

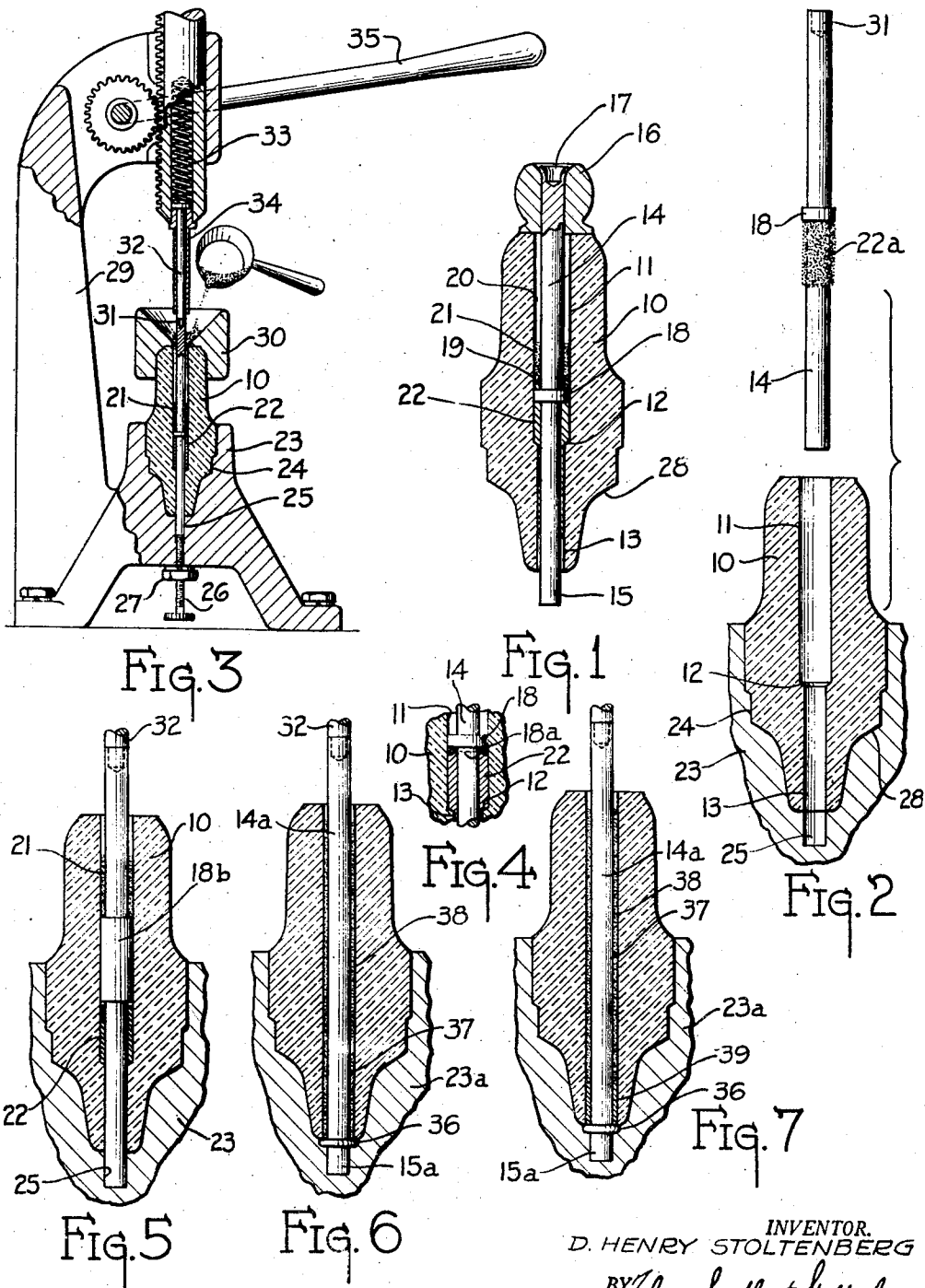
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D. H. STOLTENBERG

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SPARK PLUG

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INVENTOR.
D. HENRY STOLTENBERG
BY *Alloy, South & Stoltzenberg*
ATTORNEYS

UNITED STATES PATENT OFFICE

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SPARK PLUG

Delbert Henry Stoltenberg, Toledo, Ohio

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This invention relates to spark plugs, more particularly to methods of positioning a center electrode in a ceramic insulator and forming a seal between the electrode and the insulator.

