

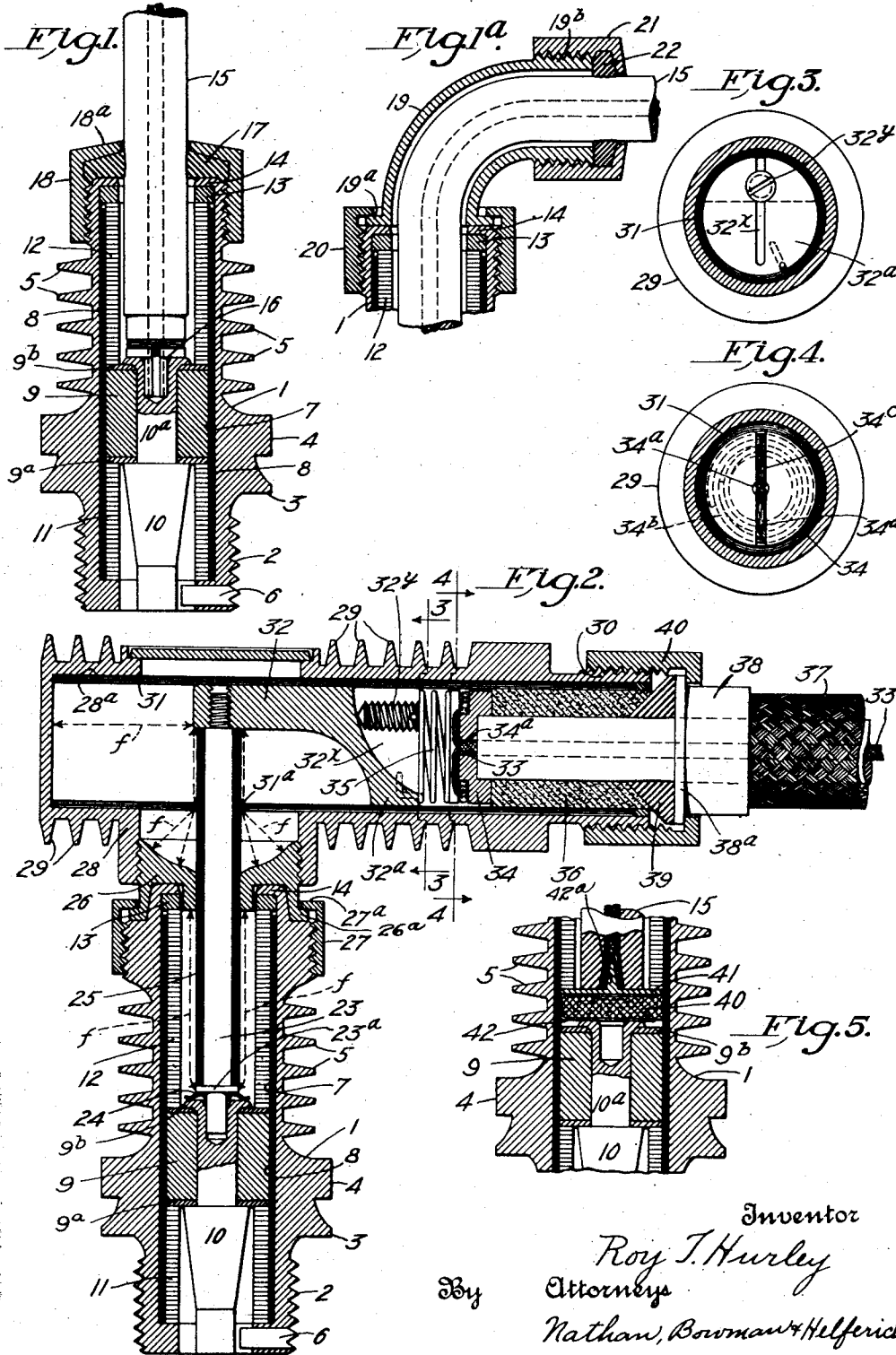
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COOLED AND SHIELDED SPARK PLUG

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COOLED AND SHIELDED SPARK PLUG

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This invention relates to spark plugs and more particularly to spark plugs for use in modern aircraft engines which operate with higher brake mean effective pressure and leaner fuel to air mixtures, and, because of their higher pressures, require larger concentration of metallic anti-knock in the fuel.

