43 and electrodes 40, the innermost disc resting on the outer face of plug 50 and the outermost disc held by washer 47 which, along with suitable means for connecting ignition wiring, is suitably secured to the small end of inner electrode 42 so that the assembly is tightly held.

Nut 48 is made integral with barrel 31 or attached thereto by suitable means, and is adapted to fit a wrench for convenience in installing the barrel 31 in the plug 50. Barrel 31 has external threads 49 at its outer end adapted to receive a shielding harness connection.

Referring in detail to Fig. 3, the spark plug barrel 61 of conductive material, which is also of high thermal conductivity, is adapted to be secured by screw threads 62 into the engine cylinder wall 63, gasket 64 making a gas tight joint. The base of barrel 61 projects into the cylinder and forms the outer electrode 65. Barrel 61 is hollow, a truncated conical recess 66 being formed commencing at outer electrode 65 and progressing with decreasing diameter a portion of the length until meeting at shoulder 67 a cylindrical recess 68 formed commencing at the external end of barrel 61. Sleeve 75, of insulating material, covers the inside of cylindrical recess 68 abutting against the shoulder 67, which shoulder is of width slightly less than the thickness of sleeve 75. Within conical recess 66 are inserted several intermediate electrodes 70, two of which are shown in the present embodiment. These electrodes 70 consist of sleeves of conductive material, which is also of high thermal conductivity, of truncated conical shape.

The electrodes 70 are placed within conical sleeves of insulating material 71. Within the innermost of the intermediate electrodes 70 is placed the inner electrode 72, a solid truncated cone of conductive material which is also of high thermal conductivity, surrounded by an insulating sleeve 73 similar to sleeves 71. The inner electrode 72 and intermediate electrodes 70 are so placed that the outer of the intermediate electrodes 70 has its base in the same plane as the base of outer electrode 65, and the remaining electrodes have their bases progressively further away from the interior of the cylinder.

The bases of the sleeves 71 and 73 are in the same planes as the bases of the electrodes 70 and 72 which they surround. The series spark gaps 74 are around the ends of the sleeves 71 and 73.

An insulating piece 76 fills the space between cylindrical sleeve 75 and the conical insulating sleeves 71 and 73 and electrodes 70. The outer end of insulating piece 76 is held by washer 77 which, along with suitable means for connecting ignition wiring, is suitably secured to the small end of inner electrode 72, so that the assembly is tightly held.

Nut 78 is made integral with barrel 61 or attached thereto by suitable means, and is adapted to fit a wrench for convenience in installing the barrel 61 in the cylinder wall 63. Barrel 61 has external threads 79 at its outer end adapted to receive a shielding harness connection.

Referring in detail to Fig. 4, the spark plug barrel 81, of conductive material, is adapted to be secured by screw threads 82 into hollow base plug 100, also of conductive material, abutting against shoulder 87. Plug 100 has its upper portion internally threaded to receive barrel 81 and is adapted to be screwed by screw threads 101 into the engine cylinder 83, gasket 84 making a gas tight joint. The outer end of plug 100 is adapted to fit a wrench for convenience in installing the plug 100 in the cylinder wall 83. Plug 100 has a cylindrical recess 108 commencing at its inner end.

Core 103, an annular ring of conductive material, is of larger diameter than that of cylindrical recess 108. Core 103 has beveled edges. An annular recess 109 is formed in the interior of plug 100, between the end of cylindrical recess 108 and shoulder 87, to receive core 103 and leave a void space around its periphery. Gasket 110, of conductive material, separates the core 103

at its beveled edge from plug 100 where the core 103 fits into annular recess 109, with a gas-tight seal. Vent passage 111 will permit escape of gas from the void space of annular recess 109 in case of failure of gasket 110. Vent passage 111 is fitted with check valve 112, of standard design. Barrel 81 has a cylindrical recess 113, the inner end of which is beveled to continue annular recess 109. Gasket 114 separates core 103 at a beveled edge from barrel 81 at the extension of annular recess 109, with a gas-tight seal.

The inner flat surface of core 103 forms the outer electrode 85. Core 103 is hollow, a truncated conical recess 86 being formed commencing at outer electrode 85 and progressing with decreasing diameter. Within conical recess 86 are inserted several intermediate electrodes 90, two of which are shown in the present embodiment. These electrodes 90 consist of sleeves of conductive material, of truncated conical shape, and of successively greater length so that the innermost is the longest. The electrodes 90 are placed within truncated conical sleeves of insulating material 91, each one of length somewhat less than the electrode within it. Within the innermost of the intermediate electrodes 90 is placed the inner electrode 92, a solid truncated cone of conductive material longer than the innermost of the intermediate electrodes 90, surrounded by an insulating sleeve 93 similar to sleeves 91. Electrodes 85, 90 and 92, or some of them, have a thin coating of plated metal or a thin sheath 115 placed about their exterior surfaces covering the area within cylinder 83, in order to improve the heat flow and the tightening of the seal on expansion, by choice of material for sheaths 115 having suitable coefficient of heat conductivity and coefficient of expansion.

