Dec. 19, 1944. J. J. ROSE 2,365,219

FLASH-OVER PREVENTION MEANS FOR HIGH-TENSION IGNITION APPARATUS

Filed Sept. 16, 1942

FIG 1

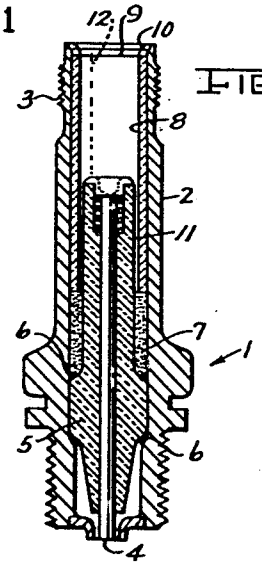


FIG 2

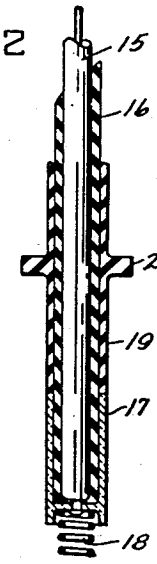


FIG 3

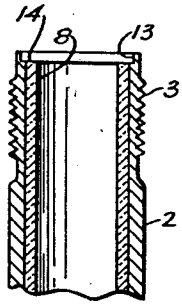


FIG 7

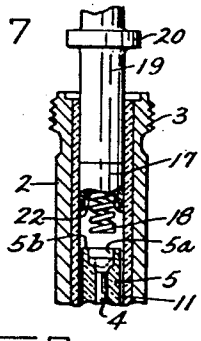
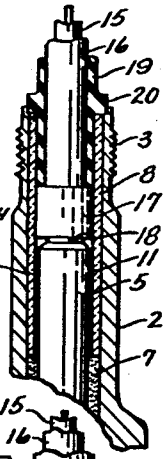


FIG 4



SPACE 11 FILLED WITH CORONA PROOFING COMPOUND

FIG 5

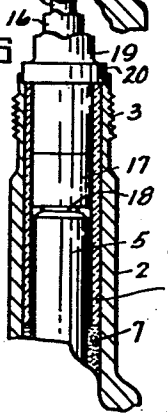
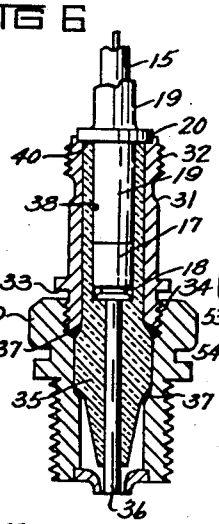
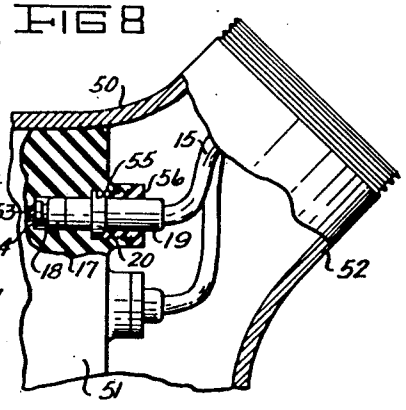


FIG 6



SPACE FILLED WITH THERMO-SETTING SYNTHETIC RESIN OR FUSED VITREOUS ENAMEL

FIG 8



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UNITED STATES PATENT OFFICE

2,365,219

FLASHOVER PREVENTION MEANS FOR HIGH-TENSION IGNITION APPARATUS

John J. Rose, Dayton, Ohio

Application September 16, 1942, Serial No. 458,583

9 Claims. (Cl. 315—85)

(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.

This invention relates to an improved electrical insulation of shielded spark plugs and the terminals therefor, or the connection of the ignition cable to the magneto distributor block, so that the liability of flash-over to ground, when such apparatus is employed on aircraft engines at high altitude, is substantially eliminated. It is well known in the art that at high altitudes flash-over of the high-tension ignition current most frequently occurs in the shielding well of the spark plug or in the corresponding well at the connection of the ignition cable to the magneto distributor block and is due to the fact that reduced atmospheric pressure at these points allows the spark to jump over a considerable distance to the plug shell or to the grounded shielding elements which causes a cutting out of the ignition within the engine cylinder.

