Aug. 8, 1944. R. L. SHUMAKER 2,355,116

SPARK PLUG SHIELD

Filed July 7, 1931

FIG 1

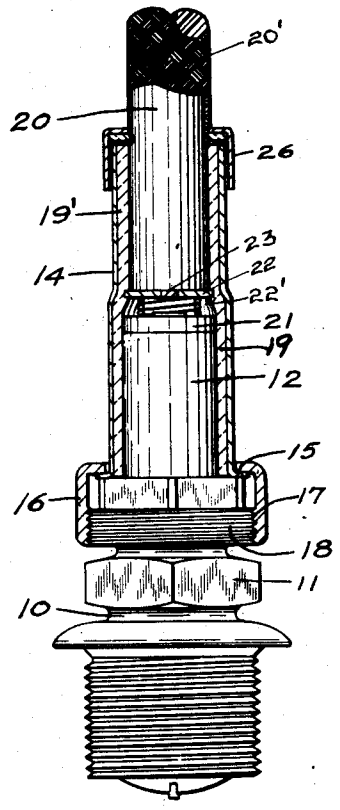


FIG 2

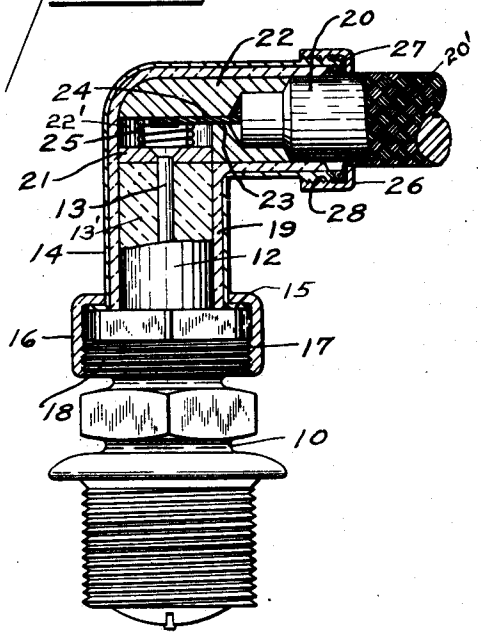
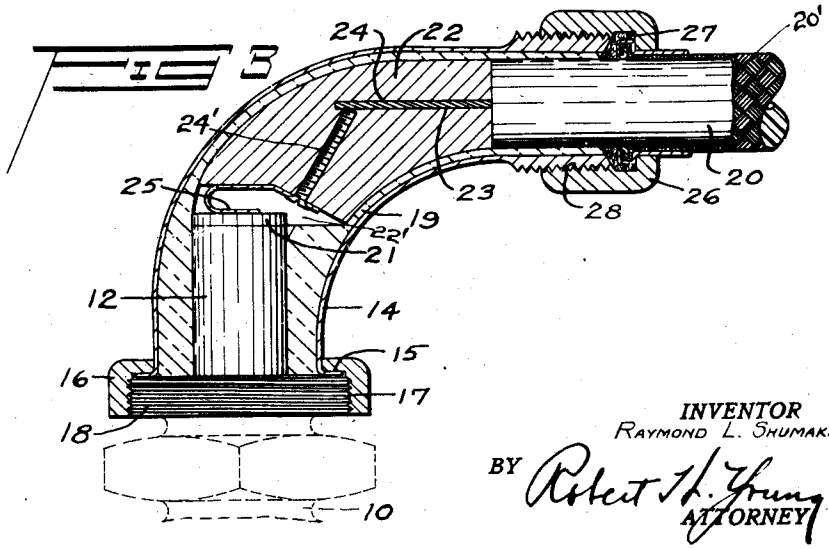


FIG 3



INVENTOR
RAYMOND L. SHUMAKER.

BY Robert H. Young
ATTORNEY

Patented Aug. 8, 1944 2,355,116

UNITED STATES PATENT OFFICE

2,355,116

SPARK PLUG SHIELD

Raymond L. Shumaker, Xenia, Ohio

Application July 7, 1931, Serial No. 549,203

11 Claims. (Cl. 123—169)

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

The invention described herein may be manufactured and used by or for the Government for governmental purposes, without the payment to me of any royalty thereon.