Spark plugs for this purpose are required to operate under extremely severe and exacting conditions. For example, the insulation on the firing end of the spark plug must operate at a temperature high enough to prevent the normal fouling from oil, and, at the same time must be so positioned in the spark plug as to prevent lead fouling due to thermal breakdown of the deposit resulting from the use of tetraethyl lead or the like in the fuel.

In addition, these plugs are often shielded electrically in order that the aeroplane may successfully use radio equipment, and, in addition these plugs should be waterproof in order to maintain the high dielectric on the outside of the plug and to combat with the adverse conditions encountered in supercharged military engines that must operate at altitudes of 30,000 feet and higher.

The combination of high pressures, temperatures and severe conditions brought about by lean fuel mixtures have caused rather serious failures in the conventional type of spark plug in which a core is mounted within the shell and the insulation is built into the said core.

The invention has as its object to provide a construction that will meet successfully the above conditions; will be small in size to fit within V type engines, and because it may be made without exacting machining operations on the insulation, it may be manufactured therefore at a minimum expense.

This object has been attained as hereinafter will be more fully described, by forming the spark plug with a one piece body member (carrying one of the electrodes) adapted to be screwed into the usual threaded hole in the engine casing; lining the body member with a sleeve of insulating material—preferably mica—and fitting within said sleeve the mica washers that heretofore usually have been supported around the outside of said sleeve.

In position between the two groups of mica washers is a metal slug to support the center electrode and to form the terminal for the high tension wire. This slug of metal may be located in place and a gas-tight joint formed by either expanding the slug outwardly to cause it to firmly

grip the mica sleeve between itself and the inner wall of the body member to form a gas-tight joint, or the body piece can be contracted inwardly causing it to firmly grip the mica sleeve between itself and the outer wall of the slug of metal. A central electrode is fitted gas-tight into the slug of metal by pressing it in place and riveting it over at its upper end.

An important feature of this invention resides in having the mica sleeve extend the full length of the body member and having the mica washers within the mica sleeve both above and below the metal slug. By means of this construction complete insulation and rapid heat dissipation is attained and no machining operations are required after the parts are assembled, as they are in a construction having exposed mica insulation.

Another object of this invention is to provide an improved radio shielded spark plug of relatively small size and of such shape as will occupy substantially no more space than does the usual unshielded plug; which readily may be assembled and installed; and which will be fully protected against overheating. This object has been attained by the provision of a construction hereinafter to be fully described.

Other objects and advantages will be in part indicated in the following description and in part rendered apparent therefrom in connection with the annexed drawing.

To enable others skilled in the art so fully to apprehend the underlying features hereof that they may embody the same in the various ways contemplated by this invention, a drawing depicting a preferred typical construction has been annexed as a part of this disclosure and, in such drawing, like characters of reference denote corresponding parts throughout all the views, of which:—

Figure 1 is a vertical sectional view of one form of radio shielded spark plug embodying the present invention.

Fig. 1* is a vertical sectional view of the upper end of a spark plug showing a modified construction in which the lead-in wire is brought into the plug at a right angle to the major axis of the plug.

Fig. 2 is a vertical sectional view of another form of radio shielded spark plug constructed in accordance with the present invention.

Fig. 3 is a cross sectional view on the line 3—3 of Fig. 2.

Fig. 4 is a cross sectional view on the line 4—4 of Fig. 2.

Fig. 5 is a detail sectional view showing a modi-

fied means to prevent overheating of the lead-in wire.

Referring more specifically to the drawing and first to Fig. 1, the invention is disclosed as embodied in one form of radio shielded spark plug comprising a body member 1, preferably of steel, formed with the usual threaded end 2 adapted to be screwed into the threaded aperture in the engine casing. This body member also is provided with the sealing flange 3 and the hexagonal wrench-receiving portion 4 by means of which the plug is screwed into the engine. Above the portion 4 the body member is provided with a plurality of annular heat-radiating fins 5, later to be referred to, and at its lower end it forms, or is provided with, an electrode 6.