Various remedies have been suggested for correcting this condition, one remedy being to increase the length of the path from the high-tension contacts within the magneto distributor block or within the shielding well of the spark plug to such an extent that the spark can not jump to grounded metal elements within the vicinity of said contact. However, increasing the length of the path to ground requires making the overall length of the shielding well of a spark plug as much as six or seven inches, and obviously this remedy is not feasible because of installation difficulties of such plugs. A second remedy is to supercharge the distributor, ignition harness and the spark plug shielding wells by connecting the same to the output side of the engine supercharger or special charging pump, which solution, however, requires special sealing provisions in the harness and plugs to prevent excessive air leakage, and further except for the distributor requires special attention from the servicing standpoint.

In according with the present invention a very simple means is employed to prevent flash-over from the high-tession terminals by providing insulating barriers to electrical leakage at each end of the terminal shielding well to adjacent grounded metallic parts. This electrical sealing of the high-tension contact requires only a simple modification of the present type of plug, or distributor block connection, when used in conjunction with an improved terminal construction described and claimed in my United States Patent No. 2,280,855.

It is, therefore, the object of this invention to improve the electrical insulation of the shielding well of aviation spark plugs and the connection of the ignition cable to the distributor block of the magneto to prevent flash-over of the high-tension ignition current ground which such apparatus is employed on high-altitude aircraft.

It is a further object of the invention to completely surround the terminals of a high-tension ignition cable by an insulating barrier which will effectively prevent the flash-over of high-tension ignition current from the terminals to adjacent grounded metal objects.

Other objects of the invention will appear by reference to the detailed description in the specification hereinafter given, and to the appended drawing in which:

Figure 1 is a sectional view illustrating the construction of a conventional shielded spark plug now widely employed for aviation engine ignition purposes;

Figure 2 is a view partly in section illustrating to an enlarged scale the construction of a cable terminal employed as a feature of the invention;

Figure 3 is a fragmentary enlarged sectional view illustrating a modification of the construction of the plug illustrated in Figure 1 in order to carry out the invention;

Figure 4 is a fragmentary view, partly in section, illustrating the manner in which the spark plug shielding well is insulated against electrical flash-over to ground;

Figure 5 is a view similar to Figure 4 illustrating a modified form of insulating the bottom of the shielding well of the spark plug against flash-over;

Figure 6 illustrates a modified spark plug construction in which the insulating lining of the shielding well of the spark plug is made as a unitary part of the central electrode of the spark plug to prevent flash-over from the ground through the lower end of the shielding well;

Figure 7 is an illustration of a sealing means for enclosing the contacts of the cable terminal and spark plug electrode to prevent flash-over;

Figure 8 is a fragmentary view, partly in section, illustrating the application of the invention in preventing electrical flash-over at the connection of the spark plug ignition cable to the distributor block of the magneto.

Referring now to Figure 1 there is illustrated

in this figure a conventional shielded spark plug now widely employed for aviation engine ignition, this plug being illustrated for a better understanding of the invention. The spark plug has a metallic body 1 adapted to be screwed into the engine cylinder and is provided with an integral tubular metal shielding extension 2 threaded at its upper end as at 3 for coupling to the ignition cable shielding harness, not shown. The central electrode 4 and insulator 5 are seated within the plug body on copper sealing gaskets 6 maintained in sealing relation by highly compressed powdered ceramic material 7. The interior of the tubular extension 2 forms a shielding well, which is lined with an insulating ceramic sleeve 8, which rests at its lower end on the insulating material 7 and at its upper end is clamped in place by a sealing ring 9 retained by a spun-over flange 10 formed on the upper part of the shielding extension 2. At high altitudes the pressure within the shielding well is greatly reduced so that the high voltage ignition current passing from the ignition cable conductor to the contact on the upper end of the central electrode 4 will jump to ground by way of the path of least resistance, which generally occurs within the shielding well, such as though the clearance space 11 between the annular ceramic shielding sleeve 8 and the upper end of the insulator 5 and then through the porous insulating material 7 directly to the grounded shell of the plug. A second path for flash-over is upward from the contact on the central electrode 4 along the inner surface of the insulating sleeve 8, the spark then jumping on to the grounded flange or lip 10 of the tubular shielding extension 2. In either of the above cases of flash-over, the plug will fail to fire at the spark gap within the engine cylinder. The plug as so far described is entirely conventional and the construction per se is not a part of my invention. By a very simple means, however, this plug can be so modified as to prevent flash-over in the shielding well, as will be hereinafter described. The flash-over prevention means includes a novel terminal construction described and claimed in my United States Patent No. 2,280,855, which will now be described as illustrated in Figure 2.