The present invention relates generally to electrical apparatus and more particularly to apparatus adapted for use in connection with electric currents which are intermittent in character and/or in which the intensity of the current changes rapidly.

It is found that when the current changes rapidly in character or is intermittent, for example, in an ignition system for an internal combustion engine that, as a result of the electrical field set up by the high tension circuit and the spark discharge of the spark plugs and/or magneto, electrostatic or electromagnetic waves are propagated in the atmosphere surrounding the system to such an extent as to create considerable interference with proper reception in radio communication in apparatus that is in the vicinity of the ignition system. The high tension ignition systems essential in engines, particularly aircraft engines, produce such violent electrical disturbances that radio reception and transmission have been found to be practically impossible. As a result therefore of these disturbances proper shielding of the ignition leads, the magneto and spark plugs of the system are imperative for the successful functioning of the radio equipment.

The use of shielding for the ignition cables, properly grounded, and for the magnetos of the ignition system are known to be old in the art and form no part of the present invention. To be effective the shield must, however, be continuous throughout the entire extent of the system including means for shielding the spark plugs in order that the disturbances produced by the spark discharge of the plugs may be confined so that they produce no interference with the radio equipment.

The main object therefore of the present invention is to provide means for enclosing the terminal portion of a spark plug to not only effect an electric bond between the shielding of a shielded cable and the ground portion of a spark plug, but also to completely insulate the terminal portion of the spark plug and cable, confine the disturbances produced by the spark discharge of the plug and thereby form a continuous shield the purpose of which is to prevent the emanation of any electromagnetic waves into the atmosphere surrounding the plug as well as the remainder of the ignition system.

The invention is further characterized by providing shielding means adapted for ready attachment to or detachment from a spark plug which is so constructed and arranged that accumulation or deposits of any substance or material upon the insulated portion of the plug which may be a conductor of electric currents is substantially prevented.

A further object of the present invention is to provide shielding means of this character comprising a metallic sleeve which is held in good electric contact with the ground portion of the spark plug and being provided with an insulator on its inner surface, essentially a heat resisting sleeve of insulating material of high dielectric strength having intimate contact with the inner wall of the metallic sleeve to provide for maximum heat conductivity from the heated end of the plug.

A further object of the present invention is to so arrange the insulating material that the space between the inner wall of the metallic sleeve and the surface of the terminal portion of the plug is substantially completely filled. The use of an insulating sleeve constructed in the manner of the present invention provides for an insulator whose dielectric strength is not affected by moisture, oils or changes in atmospheric pressure, and if damaged in any way can be readily replaced independently of the spark plug.

The provision of insulating material in the inner wall of the metallic sleeve makes the same practically airtight by reason of the minimum of air space occurring between the inner wall of the shield and the spark plug; therefore accumulation of moisture upon the insulated surface of the plug is substantially prevented.

A further object of the present invention is to provide in a metallic sleeve of this character suitable coupling means comprising an insert of a material having high electrical conductivity for effecting a good electric contact between the conductor wire of the cable and the terminal end of the spark plug, particularly designed to effectively dissipate the heat from the terminal end of the spark plug to the external shielding in order to keep the temperature of the conductor wire adjacent the terminal of the spark plug at the minimum and prevent drying out and cracking of the insulation covering the wire. The insert is so constructed that diffusion of electrostatic stress over as great an area as possible may be effected, thus decreasing the charge density at any one point to a minimum. The charge per unit area is maintained as small as possible and any tendency to breakdown of the air gap and

consequent flash over to ground is substantially prevented.

A still further object of the present invention is to provide a novel arrangement of parts so assembled as to retain the elements in their operative relation to one another yet permitting their disassociation for the purpose of cleaning the spark plug, renewing worn or broken parts and the like.

With the above and other objects in view, which will appear as the description proceeds, the invention resides in the combination and arrangement of parts and details of construction hereinafter described and claimed, it being understood that within the scope of what is claimed changes in the precise embodiment of the invention shown may be made without departing from the spirit of the invention.

