Dec. 12, 1961 B. H. MARKS ET AL 3,013,181

COMBINATION SPARK PLUG AND ELECTRICAL ELEMENT

Filed Jan. 12, 1960 2 Sheets-Sheet 1

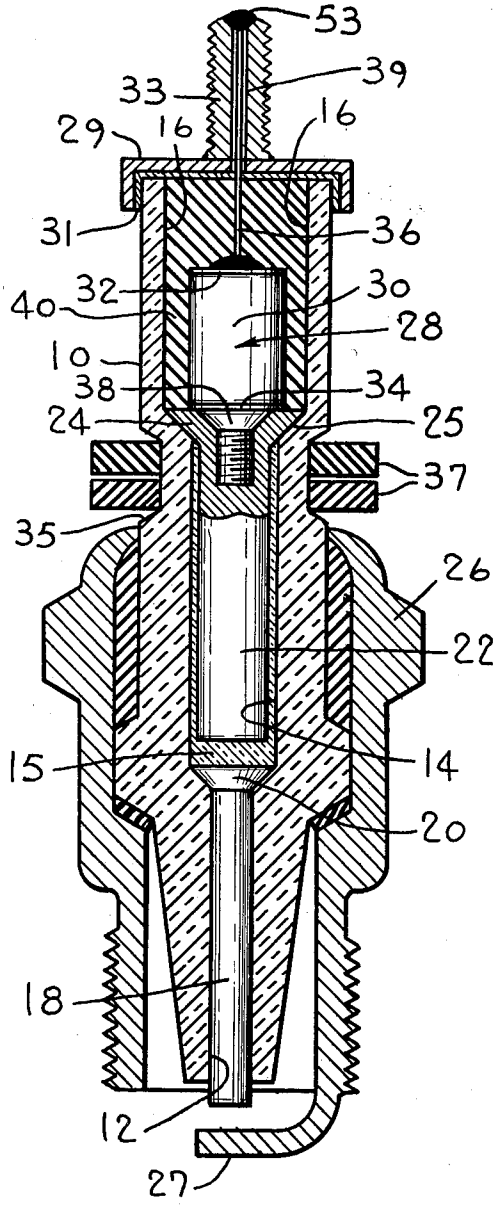


FIG. 1

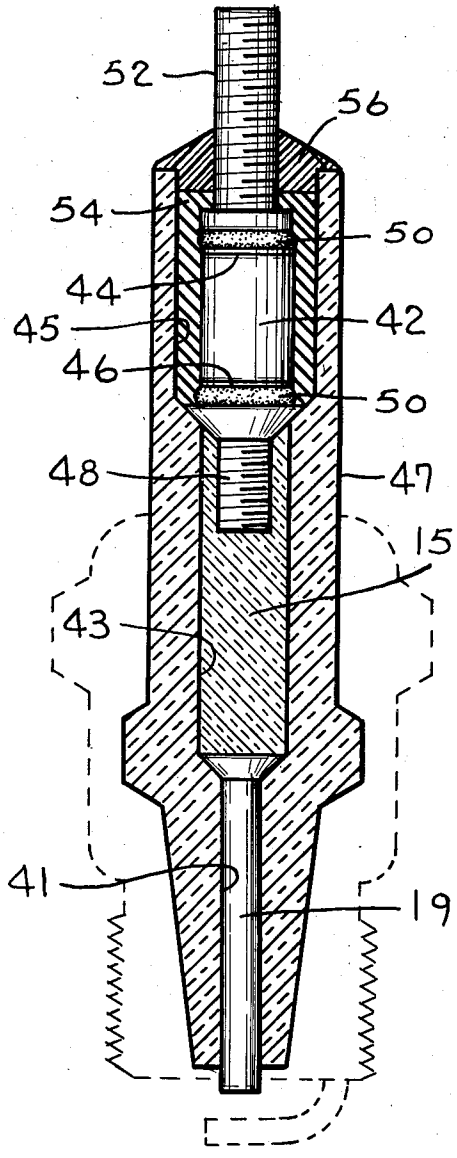


FIG. 2

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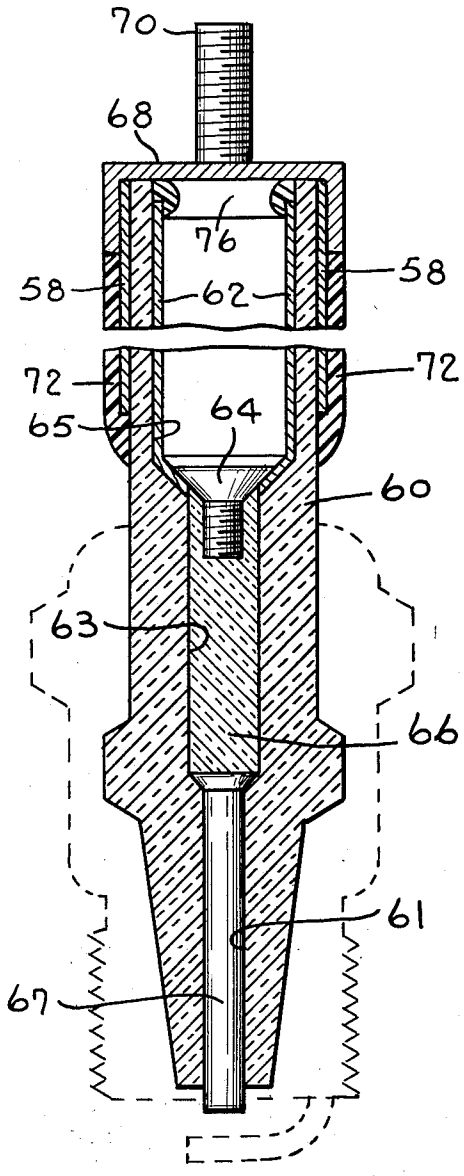


FIG. 3

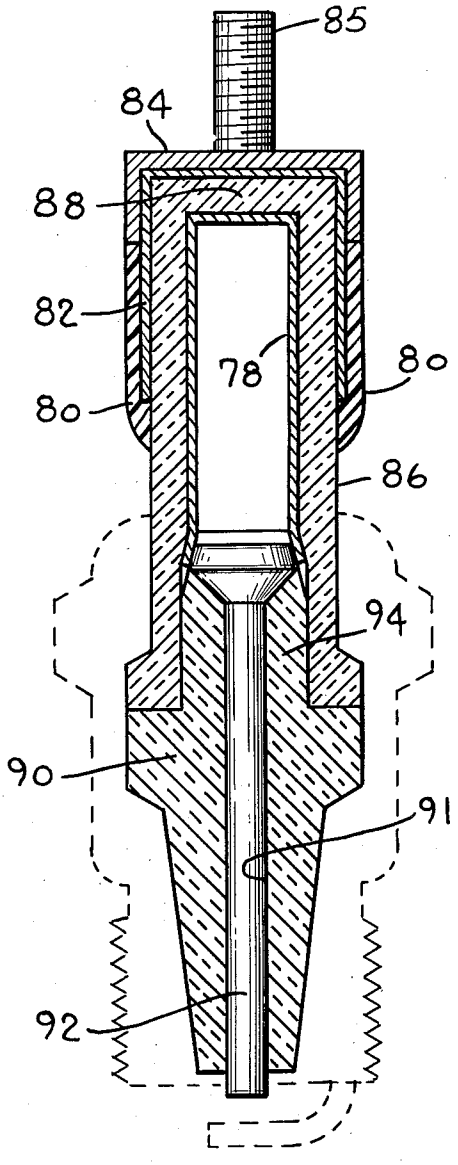


FIG. 4

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COMBINATION SPARK PLUG AND ELECTRICAL ELEMENT

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6 Claims. (Cl. 315—58)

This invention relates to spark plugs which incorporate within their bodies electric circuit elements, and particularly to such plugs which are essentially no larger than a conventional spark plug and the electric circuit element incorporated therein limits the current passing through the center electrode to adapt the plugs for use in a distributorless ignition system.