Referring to Figure 2 the terminal for the spark plug ignition cable 15, which may be, for example, of five millimeter diameter, comprises a tubular rubber protecting sleeve 16, which tightly encompasses the cable and extends upward a distance sufficient to pass through the shielding harness elbow, not shown, and the cable and sleeve being inserted into a ceramic thimble 17 which carries a contact spring at its lower end, which is adapted to engage the contact on a central electrode of the spark plug and the contact spring 18 being suitably connected to the conductor cable 15. A second rubber sleeve 19 surrounds the cable and the sleeve abuts the upper end of the thimble 17 and extends upward for a distance sufficient to pass through the elbow or other type of shielding harness connection. The sleeve 16 has integrally formed therewith intermediate its ends an annular sealing washer 20 which normally seats on the flanged lip 10 of the shield extension 2 of the plug of Figure 1 to seal the junction between the shielding well and the ignition harness, but which, however, does not prevent flash-over from the contact on the central electrode upward to the aforementioned lip 10. In the event that standard seven millimeter ignition cable is employed the inner sleeve 16 is eliminated but the terminal construction otherwise remains the same.

In accordance with the present invention, as illustrated in Figure 3, the plug of Figure 1 is modified by removing the flange 10 so that the sealing washer forms a counterbore 13, which provides a gasket seat 14 directly on the upper end of the ceramic lining 8 of the tubular shielding extension 2 of the plug of Figure 1 so that the sealing washer 20 (Figure 2) can tightly seat directly on the upper end of the ceramic insulating sleeve 8 and thus insulate the upper end of the spark plug shielding well against the flash-over of high-tension current to the grounded shell 2. It is to be understood that in this construction the sealing washer may trap air at atmospheric pressure within the shielding well and that the invention is not concerned with maintaining atmospheric pressure within the well, but rather to employ the sealing washer and the sleeve formed integrally therewith to electrically seal the upper end of the shielding well from flash-over, and the term "sealing," as referred to the function of the washer 20 (Figure 2), refers primarily to the forming of an insulating barrier to the passage of electric current through the joint between the washer and the gasket seat 14 formed on the upper end of the ceramic sleeve 8.

The assembly of the terminal construction of Figure 2 with the modified form of plug as illustrated in Figure 3 is illustrated in Figure 4, wherein it will be seen that the sealing washer 20 and sleeve 19 effectively prevent any passage of electric current upward from spring contact 18 of the cable terminal and contact on the upper end of the central electrode 4 from reaching the grounded metal shell 2 through the upper end of the shielding well. However, the insulation of the upper end of the shielding well alone is not sufficient to prevent flashover within the well to ground unless the lower end of the shielding well is suitably insulated because otherwise high voltage current may pass downward through the clearance space 11 and through the porous powdered insulating material 7 directly to the grounded body 1 of the spark plug. In order to insulate the lower end of the shielding well against flashover one of the commercial corona proofing materials is used, which is a wax-like composition and well known in the art, the material being applied to the bottom of the shielding well while the plug is heated so that the insulating compound melts and flows downward, impregnating the porous insulating material 7 and completely filling the clearance space 11. In laboratory tests this method of insulating the lower portion of the shielding well has been proven to be effective at pressures equivalent to altitudes in excess of 50,000 feet.

Obviously the insulating of the lower portion of the shielding well against flash-over may also be accomplished by using a Bakelite varnish, or similar uncured thermo-setting synthetic resin, in place of the above-mentioned corona proofing composition, the varnish or uncured resin being forced into place under high-pressure and then cured by heat applied simultaneously with the application of pressure. This mode of insulating would form an actual bond between the central electrode insulator 5 of the spark plug (Figure 4) and the ceramic lining 8 of the shielding well and further would impregnate the powdered ceramic insulation 7 to effectively prevent flash-

over through the bottom of the shielding well. In place of the synthetic resin as noted above the clearance space 11 may also be filled with a vitreous enamel which can be fused at a low enough temperature to avoid damage of the plug, and such an enamel filler will effectively bond the insulator of the central electrode insulator to the lining of the shielding well of the spark plug, and also prevent flash-over to the lower portion of the shielding well. Both the aforementioned methods are illustrated by the note in Figure 5.