In the drawing:

Fig. 1 illustrates a spark plug showing in longitudinal cross-section a shield embodying my invention;

Fig. 2 illustrates in a modified form a cross-sectional view of the shield per se;

Fig. 3 illustrates a further modified form of the shielding.

Referring more particularly to the drawing wherein corresponding parts are designated by like numerals throughout the several views thereof, 10 indicates a spark plug of any well-known make, which comprises generally the body portion 11 having a threaded portion at its lower end adapted for attachment to the cylinders (not shown) of an internal combustion engine, and a core 12 that comprises a stem or center electrode 13 and insulation material 13' surrounding said electrode. The outlet of said electrode is provided with a metal disk or terminal 21 for making electrical connection with the ignition or cable of the ignition system of the engine.

The ignition cable 20 is provided with a metallic shield 20' that is electrically grounded to the engine (not shown) by means of a spark plug shield or head that is electrically connected at one end to the metallic shield 20' and at its other end to the body portion 11 of the spark plug.

The spark plug shield or head comprises an outer metallic casing or covering, an inner shell of insulation material in intimate contact with the outer shield and a partition formed within the inner shell and suitably constructed to isolate the cable insulation from the spark plug terminal but through which electrical connection is made between the spark plug terminal and the cable terminal.

In the illustrations of the present invention the shield or head comprises a thin metallic sleeve 14 that completely surrounds the end portion of the cable and the terminal end of the spark plug core, but which is electrically insulated from their terminal connections. This sleeve serves to electrically ground the cable shielding to the spark plug and for this purpose is formed at its lower end with a flange 15 to provide a shoulder against which a knurled lock nut 16 is adapted to bear, the latter being suitably provided with internal threads 17 adapted to engage with the threaded portion 18 of the spark plug. This arrangement permits the metallic sleeve to be held in good electric contact with the grounded portion of the spark plug.

Provision is made for insulating the electrical connection between the cable 20 and the spark plug. This is accomplished by providing a suitable dielectric between the sleeve and the electrical connection between the cable and spark plug and is illustrated as an inner shell or lining 19 that is disposed within and extending substantially throughout the entire length of the inner wall of the sleeve 14. This lining 19 is made of insulating material of non-carbonizing material having a high dielectric strength, preferably mica, the latter having intimate contact with the inner walls of the sleeve to provide for maximum heat conductivity to the said sleeve. The insulating material is of sufficient thickness to practically fill the space between the metallic sleeve and the outer surface of the terminal portion of the spark plug to thereby maintain the same substantially in direct contact with the said surface.

This construction permits of a shield which is practically airtight and by reason of the very small amount of air space which may occur between the terminal of the plug and shield, accumulation of moisture upon the insulating surface tending to foul the plug is substantially prevented. The material forming the outer sleeve is of sufficient thickness to permit of a rigid construction and imparts sufficient strength to the structure to enable the sleeve to withstand considerable rough treatment without disturbing the proper functioning of the spark plug. It also acts as a protection for the insulated end of the spark plug. Its overall dimension as to width is such that it requires no additional space in mounting the spark plug on the engine.

Provision is made for suitably protecting the cable insulation so as to prevent its deterioration by the heat within the shielded spark plug. Accordingly an enclosure for the end portion of the cable insulation that is disposed within the shielded spark plug is provided to isolate the cable insulation from the spark plug center electrode. As illustrated in the several views of the drawing this enclosure is formed by providing a partition within the shielded spark plug. Various means of enclosing the end portion of the cable insulation will be obvious to those skilled in the art without departing from the spirit of the invention. As illustrated in the several views of the drawing, the partition is formed by providing an insert 22 that has intimate surface contact with the wall of the inner shell 19. This insert is preferably made of steel and is provided with a central opening to receive a closely fitting conductor part through which it is connected to the cable terminal. As shown in Fig. 1, the insert is connected to the cable by the terminal ends 23 of the cable conductor. As shown in Fig. 3, the terminal 24 of the cable and a threaded element 24' constitute the conductor part, the element 24' serving to connect the resilient contact member 25 and the cable terminal 23 to the insert. As shown in Fig. 2, the end of the conductor wire is secured to the inner end of the coiled spring 25, which make direct contact with the spark plug terminal 21, and by its spring action permits drawing down of the sleeve to make good electrical contact and a tight joint at its junction with the grounded portion of the spark plug.