The problem of holding and sealing a center electrode in the bore of a ceramic insulator has generally involved the use of a shouldered bore in the insulator against which an integral ring on the electrode rested with sealing material either in the form of a compacted powder or fused glass, positioned above the shoulder in the insulator bore to hold the integral ring on the electrode against the shoulder and to form a seal between the electrode and the insulator. The distance which the firing point of the center electrode projected from the lower end of the insulator was dependent upon at least two factors, the position of the shoulder in the bore of the insulator and the relative position of the integral ring on the center electrode. The relative position of the integral ring is easily controllable but the position of the shoulder of the insulator is relatively more difficult to control due to the fact that shrinkage in ceramic bodies comprising the insulator is subject to many variables which cause displacements of the shoulder position in the bore.

The present invention obviates these difficulties by providing a means whereby the projection of the electrode from the firing tip of the insulator is made independent of the manufacturing variables incident to the manufacture of spark plugs. The projection of the firing tip of the electrode is made the determining factor in the manufacturing process and results in absolute uniformity in the distance between the firing gap and the external shoulder on the insulator, which is the locating point for the dimension of the shell which surrounds the insulator in the completed plug.

A novel holding means is provided to hold the insulator and the firing tip of the center electrode in predetermined position during the period in which a holding and sealing body of compacted granular material, such as powdered talc or a mixture of powdered talc and comminuted metal, is packed into a space between the center electrode and the bore of the insulator. The position of the compacted material is not critical in the bore of the insulator, and is determined by an integral ring on the electrode which substantially closes the bore so that the granular material may be compacted above the ring to form a holding and sealing body. The thrust or force required for compacting the granular material is

transmitted to the ring integral with the center electrode, the electrode in turn transmitting the force to the holding means.

By establishing a predetermined relation between the firing tip of the electrode and the external shoulder of the insulator, the spatial relation of the electrodes of the completely assembled plug may be readily controlled by a method which is excellently suited for use in large production of spark plugs. One step in the manufacturing processes in the making of spark plugs is thereby obviated, by making the final trimming of the firing tip of the electrode unnecessary. This trimming step is often accompanied with manufacturing difficulties, particularly in the case where the firing tip of the electrode is made of refractory material, such as, for example, tungsten.

The present invention has the further advantage in that it provides a means for conveniently positioning a mass of cement between the center electrode and the bore of the insulator below the integral ring on the center electrode. This mass of cement is necessary in spark plugs to conduct heat from the center electrode into the body of the insulator from which the heat is dissipated either by being radiated to the ambient atmosphere or by being conducted to the shell of the spark plug to be carried away by the cooling water circulating in the motor block. The present methods of positioning this cement are uncertain, wasteful and uncleanly.

It is therefore a principal object of this invention to provide a method of holding and sealing a center electrode of metal in the bore of a ceramic insulator of a spark plug by compacting a body of granular material in a space between the electrode and the bore of the insulator above a functionally integral ring on the electrode by holding the center electrode in the bore of the insulator in a predetermined position by an external holding means cooperating with an end of the electrode and locating from a predetermined external portion of the insulator.

It is a further object of this invention to provide a method of holding and sealing a center electrode in the bore of a ceramic insulator of a spark plug which allows the positioning of a cement mass between the electrode and the bore of the insulator, with great convenience, cleanliness and economy.

It is a further object of this invention to provide a method of holding and sealing a metallic center wire in the shouldered bore of a ceramic insulator which is excellently suited for use in

mass production of spark plugs, in that the position of the center wire in the bore is determined by the predetermined projection of the firing tip thereof, from the tip of the insulator, with the conditions in the bore of the insulator being insensitive and capable of varying within relatively wide limits without interfering with the manufacturing processes causing rejections of the finished products.