A further modified form of plug construction is illustrated in Figure 6 in which the spark plug body 30, similar to that of the plug of Figure 1, is provided with an annular metal shield 31 threaded as at 32 to receive the coupling member of the ignition harness. The shield 31 is provided with a threaded extension 33 adapted to be screwed into a threaded aperture 34 in the upper portion of the plug body 30. A conventional electrode insulator 35 supporting the central electrode 36 is positioned in the plug body to seat upon gaskets 37 which gaskets are compressed into tight sealing relation by the threaded extension 33 of the shielding well. Central electrode insulator 35 is provided with an annular portion 38 which is formed integral therewith and which serves as a lining for the shielding extension 31 of the spark plug, and since this lining is made in one piece with the insulator, all leakage or flash-over through the lower portion of the shielding well is prevented. At its upper end the insulating lining 38 is provided with a gasket seat 40, which is adapted to receive the gasket 20 of a terminal construction of the same character as illustrated in Figure 2, and which effectively prevents the flash-over through the upper en of the shielding well. As will be noted in Figure 6, this type of construction permits the overall length of the plug to be appreciably reduced which, of course, requires that the terminal thimble 17 be shortened. This modification serves the same function of effectively preventing flashover in the shielding well in the same manner as in modifications heretofore described.

A further manner of preventing flash-over in the shielding well of the spark plug, such as illustrated in Figure 1, is schematically shown in Figure 7, and while this construction is capable of being employed without any additional insulating precautions other than as provided in the plug of Figure 1, it is preferred that the improved construction be employed with the modifications illustrated in Figures 4, 5, and 6, and it consists of forming the upper end of the central electrode insulator 5—of the same character as in the plug of Figure 1—with a depression 5a into which the contact of the central electrode 4 is seated, the upper end of the insulator 5 being ground to form a flat annular gasket seat 5b. The thimble 17 of the terminal construction illustrated in Figure 2 is slightly modified by making the contact spring 18 of smaller diameter so as to fit into the depression 5a of the insulator 5 to engage the contact of the central electrode, and this spring is surrounded by an annuular cup-shaped seal 22 made of rubber or similar resilient insulating material which is bonded to the bottom of the ceramic thimble 17 and adapted to be brought into engagement with the annular gasket seat 5b to prevent the leakage of high voltage current from the contacts enclosed thereby. In carrying out this procedure the overall length of the terminal assembly below the annular sealing washer 20 must be such that when the washer 20 is firmly seated in the upper end of the shielding well of the spark plug there will be sufficient compressive force exerted on the sealing member 22 to compress the spring 18 and bring the sealing member into firm engagement with the gasket seat 5b.

In addition to the use with spark plugs, the general principle of the invention is also applicable to prevent flash-over at the terminal connection of the spark plug ignition cable to the magneto distributor block and this application is illustrated in Figure 8. As seen in this figure the reference numeral 50 indicates the metallic housing surrounding the distributor block 51 of a magneto (not shown), the housing 51 being provided with a conventional extension 52 through which the ignition cables pass into the respective cable harness conduits. The distributor block 51 is provided with the usual high-tension contacts 53, each of which is respectively located in a well such as 54, formed in the distributor block, the well being open at its outer end to permit the insertion of a terminal construction substantially identical with that as illustrated in Figure 2 and indicated by the same reference numerals as in the latter noted figure. Each well 54 is provided with a counterbored portion 55 which at its lower end serves as a gasket seat for the annular gasket 20 of the terminal and threaded at its outer end to receive an insulating gland nut 56, which holds the sealing washer and terminal construction in place when the contact 18 is brought into engagement with a contact 53, and the gland nut 56 is brought into engagement with the sealing washer which serves as an effective barrier against flash-over from within the well 54 to the grounded shielding elements of the distributor block. It is also noted that the type of gland screws or other clamping means to retain the terminal in electrically sealing engagement in the terminal well will depend upon the construction of the magneto distributor head and shielding housing.

Although preferred forms of the invention have been illustrated and described it will become apparent to those skilled in the art that other modifications and alterations may be made therein falling within the scope of the invention defined by the appended claims.

I claim:

1. A flash-over proof shielded spark plug and terminal construction in which the spark plug is of the character having a central electrode extending into a tubular shielding extension of the plug, the tubular shielding extension being lined with an insulating material to form a terminal shielding well; the improvement which comprises means for electrically insulating the bottom of the shielding well from electrical flash-over from the central electrode to the grounded spark plug shell, a gasket seat provided on the upper end of the insulated lining of the shielding well, a sleeve of rubber or like resilient insulating material tightly surrounding the ignition cable and extending into the shielding well and having a length sufficient to extend beyond the spark plug shield into the shielding harness, and a sealing washer integrally formed with said sleeve intermediate its ends and adapted to be brought into tight sealing engagement with the said gasket seat provided on the insulating lining of the shielding well, whereby electrical flash-over from the central electrode of the spark plug to the grounded tubular shielding extension of the plug is prevented.