The body member is provided with a central bore 7 into which is fitted, throughout its entire length, an insulating sleeve 8, preferably of mica. Within the sleeve 8 and adjacent the portion 4 of the body member, there is secured, a relatively heavy plug 9 of copper or other metal having high heat conductivity and into this plug there is secured, by a gas-tight joint, the shank 10^a of a central electrode 10. The plug 9 is positioned in the assembly to form a rigid support for the central electrode and this plug is preferably expanded so as to clamp the mica against the body thereby securing a gas tight joint at that point. In this way the mica can be clamped rigidly between the adjacent metal surfaces forming an effective gas tight joint for the mica sleeve.

It is to be noted that the member 9 is relatively short and massive, as distinguished from a long thin sleeve, and that it is preferably located within the lower half of the spark plug adjacent the heavy hexagonal portion 4 of the body member. In this position it serves to absorb heat from the electrode 10 to cool that element, and to transmit that heat through the mica sleeve to the body member from which it is dissipated into the atmosphere by the fins 5. Thus the block 9 forms, in effect, a dam which diverts the major portion of the heat to the outside of the spark plug and thereby prevents it from passing to the upper inner portion of the plug.

Fig. 5, later to be described, shows additional means to prevent the heat from flowing upwardly in the plug.

Further electrical insulation of the spark plug is effected by means of a first series of mica washers 11 interposed between the ring 9 and the lower end of the plug and a second series of mica washers 12 between the ring and a metallic washer 13 over which the upper end of the body member is spun, as at 14, to hold the parts in compressed condition. Preferably, but not necessarily, metal washers 9^a and 9^b will intervene between the block 9 and the mica washers 11 and 12 respectively. All of the mica washers are wholly within the body member of the spark plug and, therefore, no machining or finishing operations are required after the parts have been assembled.

Electric current is transmitted to the central electrode 10 through a rubber insulated lead-in wire 15 passing into the upper end of the plug and contacting with the electrode as shown at 16. To maintain the plug watertight, a suitable grommet 17 is fitted about the lead-in wire and is compressed thereagainst by means of the overlying flange 18^a of a ferrule 18 threaded upon the upper threaded portion of the body member.

If desired additional means may be provided to prevent upward flow of heat in the spark plug,

thereby to preclude undue heating of the insulation on the lead-in wire. Fig. 5 illustrates a modified construction in which an asbestos disk 40 is inserted in the mica sleeve 8 adjacent the upper end 10^a of the electrode 10. In this construction electrical contact is made from the lead-in wire to the electrode in the following manner. Intermediate the mica washers and the asbestos disk there is inserted a metallic washer 41 having a pin 42^a projecting therefrom and engaging the lead-in wire. A relatively fine wire 42, underlying the washer 41, extends around the edge of the asbestos disk and contacts with the upper end of the electrode shank.

In Fig. 1^a there is shown a modified construction in which the lead-in wire 15 is brought into the spark plug at a right angle to the major axis of the plug. This construction differs from that shown in Fig. 1 in that it includes an elbow member 19 one end of which is provided with a flange 19^a which is clamped to the plug by a ferrule 20 threaded upon the upper end of the body member 1. The outer end of the elbow is threaded, as at 19^b, to receive a ferrule 21 between which and the elbow 19 is maintained a suitable sealing grommet 22 which precludes the entrance of moisture into the plug.

Another feature of this invention is illustrated in Fig. 2 which shows another form of radio shielded spark plug of the right angle type. The spark plug proper is similar to the plug shown in Fig. 1 and differs therefrom principally in the means for conducting the current to the central electrode and the means for insulating and radio shielding the lead-in.

This spark plug also comprises a base member 1, having the threaded end 2, sealing flange 3, hexagonal wrench portion 4, annular heat radiating fins 5, electrode 6 and central bore 7. The bore 7 also is lined with a mica sleeve 8 and mica washers 11 and 12 are arranged within the sleeve 8 below and above a heat absorbing and transmitting plug 9 of copper, or other suitable material, and the plug 9 is secured within the sleeve 8 to form a gas-tight joint, all as hereinbefore described in connection with Fig. 1.