In a distributorless ignition system where a single power supply is continuously connected to a multiplicity of spark plugs it is necessary to provide current limiting condensers or resistors or inductors in series with each plug to cause all the plugs to spark simultaneously as stated in United States Patent No. 2,866,839 and No. 2,866,447. These current limiting electric circuit elements have been connected in the electrical circuit unshielded and physically separated from the spark plugs and have consequently been subjected to severe moisture, temperature and vibration conditions. There has also resulted increased radio interference, excessive power loss, spark-over, susceptibility to breakage, and impractical usage of space.

One object of this invention is to eliminate or minimize the harmful effects of moisture, temperature and vibration encountered by existing systems in which separate electrical circuit elements are used in circuit with the spark plugs and to reduce the bulk of such systems.

A further object is to insulatively mount an electrical circuit element within a spark plug in a manner which prevents spark-over, excessive power loss, and susceptibility to breakage.

These objects are accomplished by mounting the electrical circuit element in a space within the ceramic insulator of a spark plug or by using such insulator as an integral part of such element. Thus the insulator provides protection and physical support for the element, and space requirements are minimized. The element may be cushioned within the insulator by an insulating and shock absorbing material to protect it from moisture, vibration and bad effects of temperature. In case the element is a capacitor, voltage breakdown can be lessened by utilizing part of the insulator as the dielectric. However, by mounting a unitized capacitor entirely within the spark plug insulator the insulating material will provide adequate voltage breakdown and spark-over protection from electrode to electrode of the capacitor.

Other objects and advantages will be pointed out in or be apparent from the specification and claims, as will obvious modifications of the four embodiments shown in the drawings of which:

FIG. 1 is a partial sectional view of a spark plug embodying the present invention;

FIG. 2 is a sectional view showing another embodiment of the present invention;

FIG. 3 is a sectional view showing a third embodiment of this invention in which a portion of the insulator is not shown;

FIG. 4 is a sectional view of a fourth embodiment of the present invention.

The thicknesses of all metalized coatings, silvered surfaces, and bonding pastes are exaggerated in the drawings for the sake of clarity.

Referring to the drawings, FIG. 1 shows the preferred embodiment of this invention in which the center electrode assembly comprises an insulator 10 and center electrode 18. The insulator 10 has a bore 12, a first counterbore 14 and a second counterbore 16. The center electrode 18 is mounted in bore 12 and has a head 20 which extends into the first counterbore 14 to retain electrode 18 in place. Powdered conductive glass 15 is placed in first counterbore 14 and an electrically conductive shank 22 having head 24 is pre-pressed into the glass powder. Insulator 10 is then heated to around 1500° Fahrenheit and the shank is pressed inwardly to firmly seat shank head 24 on a tapered shoulder 25 in the insulator. This provides a hermetic seal between the center electrode and the insulator.

A metal shell 26 is then applied to the insulator in a conventional manner and a ground electrode 27 is properly gapped from the center electrode 18.

After the metal shell is applied to the insulator capacitor unit indicated generally at 28 is mounted in counterbore 16. This unit includes a high-K ceramic slug 30 having silvered ends or electrodes 32 and 34. This capacitor is relatively small; about 0.250 inch in diameter and 0.400 inch in length. It may have a rating of from 10 to 50 m.m.f. A thin copper ribbon 36 is soldered to end 32, and a flat headed screw 38 is soldered to end 34. Screw 38 is screwed into the head of shank 22 which is drilled, countersunk and tapped to receive it. The ribbon projects beyond the end of the insulator 10. The space in counterbore 16 around the capacitor unit is filled with a high voltage insulating material to prevent spark-over along the sides of ceramic slug 30 and along the counterbore wall. A material found highly desirable for this purpose is a mixture of silicone oil and uncured silicone rubber. This mixture is a fairly thin liquid which is poured into counterbore 16. The spark plug is then heated to cure the silicone material into a resilient rubber capable of withstanding the high temperatures and voltages encountered in the spark plug stem. Better bonding of the silicone rubber to the bore and ceramic slug walls is secured if a suitable primer wetting agent is used to coat these walls before pouring the silicone mixture into counterbore 16.