2. The structure as claimed in claim 1, in which the spark plug central electrode has an insulator therefor extending within the shielding well and in which the means for electrically insulating the lower end of the shielding well includes a corona proofing material filling the space between the lower end of the insulating lining of the shielding well and the central electrode insulator.

3. The structure as claimed in claim 1, in which the spark plug central electrode has an insulator therefor extending into the lower end of the shielding well and in which the means for electrically insulating the lower end of the shielding well comprises a bond between the insulating lining of the shielding well adjacent its lower end and the insulator of the said central electrode.

4. The structure as claimed in claim 1, including an insulator for the spark plug central electrode and in which the insulating lining of the shielding well forms an integral part of said central electrode insulator.

5. A shielding construction for spark plugs comprising a tubular metal shielding extension on the spark plug, an insulating lining in said extension, a central spark plug electrode and insulator therefor extending within said shielding well, means for electrically insulating the lower end of said shielding well against flash-over of current from the central electrode to the grounded metal portions of the plug, a gasket seat provided on the upper end of the insulating lining of the shielding well, an insulating sleeve of resilient material adapted to tightly encompass the ignition cable and extending within the shielding well of the plug, and an annular insulating gasket integrally formed with said sleeve and adapted to be brought into tight engagement with the gasket seat on the said insulating lining of the shielding well.

6. In a shielded spark plug construction of the character in which a tubular metal shield extension of the spark plug is provided with an insulating lining forming a shielding well for the cable terminal, and the shielding well being insulated at its lower end against electrical leakage to ground from the central electrode of the spark plug; the improvement which comprises a gasket seat on the upper end of the said insulating lining, a gasket of resilient insulating material sealingly engaging the seat on said insulating lining and a sleeve formed integral with said washer to tightly encompass the ignition cable extending within said shielding well, whereby flash-over from the central electrode of the spark plug through the upper end of the shielding well to the grounded shield extension is prevented.

7. In a shielded spark plug and terminal construction in which the upper end of the spark plug central electrode and insulator therefor are surrounded by a grounded metal shield which serves as a receptacle for a cable terminal, the said terminal including a thimble of insulating material having a spring contact thereon adapted to electrically connect the ignition cable to a contact formed on the upper end of the central electrode; the improvement which comprises an annular gasket seat on the upper end of the central electrode insulator such that the seat extends above the contact on the upper end of the central electrode, and an annular resilient seal bonded to the bottom of the terminal thimble concentric with the spring contact thereon, whereby when said seal is brought into engagement with the gasket seat on said central electrode insulator flash-over from the central electrode and cable terminal contacts to grounded portions of the plug is prevented.

8. In a shielded spark plug construction of the character wherein the central electrode contact of the plug and the ignition cable terminal are housed in a grounded metallic radio shield open at one end for insertion of the cable terminal and the said shield being lined with an insulating material to form a shielding well; the improvement which comprises an insulating barrier at the lower end of the shielding well to prevent flash-over therethrough from the central electrode contact to grounded metal portions of the plug, and a removable annular insulating seal adapted to engage the insulating lining of the shielding well adjacent the open end thereof to prevent flash-over from the central electrode contact to said grounded metal shield, said annular seal having integrally formed therewith a resilient sleeve adapted to tightly encompass the ignition cable interiorly and exteriorly of the shielding well.

9. In high-tension ignition apparatus of the character described having a shielding well with the walls thereof formed of an insulating material and open at one end for insertion of an ignition cable and terminal, a contact enclosed within the cable well and adapted to be engaged by a contact on the cable terminal and the material of the walls of said well forming an insulating barrier against electrical leakage from said contact downward through said well to adjacent grounded metal parts; the improvement which comprises a gasket seat on the insulating lining of the shielding well, an annular sealing washer of rubber or like resilient insulating material adapted to be clamped in tight insulating engagement with the said gasket seat, and a sleeve formed integrally with said annular sealing washer and extending interiorly and exteriorly of said shielding well and adapted to tightly encompass the ignition cable extending into said shielding well.

JOHN J. ROSE.