It has been found that mica affords the most satisfactory insulation for aviation spark plugs but heretofore great difficulty has been experienced in the manufacture of right angle aviation spark plugs due the fact that relatively short bends may not be made with mica. This, heretofore, has led to large complicated and expensive constructions which were not entirely satisfactory. I have found a way by means of which a sharp right angle turn may be made with an electrical conductor and still employ the desirable mica insulation. This has been attained by so constructing the conductor that right angular portions thereof each may be enclosed by an individual mica sleeve one of which projects radially into an aperture formed in the wall of the other.

In Fig. 2 the central electrode 10 is tightly secured in the ring 9 and electrical contact is made with the upper end thereof by a rod 23 having a shoulder 23^a engaged with a spring washer 24 seated upon the upper end of the electrode. A sleeve 25 of mica surrounds the rod and extends through a bushing 26 seated upon the upper overturned end 14 of the body member 1. A metallic ferrule 27 threaded upon the upper portion of the body member has a flange 27^a overlying a flange 26^a on the bushing 26, thereby to clamp the bushing to the body member.

Threaded upon the bushing 26 is a metallic casing or shield 28, the main portion of which is arranged at right angles to the axis of the body member 1. This casing is provided with annular heat radiating fins 29, similar to the fins 5, and at its outermost end the casing is threaded as shown at 30. Within the bore 28^a of the casing 28 there is fitted an insulating sleeve 31, of mica, in one wall of which is formed an aperture 31^a to permit passage of the sleeve 25. The upper end of the rod 23 is threaded into a contact block 32 secured within the sleeve 31, as later will be described.

High tension current is transmitted to the spark plug by a rubber insulated cable 33 which projects into the casing 28 and insulating sleeve 31 and has secured upon its inner end a channeled metallic disk 34 to which the cable is electrically connected, as later will be described. A coil spring 35, interposed between the disk 34 and the contact block 32, serves as an electrical conductor and completes the circuit.

Between the sleeve 31 and the cable 33 and extending from the disk 34 to the threaded end 30 of the casing 28 there is fitted an insulating bushing 36 preferably made of a composition of mica and bakelite. Exteriorly of the spark plug the cable 33 is surrounded by a braided metallic casing 37 to which is secured a ferrule 38 provided with a flange 38^a. To effect a watertight joint, a suitable grommet 39 is interposed between the flange 38^a and the concaved end of the bushing 36. A ferrule 40 threaded upon the end 30 of the casing engages the flange 38^a of the ferrule 38 and serves to draw the parts together to form a watertight joint.

To secure the contact block 32 within the sleeve 31 the head 32^a of the block is slotted as shown at 32^x (see Fig. 3) and a screw 32^y threaded therinto serves to spread apart the portions of the head thereby causing them to engage the inner walls of the sleeve 31 and force it against the wall of the bore 28^a.

The disk 34 is secured to the cable 33 as now will be described. The disk is formed with a central hole 34^a, an annular groove 34^b and radially extending slots 34^c and 34^d (see Fig. 4). The cable 33, which is made up of a plurality of strands of wire (which are surrounded by a suitable rubber insulation) is passed through the hole 34^a in the disk 34. The strands of wire are then separated into two groups, one of which is carried upwardly through the slot 34^c and then wrapped around several times in the annular groove 34^b. The other group of wires is carried downwardly through the slot 34^d and then wrapped around several times in the groove 34^b in a direction opposite to that in which the first group was wound. This effects a very secure and positive contact without the use of solder.

It will be noted that this entire spark plug and its lead-in conductor are fully mica insulated; that they are radio shielded by reason of the fact that they are entirely covered with metal which is grounded on the engine casing, that the required relatively large anti-flash-over distances, indicated by the broken arrows *f*, have been maintained and the much desired right angle lead-in has been attained all without materially increasing the over-all height of the plug.

In the conventional spark plug, the central electrode and the mica washers are usually assembled together. This is not satisfactory in that the extreme temperatures of a central electrode causing the overheating of the mica washers re-

sult in plug failure because of the fusing of the deposits that occur on the mica washers as a result of using metallic anti-knock compounds in the fuel.