The bases of the insulating sleeves 91 and 93 lie in the same respective planes as the bases of the corresponding electrodes 85, 90 and 92. The series gaps 94 occur around the bases of insulating sleeves 91 and 93. The inner electrode 92 and intermediate electrodes 90 are so placed with reference to the outer electrode 85 that each extends progressively further into the cylinder. A cylindrical sleeve 95 of insulating material is inserted in cylindrical recess 88 resting in slot 89 formed on the outer plane surface of core 103. A stack of discs 96 of insulating material, of varying internal diameter, fills the space between cylindrical sleeve 95 and the conical insulating sleeves 91 and 93, the innermost disc resting on the outer plane surface of core 103 and the outermost disc held by washer 97 which, along with suitable means for connecting ignition wiring, is suitably secured to the small end of inner electrode 92 so that the assembly is tightly held. Nut 98 is made integral with barrel 81 or attached thereto by suitable means, and is adapted to fit a wrench for convenience in installing the barrel 81 in the plug 100. Barrel 81 has external threads 99 at its outer end adapted to receive a shielding harness connection.

As will be readily apparent to one skilled in the art who has this disclosure at hand, various further modifications may be made of my invention with attainment of some or all of my objects. These modifications include omission of the radio interference shield; use of a single gap; use of cylindrical electrodes with appropriate rolling, swaging, upsetting or compression or expansion methods for sealing the point between the plug body and the various layers of conducting and insulating material, and similar variations which do not depart from the nature of the invention and are within the scope of what is hereinafter claimed.

The invention described herein may be manufactured and/or used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

I claim:

1. In a spark plug having the feature of increased tightness of internal sealing during operation due to the heat generated, the combination including an integrally formed exterior body member, intermediate electrodes in the form of axially extended truncated conical sleeves, an inner electrode in the form of an axially extended truncated cone, the bases having the larger diameters of said conical sleeves and said cone being within and toward the base of said exterior body member and lying in diverse planes, the diversity of said planes and the axial extension of said sleeves being sufficient to cause the operating temperature of the base of at least one of said electrodes to lie without the respective thermal range in which fouling of said plug by deposits of each product of combustion will occur, and insulating means in the form of homogeneous conical sleeves to separate said electrodes from said exterior body member and from each other, whereby the degree of tightening of the seal between said electrodes and said body member is increased during operation.

2. In a spark plug having the feature of increased tightness of internal sealing during operation due to the heat generated, the combination including an outer barrel, a hollow base plug, a gasket of electrically conductive material, an annular core, intermediate electrodes in the form of axially extended truncated conical sleeves, an inner electrode in the form of an axially extended truncated cone, the bases having the larger diameters of said conical sleeves and said cone being within and toward the base of said base plug and lying in diverse planes, the diversity of said planes and the axial extension of said sleeves being sufficient to cause the operating temperature of the base of at least one of said electrodes to lie without the respective thermal range in which fouling of said plug by deposits of each product of combustion will occur, and insulating means in the form of homogeneous conical sleeves to separate said electrodes from said annular core and from each other, whereby the degree of tightening of the seal between said electrodes and said core is increased during operation.

3. In a spark plug having the feature of increased tightness of internal sealing during operation due to heat generated, the combination including an outer barrel, a hollow base plug removably secured thereto, an annular core within said base plug, intermediate electrodes in the form of truncated conical sleeves, an inner electrode in the form of a truncated cone, the bases having the larger diameters of said conical sleeves and said cone being within and toward the base of said hollow base plug and lying in diverse planes so that the operating temperature of each of said electrodes will lie within a different thermal range, insulating means in the form of homogeneous conical sleeves to separate said electrodes

from said core and from each other, said electrodes having recesses formed on those portions adjacent to said insulating means, which portions are toward the base of said hollow base plug, and heterogeneous metallic coatings filling said recesses, whereby the degree of tightening of the seal between said electrodes and said core is increased during operation and may be controlled through choice of the materials of said electrodes and said heterogeneous coatings.