Other objects and advantages of this invention relating to the arrangement, operation and function of the related elements of the structure, to various details of construction, to combinations of parts and to economies of manufacture, will be apparent to those skilled in the art upon consideration of the following description and appended claims, reference being had to the accompanying drawing forming a part of this specification wherein like reference characters designate corresponding parts in the several views.

Fig. 1 is a sectional elevation of the complete assembly of a ceramic insulator with its center wire.

Fig. 2 is a sectional elevation with the center electrode removed from the insulator bore prior to assembly.

Fig. 3 is an elevational view, partly in section, showing apparatus used during the compacting period of the powder.

Fig. 4 is a sectional elevation of another modification.

Fig. 5 is a sectional elevation of a modification.

Figs. 6 and 7 are sectional elevations of other modifications.

Referring to the drawing particularly to Fig. 1, a ceramic insulator 10 is shown having a longitudinal bore 11, provided with an internal shoulder 12, formed between a large bore portion adjacent the upper end of the insulator and a smaller bore portion 13 adjacent the lower or firing tip of the insulator. A center wire or electrode 14 is positioned in the bore as shown, its length being such that a tip 15 projects from the firing end of the insulator, and projects also from the upper end of the insulator 10 to cooperate with a terminal 16 which may be attached to the electrode by peening over a portion 17. The firing tip 15 may be constituted of the same material as the whole of the electrode or, if preferred, it may have welded thereto a short length of refractory material, resistant to spark erosion.

Adjacent a central location on the electrode 14 a functionally integral ring 18 is provided which is in spaced relation with the internal shoulder 12 of the bore when the center electrode is in operating position as is clearly shown in Fig. 1. The diametral dimension of the ring 18 is such as to fit snugly into the larger portion of the bore and is considerably larger than diametrical dimension of the center electrode 14 which fits snugly into the smaller portion 13 of the bore in the insulator 10 as shown. This difference in diametrical dimension between the ring 18 and the center wire 14 forms a platform 19 at the bottom of an annular space 20 between the larger portion of the bore 11 and the center electrode 14. Against this platform a powder pack 21 of granular material is compacted as will be described hereinafter, with a cement body 22 positioned below the ring 18 and above the internal shoulder 12.

Referring particularly to Figs. 2 and 3, the ceramic insulator 10 is shown mounted in a holding jig 23 which is provided with an aper-

ture 24 to embrace the lower part of the insulator 10 and a second aperture 25 which aligns with the smaller portion 13 of the bore of the insulator as shown. The depth of the aperture 25 may be made adjustable by the use of a hand screw 26 provided with a lock nut 27, as shown in Fig. 3, so that the projection of the tip 15 of the center electrode 14 may be readily controlled and maintained at a predetermined value. By controlling the conformation and spacing of these apertures, a predetermined relation between an external portion of the insulator, such as for example shoulder 28, and the projecting firing tip 15 of the center electrode may be maintained during the compacting period of granular material 21 such as powdered talc against the platform 19 by the use of a press 29 as shown in Fig. 3. Once the granular material 21 is thoroughly compacted, a holding and sealing body is formed which holds the center electrode 14 permanently in operable position in the bore of the insulator 10, in the predetermined position determined during the compact period.

With the insulator 10 in position in the aperture 24 of the jig 23, as shown in Fig. 2, the center electrode 14 is thrust into the aperture 11, being however first provided with a body 22a of viscous cement positioned about the center electrode immediately below the ring 18 as shown. This cement is readily put in this position by manual means or any other convenient methods which allow reasonably accurate control of the amount of cement used, the viscosity of the cement itself being sufficient to hold this body in compact form about the center wire during the period just before the center wire is placed into operative position in the bore of the insulator.

The center electrode 14, with the body of relatively viscous cement 22a adhering to it below the ring 18, is then inserted into the bore 11 of the ceramic insulator 10, which may be conveniently held in jig 23, so that the center wire is positioned snugly into the lower portion 13 of the bore and is thrust downwardly until the lower end of the center electrode is positioned in the aperture 25 of the holding jig. Inasmuch as the ring 18 fits snugly into the larger portion of the bore 11, the mass of cement 22a adhering to the center wire 14 is pushed ahead in the bore until it comes into contact with the internal shoulder 12 of the insulator 10, this action being in the nature of a pump in which the ring 18 performs the function of a piston.