The insert is so designed as to have as large an area as possible, the sides of which are in intimate contact with the inner surface of the insulating material. In this manner the cable insulation is baffled from direct contact with the heat emanating from the center electrode and the heat is dissipated at a sufficiently rapid rate so that at the point of surface contact between the cable insulation and the insert the degree of

heat will be such that it will have a negligible deteriorating effect upon the cable insulation.

Additional separation between the cable insulation and the spark plug terminal to prevent heat deterioration of said cable insulation may be obtained by providing a dead air chamber 22' formed by the inwardly presenting walls of the core 12, the inner shell 19 and the insert 22. The surface area of the insert is sufficient to maintain the static charge density at any one point at a minimum by permitting the charge to spread out over the area of the insert. Flash over to ground under high static stress conditions is thus effectively eliminated.

As shown in the drawing, the shielding of the cable is maintained in electrical contact with the metal sleeve enclosing the spark plug by means of a collar 26, which after the shielding of the cable is placed around the end of the sleeve is pressed into position as shown in Fig. 1.

Figs. 2 and 3 show modified forms of connecting the shielding of the cable to the metal shield. As will be noted, the method of connecting the shielding of the cable to the shield enclosing the spark plug eliminates the use of soldering. As shown in Figs. 2 and 3 the sleeve 14 is maintained watertight by means of packing 27 which is interposed between the end of the sleeve 14 and the inner side 28 of the collar 26.

I claim:

1. Means for effecting an electric bond between the shielding of a shielded cable and the grounded portion of a spark plug and for completely insulating the terminal ends of said cable and spark plug against the emanation of electrostatic or electromagnetic waves, comprising a hollow member spaced from and completely surrounding the insulated terminal end portion of said spark plug, insulating material filling the space between the hollow member and the terminal end portion of the spark plug and extending beyond said end portion to snugly fit the cable, contact means in the extended part of the insulating material and connected with the terminal end of the cable and engaged with the terminal end of the spark plug, and a metal insert confined between the contact member and the terminal end of the cable and in intimate contact with the insulating material, coupling means disposed at its opposite ends adapted for ready attachment to or detachment from the body portion of said spark plug and the shielding of said cable respectively.

2. As an article of manufacture a device adapted for connecting a shielded cable to the spark plug of an internal combustion engine to provide a continuous shield against the emanation of electrostatic or electromagnetic waves into the surrounding atmosphere, comprising a hollow tubular metallic member, insulating means of non-carbonizing material disposed within and extending substantially throughout the entire length of the inner wall of said tubular member, said member and insulating means being adapted at one end to completely enclose the terminal end portion of said spark plug and at the other end the terminal of said shielded cable, a metal insert within and snugly fitting the insulating means of the member at the cable inclosing end thereof and apertured to receive a conductor part of the cable, and a contact member within the member at the spark plug inclosing end thereof and engageable with the terminal end of the spark plug, said contact member being adapted to be connected with the said conductor part of the cable.

3. The combination with a spark plug having a shielded cable connected thereto and shielding means interconnecting the shielding of said cable and the grounded body portion of said spark plug, of metallic means mounted in said shielding means and insulated therefrom adapted for electrically interconnecting the terminal ends of said spark plug and cable and for effecting a rapid dissipation of heat from the terminal ends of said spark plug and cable.

4. The combination with a spark plug having a shielded cable connected thereto and shielding means interconnecting the shielding of said cable and the grounded body portion of said spark plug, of metallic means mounted in said shielding means and insulated therefrom for electrically interconnecting the terminal ends of said spark plug and cable, said means having intimate contact with the insulating lining of said metallic sleeve, to provide ready means of diffusing electrostatic stress occurring at the terminal end of said plug.