4. In a spark plug having the feature of increased tightness of internal sealing during operation due to heat generated, the combination including an outer barrel, a hollow base plug, a gasket of electrically conductive material, an annular core, the surface of which is separated from said base plug by said gasket and by an annular void space, means to permit escape of gas direct to the atmosphere from said void space in case of failure of said gasket, intermediate electrodes in the form of truncated conical sleeves, an inner electrode in the form of a truncated cone, the bases having the larger diameters of said conical sleeves and said cone being within and toward the base of said hollow base plug and lying in diverse planes so that the operating temperature of each of said electrodes will lie within a different thermal range, insulating means in the form of homogeneous conical sleeves to separate said electrodes from said core and from each other, said electrodes having recesses formed on those portions adjacent to said insulating means, which portions are toward the base of said hollow base plug, and heterogeneous metallic coatings filling said recesses, whereby the degree of tightening of the seal between said electrodes and said core is increased during operation and may be controlled through choice of the materials of said electrodes and said heterogeneous coatings.

5. In a spark plug having the feature of increased tightness of internal sealing during operation due to heat generated, the combination including an exterior body member, intermediate electrodes in the form of truncated conical sleeves, an inner electrode in the form of a truncated cone, the bases having the larger diameters of said conical sleeves and said cone being within and toward the base of said exterior body member and lying in diverse planes so that the operating temperature of each of said electrodes will lie within a different thermal range, insulating means in the form of homogeneous conical sleeves to separate said electrodes from said exterior body member and from each other, said electrodes having recesses formed on those portions adjacent to said insulating means, which portions are toward the base of said exterior body member, and heterogeneous metallic coatings filling said recesses, whereby the degree of tightening of the seal between said electrodes and said exterior body member is increased during operation and may be controlled through choice of the materials of said electrodes and said heterogeneous coatings.

6. In a spark plug having the feature of increased tightness of internal sealing during operation due to heat generated, the combination including an exterior body member, intermediate electrodes in the form of truncated conical sleeves, an inner electrode in the form of a truncated cone, the bases having the larger diameters of said conical sleeves and said cone being within and toward the base of said exterior body member, insulating means in the form of homogeneous conical sleeves to separate said electrodes from said exterior body member and from each other, said electrodes having recesses formed on those portions adjacent to said insulating means, which portions are toward the bases of said electrodes, and heterogeneous metallic coatings filling said recesses, whereby the degree of tightening of the seal between said electrodes and said exterior body member is increased during operation and may be controlled through choice of the materials of said electrodes and said heterogeneous coatings.

7. In a spark plug having the feature of increased tightness of internal sealing during operation due to heat generated, the combination including an exterior body member, an electrode in the form of a truncated cone within said body member, the base having the larger diameter of said cone lying within and toward the base of said exterior body member, insulating means in the form of a homogeneous conical sleeve between said electrode and said exterior body member, said electrode having a recess formed on that portion adjacent to said insulating means, which portion is toward the base of said electrode, and a heterogeneous metallic coating filling said recess, whereby the degree of tightening of the seal between said electrode and said exterior body member is increased during operation and may be controlled through choice of the materials of said electrode and said heterogeneous coating.

8. In a spark plug having the feature of increased tightness of internal sealing during operation due to heat generated, the combination including an exterior body member, intermediate electrodes, an inner electrode, insulating means to separate said electrodes from said exterior body member and from each other, said electrodes having recesses formed on those portions adjacent to said insulating means, which portions are toward the base of said exterior body member, and heterogeneous metallic coatings filling said recesses, whereby the degree of tightening of the seal between said electrodes and said exterior body member is increased during operation and may be controlled through choice of the materials of said electrodes and said heterogeneous coatings.

9. In a spark plug having the feature of increased tightness of internal sealing during operation due to heat generated, the combination including an exterior body member, an electrode within and near the base of said body member, insulating means between said electrode and said exterior body member, said electrode having a recess formed on that portion adjacent to said insulating means, which portion is toward the base of said exterior body member, and a heterogeneous metallic coating filling said recess, whereby the degree of tightening of the seal between said electrode and said exterior body member is increased during operation and may be controlled through choice of the materials of said electrode and said heterogeneous coating.

10. In a spark plug having the feature of increased tightness of internal sealing during operation due to the heat generated, the combination including an outer barrel, a hollow base plug, intermediate electrodes in the form of truncated conical sleeves, an inner electrode in the form of a truncated cone, the bases having the larger diameters of said conical sleeves and said cone being within and toward the base of said

hollow base plug and lying in diverse planes so that the operating temperature of each of said electrodes will lie within a different thermal range, said intermediate electrodes and inner electrode being of metal chosen for its non-corrosive properties, intermediate shanks in the form of truncated conical sleeves permanently joined to the bases having the smaller diameters of said intermediate electrodes, an inner shank in the form of a truncated cone permanently joined to the base having the smaller diameter of said inner electrode, said intermediate shanks and inner shank being of metal chosen for its high thermal conductive properties to promote transfer of heat from the bases of said electrodes, and insulating means in the form of homogeneous conical sleeves to separate said electrodes and said shanks from said barrel and from each other, whereby the degree of tightening of the seal between said electrodes and said base plug is increased during operation.