With this improved construction the mica washers at the firing end are supported by the body piece free of the central electrode and they are better cooled because of their close contact with the cylinder wall and with the body piece which dissipates heat through the fins 5.

A summary of some of the important features are:—

(1) The mica on the firing end of the plug is free of the central electrode and not subjected to its temperatures, and is cooled through the medium of fins 5.

(2) By having the terminal within the plug, and bringing the high tension wire inside of it to this terminal and sealing the said high tension wire with grommet 17 the plug is rendered entirely watertight.

(3) By connecting the radio shielded harness to the grommet of the ferrule 18 a radio shielded spark plug is attained.

(4) The building of a superior spark plug at a very low cost because it is not necessary to machine the mica washers—allows for a very rapid production and is of great commercial value therefor.

(5) The use of a large diameter mica cigarette eliminates the necessity of splitting the mica to extremely thin sections and allows for more economical and rapid production; the heavy mica sheets being superior from the standpoint of strength.

(6) The one piece body piece with its reinforcing fins results in an extremely strong and durable spark plug that is not subject to failures due to wrench slippage, accidental hitting of the spark plug with tools, or the dropping the same on concrete runways.

(7) This type of plug is completely waterproof and will not cause short circuiting or missing in seaplanes when sprayed with the water thrown up by the propeller and its slipstream.

Without further analysis, the foregoing will so fully reveal the gist of this invention that others can, by applying current knowledge, readily adapt it for various utilizations by retaining one or more of the features that, from the standpoint of the prior art, fairly constitute essential characteristics of either the generic or specific aspects of this invention and, therefore, such adaptations should be and are intended to be, comprehended within the meaning and range of equivalency of the following claims.

Having thus revealed this invention, I claim as new and desire to secure the following combinations and elements, or equivalents thereof, by Letters Patent of the United States:—

1. A radio shielded spark plug comprising a metallic body member affording one electrode and provided with an internal bore; a second electrode supported within the lower portion of said body member; a metallic casing secured to said body member and arranged transversely to the axis thereof, said body member and casing affording a substantially L-shaped device electrically connected throughout and adapted to be grounded on the engine; a first electric conductor extending lengthwise into said casing; a mica sleeve fitted within said casing and surrounding said conductor, said sleeve being provided in a wall thereof with an aperture aligned with the axis of said body member; a second electric con-

ductor projecting through said aperture and having one end connected to the first named conductor and its other end connected with said second electrode; and a mica sleeve surrounding said second conductor and projecting through the aperture in the first named mica sleeve and extending substantially from said first electric conductor to said second electrode.

2. A radio shielded spark plug comprising a metallic body member affording one electrode and provided with an internal bore; a mica insulating sleeve within said bore; a relatively heavy metallic ring fitted within said sleeve adjacent the lower portion of said body member and serving to effect a gas-tight barrier between the upper and lower ends thereof and to transmit to the body member heat absorbed from a second electrode; a second electrode tightly fitted within said ring; a series of mica washers within said sleeve intermediate said ring and the upper end of said body member; a metallic casing secured to said body member and arranged transversely to the axis thereof, said body member and casing affording a substantially L-shaped device electrically connected throughout and adapted to be grounded on the engine; a first electric conductor extending lengthwise into said casing; a mica sleeve fitted within said casing and surrounding said conductor, said sleeve being provided in a wall thereof with an aperture aligned with the axis of said body member; a second electric conductor projecting through said aperture and having one end connected to the first named conductor and its other end connected with said second electrode; and a mica sleeve surrounding said second conductor and projecting through the aperture in the first named mica sleeve and extending substantially from said first electric conductor to said second electrode.

3. In an aviation spark plug the combination of a metal enclosing body portion grounded at one end of said plug, an insulating member supported by said body portion, means for clamping said insulation to said body portion to form a gas tight joint, an electric cable within said plug having a terminal, means for connecting said terminal with said clamping means, an electrode and means for sealing said electrode in said clamping means thereby forming an additional gas tight joint, said metal body portion and insulating sleeve extending over substantially the length of the plug to prevent radio disturbances and protect against moisture.