When the cement is trapped in the larger portion of the bore 11 of the insulator 10 between the ring 18 on the center wire and the internal shoulder 12 formed in the bore of the insulator, a portion of the cement will be forced into the small clearance between the center wire 14 and the smaller portion of the bore 13. By controlling the amount of cement that is initially positioned below the ring 18, the distance which the cement is forced between the smaller portion 13 of the bore and the center wire 14 may be readily controlled. It is desirable to maintain a clearance between the center wire and the smaller portion 13 of the bore adjacent the lower or firing tip of the insulator and this method of positioning cement provides a reliable means for controlling this clearance.

Should any air be trapped in the bore of the insulator by this method with the insulator held by the jig 23, it may be preferable to insert the center wire 14 into the bore of the insulator

10 prior to the time the insulator is positioned in the holding jig 23. The insulator, with the center wire 14 already in position in the bore of the insulator, may then be inserted in the holding jig and the predetermined relation between the center wire tip 15 and the external shoulder 28 of the insulator established, so that the firing tip 15 may project uniformly from the lower end of the insulators in a series.

While the cement 22 is still in unset condition, a powder pack 21 of granular material, such as powdered talc, is positioned above the ring 18 by the compacting device generally illustrated in Fig. 3. Inasmuch as the cement used in the body 22 is preferably formed of a chemically-setting cement, comprising generally a sodium silicate compound with added ingredients such as powdered flint and silico-fluoride, no evaporation of the fluid carrier of the cement is necessary before the cement becomes hard. Cements having the quality of setting by chemical reaction rather than by evaporation of a fluid carrier have the characteristic of hardening within a relatively short time, for example twenty-four hours at room temperatures, and preferably the compacting of the granular material above the ring 18 is to be performed before this setting action takes place. It is desirable to have the granular material compacted within a very short time after the cement is placed in position to allow the center wire 14 to be moved in the bore with ease to establish the relation between the projecting firing tip 15 and the external shoulder 28 of the insulator.

Referring to Fig. 3, a funnel member 30 is positioned over the top of the insulator 10 to provide a convenient means for pouring powdered talc into the space 20 between the larger portion of the bore 11 and the center wire 14 located above the ring 18. It is convenient, but not necessary, to form the center wire with a uniform diameter throughout its length with the exception of the enlarged portion forming the ring 18. In order to hold the center wire 14 in concentric relation with the insulator 10, an aperture 31 is provided in the upper end of the center electrode 14 to cooperate with a longitudinally-movable spindle 32 of the press 29. The spindle 32 is pressed downwardly by means of a compression spring 33 which allows longitudinal movement of a ram 34 in concentric relation with the spindle 32. The dimensions of the ram 34 are such as to snugly fill the space 20 so that the powdered talc may be compacted against the platform 19 formed by the upper side of the ring 18. The ram 34 is conveniently raised and lowered into this compacting relation by means of the rack and pinion of the press which is conveniently manipulated manually by means of a handle 35. The action of the press is well known in the art and need not be described in further detail.

The press reciprocates the ram 34 through the manual manipulation of the handle 35 to compress small portions of the powdered talc against the platform 19 until a sufficient body of compacted material is formed above the platform 19 to comprise a holding and sealing body for the center electrode 14. The longitudinal force due to the action of the ram 34 during the compressing period of the powdered talc is carried by the center wire 14 and is transmitted to the holding jig 23 adjacent the firing tip 15 which projects into aperture 25 of the holding jig. The cement body 22, positioned below the ring 18, still being in unset condition, would not carry any of the

force necessary to compress the powdered talc on the platform 19. A small portion of the cement may ooze past the ring 18 to come into contact with the compacted talc above the platform 19 to form a mixture of powdered talc and cement which is believed may have some efficacy in forming a seal for the center wire.

It is not clearly understood whether this mixture of cement and powdered talc plays a large part in forming the seal, but it is believed that this commingling of cement and powdered talc has some function in improving the sealing qualities of the compacted powder. After the powder has been compacted in position, the cement is allowed to harden below the ring 18 in the space between the ring 18 and the internal shoulder 12 of the bore.