11. In a spark plug having the feature of increased tightness of internal sealing during operation due to the heat generated, the combination including an exterior body member, intermediate electrodes in the form of truncated conical sleeves, an inner electrode in the form of a truncated cone, the bases having the larger diameters of said conical sleeves and said cone being within and toward the base of said exterior body member and lying in diverse planes so that the operating temperatures of each of said electrodes will lie in a different thermal range, said intermediate electrodes and inner electrode being of metal chosen for its non-corrosive properties, intermediate shanks in the form of truncated conical sleeves permanently joined to the bases having the smaller diameters of said intermediate electrodes, an inner shank in the form of a truncated cone permanently joined to the base having the smaller diameter of said inner electrode, said intermediate shanks and inner shank being of metal chosen for its high thermal conductive properties to promote transfer of heat from the bases of said electrodes, and insulating means in the form of homogeneous conical sleeves to separate said electrodes and shanks from said exterior body member and from each other, whereby the degree of tightening of the seal between said electrodes and said body member is increased during operation.

12. In a spark plug having the feature of increased tightness of internal sealing during operation due to the heat generated, the combination including an exterior body member, intermediate electrodes in the form of truncated conical sleeves, an inner electrode in the form of a truncated cone, the bases having the larger diameters of said conical sleeves and said cone being toward the base of said exterior body member, said intermediate electrodes and inner electrode being of metal chosen for its non-corrosive properties, intermediate shanks in the form of truncated conical sleeves permanently joined to the bases having the smaller diameters of said intermediate electrodes, an inner shank in the form of a truncated cone permanently joined to the base having the smaller diameter of said inner electrode, said intermediate shanks and inner shank being of metal chosen for its high thermal conductive properties to promote transfer of heat from the bases of said electrodes, and insulating means in the form of homogeneous conical sleeves to separate said electrodes and said shanks from said exterior body member and from each other, whereby the degree of tightening of the seal between said electrodes and said body member is increased during operation.

13. In a spark plug having the feature of long life, the combination including an exterior body member, intermediate electrodes, an inner electrode, said electrodes being within said exterior body member and being of metal chosen for its non-corrosive properties, intermediate shanks, an inner shank, said shanks being permanently joined to said electrodes and being of metal chosen for its high thermal conductive properties to promote transfer of heat from the base of said electrodes, and insulating means to separate said electrodes and said shanks from said exterior body member and from each other.

14. In a spark plug having the feature of long life, the combination including an exterior body member, an electrode in the form of a truncated cone within said body member, the base having the larger diameter of said cone being toward the base of said body member, said electrode being of metal chosen for its non-corrosive properties, a shank in the form of a truncated cone permanently joined to the base having the smaller diameter of said electrode, said shank being of metal chosen for its high thermal properties to promote transfer of heat from the base of said electrode, and insulating means in the form of a homogeneous conical sleeve between said electrode and shank and said exterior body member, whereby the degree of tightening of the seal between said electrode and said body member is increased during operation.

15. In a spark plug having the feature of long life, the combination including an exterior body member, an inner electrode within and near the base of said body member, said electrode being of metal chosen for its non-corrosive properties, a shank of metal chosen for its high thermal conductive properties permanently longitudinally joined to said electrode to promote transfer of heat from the base of said electrode, insulating means between said shank and electrode and said exterior body member, and covering means to shield said shank from the heat of combustion on firing of said spark plug.

16. In a spark plug, the combination including an outer barrel, a hollow base plug, a gasket of electrically conductive material, an annular core, the surface of which is separated from said base plug by said gasket and by an annular void space, means to permit escape of gas direct to the atmosphere from said void space in case of failure of said gasket, intermediate electrodes, an inner electrode, and insulating means to separate said electrodes from said annular core and from each other.

17. In a spark plug, the combination including an outer barrel, a hollow base plug, a gasket of electrically conductive material, an annular core, the surface of which is separated from said base plug by said gasket and by an annular void space, means to permit escape of gas direct to the atmosphere from said void space in case of failure of said gasket, an inner electrode, and insulating means between said electrode and said annular core.

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