4. In a spark plug a shielding body portion, a mica cigarette supported within said body portion, a metal support clamping said mica to said body portion and forming a sealed joint at the inner wall of said body portion; an electric cable within said insulated body; an electrode secured to said support and connected with said cable and means for sealing the electrode within said metal support to form a gas tight joint.

5. In a spark plug for an aviation motor a radio shielding body portion, an insulating sleeve wound within and supported by said body portion, permitting an unobstructed flow of heat from the motor cylinder, a cable, an electric terminal for same, a metal member clamped against said insulating sleeve and forming a gas tight joint, an electrode enclosed by said sleeve and clamped to said metal member, means for connecting said terminal with said electrode and means for forming a gas tight joint adjacent said

terminal to protect said electrode and its terminal against gases and moisture and to prevent external radio disturbances.

6. A radio shielding spark plug comprising a metallic radio shielded body member affording an enclosing member for an insulated cable, an electrode supported within the lower portion of said body member, a solid metal heat conductor inserted within said body member, a terminal of said cable connected with said metal conductor, a mica sleeve supported within said body member for enclosing the electrode terminal and a substantial portion of said cable, the metal conductor clamping said mica member against the body member and thereby forming a gas tight joint.

7. An insertable aviation spark plug comprising a heat conducting and radio shielded member having a continuous body portion, a mica cigarette clamped within and to said body portion, a depending electrode near one end of said cigarette, an insulated cable having a terminal connected with said electrode, means for forming a gas tight joint between the cigarette and said body portion and means for forming a gas tight joint near the juncture of the terminal and electrode thereby protecting said plug against moisture and gases and from causing external electrical disturbances.

8. In an aviation spark plug the combination of a shielding body portion having fins thereon, an insulating sleeve enclosed within and supported by said body portion, a metal heat conductor forming a gas tight joint between said cigarette and said body portion, an electrode suspended from said metal support, an electric cable positioned within said insulating sleeve having an exposed terminal connected with said electrode, means for forming an additional gas tight joint to protect the terminal against hot gases, the heat of said gases being dissipated through the metal to the fins of said body portion.

9. A spark plug comprising a one-piece metal body member having a central bore and having formed integrally therewith, at its opposite ends, inwardly extending annular flanges; a mica sleeve fitted within said bore intermediate said flanges; a metal block fitted within said sleeve intermediate its ends and having a radial compression fit with said sleeve to effect a gas tight joint between said block and said sleeve and between said sleeve and said body member; a first series of mica washers interposed between said block and the flange, at the upper end of said body member; a second series of mica washers interposed between said block and the other flange of said body member; and an electrode projecting through and supported solely by said block and having shoulders above and below said block forming a gas tight joint between said block and said electrode.

10. A spark plug comprising a metal body member having a central bore; a mica sleeve fitted within said bore and substantially coextensive therewith; a block of metal, of relatively high heat conductivity, fitted within said sleeve intermediate its ends, said block having a radial compression fit with said sleeve and effecting a gas tight joint between said block and sleeve and between said sleeve and body member; and an electrode of relatively low heat conductivity supported by and having a gas tight joint in said block, said block serving to absorb heat from said electrode and to transmit it through said mica sleeve to

said body member for dissipation in the atmosphere.

11. In a spark plug of the kind specified, the combination of an electric conductor having at one end an electric terminal, a metal body portion enclosing said conductor, means including a first insulating sleeve 25 surrounding said conductor and terminating adjacent said terminal, a second insulating sleeve 8 supported within and by said body portion and surrounding said terminal for preventing electric flash over from the conductor to said body portion, a metal insert expanded within said second insulating sleeve and forming a gas tight joint between said body

portion and said metal insert, an electrode secured to and depending from said metal insert and electrically connected with the terminal of said conductor; and means for forming a gas tight joint between said electrode and said metal insert thereby protecting said electrode and terminal from moisture and gases, said metal insert and said electric terminal being located intermediate the ends of said second insulating sleeve thereby limiting to two the possible flash-over paths between said electric terminal, metal insert, and said body portion.

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