Referring to Fig. 4 of the drawing, a washer 18a of relatively flexible material, such as asbestos, may be positioned on the lower side of the ring 18 to improve the piston action of the ring 18 so that the cement will be trapped with greater efficiency between the ring 18 and the internal shoulder 12.

After the cement has become fully hardened, the terminal tip 16 is positioned on the projecting end of the center wire adjacent the upper end of the insulator 10 as is clearly shown in Fig. 1. The aperture 31 in the end of the center wire is then peened outwardly as shown at 17 to hold the terminal 16 firmly in position.

It is to be understood that the cement positioned below the ring 18 may be dispensed with entirely or may be positioned by other methods well known in the art. The invention allows the positioning of a center wire in the bore of an insulator by referring or locating only from an external portion of the insulator, to obviate any critical dimensions in the bore of the insulator, for example the position of the internal shoulder 12. Substantial uniformity of projection of the firing tip 15 of the center wire is possible by the use of this invention, with or without the use of a cement. The cement has a function of controlling the heat rating of the completed plug and its conductivity may be further increased by the addition of comminuted metals.

Referring to Fig. 5, a modification of the invention is shown in which the ring 18 is given a greater longitudinal dimension as shown at 18b which may have advantages under certain conditions of use of the spark plug, particularly for the purpose of controlling the heat rating of the completed plug. In other respects the invention is carried out as described above.

In Figs. 6 and 7 still other modifications of the invention are shown wherein a ring 36 is positioned on a center electrode 14a adjacent the firing tip 15a to cooperate with the firing tip of the insulator as is clearly shown. In this modification a holding jig 23a is provided which holds the ring 36 firmly against the firing tip of the insulator so that granular material 37 may be compacted above the ring 36 in a smooth bore 38 of the insulator. The shoulder is omitted in this modification and a uniform annular space is formed between the center wire 14a and the bore 38. The same methods are used in compacting the powdered granular material in the space between the bore and the center wire in this modification. The space between the bore 38 and the center wire may be filled entirely or to any degree that is found to be desirable. The packing is accomplished by the use of a device similar to the press 29 shown in Fig. 3.

In Fig. 7 a collar 39 of inflammable material is provided above the ring 36 against which the granular material 37 is compacted in the bore 38 between the center wire and the bore. This inflammable material will burn out when the plug is in use to leave an annular space adjacent the firing tip of the insulator between the center wire 14a and the bore 38. In other respects this modification is substantially the same as that shown in Fig. 6.

It is to be understood that the above detailed description of the present invention is intended to disclose an embodiment thereof to those skilled in the art, but that the invention is not to be construed as limited in its application to the details of construction and arrangement of parts illustrated in the accompanying drawing, since the invention is capable of being practiced and carried out in various ways without departing from the spirit of the invention. The language used in the specification relating to the operation and function of the elements of the invention is employed for purposes of description and not of limitation, and it is not intended to limit the scope of the following claims beyond the requirements of the prior art.

What is claimed:

1. In a spark plug having a ceramic insulator and a metallic center wire positioned in a bore of the insulator, a functionally-integral ring on the center wire, a shoulder in the bore of the insulator formed between a larger portion of the bore having approximately the same diametrical dimension as the ring on the center wire and a smaller portion of the bore having approximately the same diametrical dimension as the center wire, the center wire being positioned in the bore of the insulator with the ring in spaced relation with the shoulder of the insulator to provide a space therebetween, a mass of cement between the center wire and the smaller portion of the bore and in the space between the ring on the center wire and the shoulder on the insulator, and a compacted mass of granular material positioned above the integral ring to hold and seal the center wire in the bore of the insulator.

2. In a spark plug having a ceramic insulator and a metallic center wire positioned in a bore of the insulator, a functionally-integral ring on the center wire, a shoulder in the bore of the insulator formed between a larger portion of the bore having a dimension approximately the same as the ring on the center wire and a smaller portion of the bore having a dimension approximately the same as the center wire, the center wire being positioned in the bore with the ring in spaced relation with the shoulder of the insulator to provide a space therebetween, a body of cementitious material substantially filling the space between the ring on the center wire and the shoulder of the insulator, and a compacted mass of material positioned above the ring of the center wire filling the space between the center wire and the larger portion of the bore to form a holding and sealing body.