5. The combination with a spark plug having a shielded cable connected thereto and shielding means interconnecting the shielding of said cable and the grounded body portion of said spark plug, said shielding means having an inner lining of insulating material and a metallic insert having intimate contact with the insulating lining of said metallic sleeve, said insert being disposed intermediate of and having electrical connection with the terminal ends of said plug and cable to permit diffusion of electrostatic stresses occurring at the terminal end of said plug to thereby prevent discharge to a ground.

6. In combination, a spark plug comprising a metallic cap and a vertical stem having an outlet, a conductor having a connection with said stem at the outlet, a dielectric member mounted on said cap and enclosing said outlet and providing for the free movement of said connection therein and a thin metallic coating on said conductor and a thin metallic coating enclosing said member, said coatings being electrically connected with said metallic cap.

7. In a shielded spark plug, the combination of an insulated spindle, a member in which said spindle is fixed, a metal sleeve electrically connected to said member and extending upwardly therefrom and above said spindle to provide a socket and a part of the shielding of the plug, an insulated high-tension conductor insertable into said socket to make electrical connection with said spindle, a metallic sheath about said conductor outside the spark plug, a metal connector through which the insulated conductor is passed and to which said sheath is connected, said connector having detachable engagement with said sleeve, an insulating sleeve within the metal sleeve and extending about the portion of the insulated conductor within the socket, and a metal tip piece between and in electrical connection with the terminal ends of the spindle and the conductor and having intimate contact with the insulating sleeve.

8. In a spark plug having a member provided with a sleeve extending upwardly therefrom and electrically connected thereto, said sleeve forming a socket for the insertion of an insulated high-tension conductor, a connection through which the conductor is passed and which has detachable engagement with said sleeve, an insulating sleeve within the socket-forming sleeve and coextensive therewith for surrounding the portion of the insulated conductor within the socket and a tip piece of material having high heat conduc-

tivity within and having intimate contact with the insulating sleeve, said tip piece being engageable with the conductor for establishing electrical connection therebetween.

9. In a spark plug having a member provided with a tubular extension, the outer portion of which constitutes a socket for the insertion of an insulated high-tension conductor, a conductor having an end inserted in the said socket, a connection through which the conductor is passed and which has detachable engagement with said member, a spacer tube of insulating material within the socket and surrounding the portion of the insulated conductor within the socket, a tip piece at the end of the conductor and apertured to receive the conductor, said tip piece being of material having a high heat conductivity and in intimate contact with the said tube, and a contact member in expansion between the said tip piece and the terminal end of the spark plug and serving to maintain the tip piece in contact with the tube.

10. In a spark plug having a member provided with a tubular extension, the outer portion of which constitutes a socket for the insertion of an insulated high-tension conductor, an insulated conductor inserted in the said socket, a connection through which the conductor is passed and which has detachable engagement with said member, a spacer tube of insulating material within and coextensive with the socket for surrounding the portion of the insulated conductor within the socket, a tip piece of material having a high heat conductivity within and intimately contacting the spacer tube between terminal ends of the spark plug and conductor, said conductor having a terminal wire penetrating the tip piece, and a contact spring between the tip piece and the terminal end of the spark plug and connected with the said terminal wire of the conductor.

11. In a shielded spark plug assembly, a spark plug having a shell and an upwardly extending insulator through which an electrode extends, a metal sleeve connected with the shell and extending beyond the insulator, an insulated and shielded conductor having a terminal end inserted in the extension of the metal sleeve, an insulating sleeve within the metal sleeve and between the latter and the spark plug insulator and the conductor, said insulating sleeve having a variable diameter bore larger at the bottom to snugly fit the spark plug insulator and smaller at the top to snugly fit the conductor, detachable means connecting the metal sleeve and the shielding of the conductor, and terminal contact means within the insulating sleeve fixed to the terminal end of the conductor for electrically connecting the conductor with the spark plug electrode, said contact means including a disk within the larger diameter of the bore of the insulating sleeve and of greater diameter than the conductor.

RAYMOND L. SHUMAKER.