3. The combination set forth in claim 2, further characterized by having a body of heat-conductive cementitious material positioned in the space between the ring on the center wire and the shoulder in the bore of the insulator.

4. In a spark plug having a ceramic insulator and a metallic center wire positioned in a bore of the insulator, a functionally-integral ring on the center wire, a shoulder in the bore of the insulator formed between a larger portion of the

bore having a dimension approximately the same as the ring on the center wire and a smaller portion of the bore having a dimension approximately the same as the center wire, the center wire being positioned in the bore of the insulator to project a predetermined distance from the insulator at the firing tip with the ring in spaced relation with the shoulder of the insulator to provide a space therebetween, the position of the ring being determined by the projecting firing tip of the center wire, and a body of compacted granular material positioned above the ring on the center wire filling the space between the center wire and the larger portion of the bore to form a holding and sealing body.

5. The method of sealing a metallic center wire in the bore of a ceramic insulator comprising, providing a shoulder in the bore of the insulator between a larger portion of the bore adjacent the outer end of the insulator and a smaller portion of the bore adjacent the firing tip of the insulator, positioning a functionally-integral ring on the center wire having approximately the same dimensions as the larger part of the bore of the insulator to fit snugly therein at a point on the center wire to be in spaced relation with the shoulder on the insulator when the center wire projects a predetermined distance from the insulator at the firing tip of the insulator, holding the center wire at the firing tip of the insulator in its predetermined position by an external holding means, and compacting granular material above the ring on the center wire to fill the space between the center wire and the larger portion of the bore to form a holding and sealing body.

6. The method of sealing a metallic center wire in the shouldered bore of a ceramic insulator, comprising, providing an enlarged portion in the nature of an integral ring on the center wire having a dimension to fit snugly into the larger portion of the bore above the shoulder, the center wire fitting snugly into the smaller portion of the bore located adjacent the firing tip of the insulator, holding the center wire at the firing tip by an external, removable holding means so that the firing tip of the center wire projects a predetermined distance from the tip of the insulator, the enlarged portion being located on the center wire to provide a space between the enlarged portion and the shoulder in the bore of the insulator when the firing tip projects the predetermined distance from the tip of the insulator, and compacting granular material from the opposite end of the bore into the enlarged portion thereof against the enlarged portion of the center wire to form a holding and sealing body in the space between the center wire and the larger portion of the bore of the insulator.

7. The method of sealing a metallic center wire in the shouldered bore of a ceramic insulator, comprising, providing a functionally-integral ring on the center wire having a dimension to fit snugly in the larger portion of the bore, the center wire having a dimension to fit snugly in the smaller portion of the bore, positioning the center wire in the bore with the firing tip of the center wire projecting a predetermined distance from the tip of the insulator and the ring on the center wire in spaced relation with the shoulder in the bore of the insulator, holding the projecting tip of the center wire in the predetermined position by an external holding means, and compacting granular material above the ring while holding the firing tip of the center wire to form a holding and sealing body.

8. The method of sealing a metallic center wire in the shouldered bore of a ceramic insulator, comprising, providing a functionally-integral ring on the center wire having a dimension to fit snugly in the larger portion of the bore, the center wire having a dimension to fit snugly in the smaller portion of the bore, coating the center wire with a viscous fluid ceramic cement from the firing tip to the ring, positioning the cement coated center wire into the bore of the insulator from the larger end of the bore whereby the fluid cement repelled by the shoulder of the bore in the insulator from the firing tip of the center wire is trapped between the shoulder and the ring and placed under pressure, thrusting the center wire into the bore of the insulator until the firing tip of the center wire projects a predetermined distance from the tip of the insulator thereby forcing the fluid cement trapped between the ring and the shoulder to fill the space between the smaller portion of the bore and the center wire, holding the center wire in the predetermined position by an external holding means, and compacting granular material above the ring to fill the space between the center wire and the larger portion of the bore to form a holding and sealing body.

9. The method of positioning a holding and sealing body of compacted granular material between a metallic center wire and the bore of a ceramic insulator, comprising holding the center wire in predetermined position in the bore of the insulator at one end by an external removable holding means during the compacting period, and compacting a body of granular material into an annular space between a portion of the center wire and the bore of the insulator from the end opposite from the holding means, the force for compacting the granular material being transmitted by the center wire to the external holding means.

10. The method of positioning a holding and sealing body of compacted granular material between a metallic center wire and the bore of a ceramic insulator, comprising holding the center wire in predetermined position in the bore of the insulator at one end thereof by an external removable holding means during the compacting period, and compacting a body of granular material into an annular space between a portion of the center wire and the bore of the insulator, said body being compacted against an abutment on the center wire whereby the force for compacting the granular material is transmitted by the center wire to the external holding means.

11. The method of positioning a holding and sealing body of compacted granular material between a metallic center wire and the bore of a ceramic insulator, comprising holding the center wire in predetermined position in the bore of the insulator at the firing tip of the center wire by an external removable holding means during the compacting period by locating from an external shoulder on the insulator, providing an abutment on the center wire of relatively larger diametrical dimension than the center wire portion above so as to form an annular space between the center wire portion above the abutment and the bore of the insulator, and compacting a body of granular material in said space against the abutment on the center wire to form a holding and sealing body between the center wire and the bore of the insulator.

12. The method of sealing a center wire in the bore of a ceramic insulator comprising, providing a shoulder in the bore of the insulator between a larger portion of the bore adjacent the outer end of the insulator and a smaller portion of the bore adjacent the firing tip of the insulator, positioning a functionally-integral ring on the center wire having approximately the same dimension as the larger part of the bore of the insulator to fit snugly therein at a point in spaced relation with the shoulder in the bore of the insulator when the center wire projects a predetermined distance from the insulator at the firing tip of the insulator, holding the center wire at the firing tip of the insulator in its predetermined position by an external holding means, and compacting a body of compactible material above the ring on the center wire to fill the space between the center wire and the larger portion of the bore to form a holding and sealing body.

13. The method of sealing a center wire in the bore of a ceramic insulator comprising, positioning the center wire in the bore of the ceramic insulator to project a predetermined distance from the insulator at the firing tip of the insulator, holding the center wire in its predetermined position by at least one end thereof by a holding means external of the bore, providing an annular space between the center wire and the bore of the insulator, providing a floor for the annular space functionally-integral with the center wire, and compacting compactible material against said floor on the center wire to fill the annular space between the center wire and the bore to form a holding and sealing body therebetween.

14. The method of sealing a center wire in the bore of a ceramic insulator comprising, positioning the center wire in the bore of the insulator with the firing portion of the center wire projecting a predetermined distance from the insulator, holding the center wire in its predetermined position by at least one end thereof by a holding means external of the insulator, providing a narrow annular space between the center wire and the bore of the insulator having a floor comprising a functionally-integral portion of the center wire, and compacting compactible material in the annular space above the floor to fill the annular space between the center wire and the bore to form a holding and sealing body therebetween.

15. The method of sealing a center wire in the bore of a ceramic insulator comprising, positioning the center wire in the bore of the insulator with the firing portion of the center wire projecting a predetermined distance from the insulator, providing a narrow annular space between the center wire and the bore of the insulator having a floor in the nature of a functionally-integral platform on the center wire, holding the center wire by at least one end thereof by a holding means external of the insulator, and compacting compactible material in the annular space above the floor with the external holding means forming an anvil for the compacting forces to fill the annular space between the center wire and the bore at least in part to form a holding and sealing body therebetween.

DELBERT HENRY STOLTENBERG.

CERTIFICATE OF CORRECTION.

Patent No. 2,367,445.

January 16, 1945.

DELBERT HENRY STOLTENBERG.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 2, second column, line 23, for the word "compact" read --compacting--; page 5, second column, line 61, claim 15, for "plateform" read --platform--; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 15th day of May, A. D. 1945.

Leslie Frazer

(Seal)

Acting Commissioner of Patents.

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