After the rubber is cured, a terminal unit is bonded to the insulator stem by adhesive 31. This unit comprises a cap 29 having a central opening and a threaded terminal 33 having a bore 39. This terminal is secured to the cap with the opening and central bore aligned so that when the unit is placed over the end of the insulator the conductive ribbon 36 is threaded through the terminal. Ribbon 36 is then soldered at 53 to terminal 33 and cut off.

Connection of capacitor unit 28 to terminal 33 as described permits the relative motion between the component parts of the spark plug, caused by the different coefficients of expansion of the various components, to occur without damaging the connection between terminal 33 and capacitor unit 28. The stresses ordinarily caused by vibration and relative motion of the parts are relieved by the resilient insulating material. The capacitor being mounted within the insulator and hermetically sealed will not be affected by moisture.

Spark-over along the outside of insulator 10 is prevented by providing an indentation 35 in the insulator in which silicone rubber washers 37 are mounted.

The center electrode assembly shown in FIG. 2 is constructed similarly to that shown in FIG. 1. The insulator 47 has a bore 41, a first counterbore 43 and a second counterbore 45. A center electrode 19 is mounted in the bore 41 in the same manner electrode 18 is mounted in the bore 12. Powdered conductive glass 15 is placed in first counterbore 43 and a headed stud 48 is pressed into the glass powder. These components are then heated as

previously described to seat the head of the stud 48 on the shoulder between the first and second counterbores. A ceramic slug 42 with silvered ends or electrodes 44 and 46, substantially identical with ceramic slug 30, has its end 46 secured to headed stud 48 by conductive paste 50 or by soldering and its other end 44 is secured directly to a threaded terminal 52 by conductive paste 50 or the like. Finely ground mica is compacted around slug 42 and the head of terminal 52 and dried. A fluorchemical is then applied to saturate the mica thereby providing a good high voltage insulating material indicated as 54. The center electrode assembly is next placed in a vacuum and an epoxy seal 56 is made between the terminal 52 and the insulator 47 thereby preventing the ingress of air inside the insulator and also supporting the terminal. Epoxy resin and silicone material are also good high voltage insulators and may be substituted for the mica and fluorchemical mixture 54.

A capacitor may also be built into the center electrode assembly by using the insulator itself as the dielectric of the capacitor. In FIG. 3 the insulator 60 has a bore 61, a first counterbore 63 and a second counterbore 65. An internal electrode 62 is bonded to the inner side of the wall of the second counterbore 65 and an external electrode 58 is bonded to the outside of such wall opposite the inner electrode. A center electrode 67 is secured in bore 61 and a headed stud 64 is sealed in conductive glass 66 in the manner heretofore described; the head of stud 64 being in good electrical contact with the electrode 62. A cap 68 with a threaded terminal 70 secured thereto fits over the end of the insulator and is soldered to the electrode 58 to form a seal and a conductive contact therewith. A protective insulating glaze 72 covers electrode 58 thereby protecting it from deleterious forces and preventing flashover to the metal shell in which the assembly is mounted. In order to provide sufficient capacity, the spark plug insulator 60 must be longer than that used in conventional spark plugs. The increased length is also necessary to provide enough space between cap 68 and electrode 62 to prevent spark-over. This spacing may be minimized by using insulating material 76 between the cap and electrode 62.

In FIG. 4 a center electrode assembly is shown in which the dielectric of the capacitor also is formed by the insulator. In this modification a two-piece insulator is used which provides an end wall as an additional dielectric thereby cutting down on the required length of the insulator and lessening the chances of spark-over. The insulator consists of a top piece 86 open at only the lower end and a bottom piece 90. The inside of piece 86 including its end wall 88 has a metalized coating or electrode 78. The outside of piece 86 including its end wall has a metalized coating or electrode 82. An insulative coating 80 is applied over electrode 82 to prevent spark-over along the outside of the insulator stem. The bottom piece 90 of the insulator has a boss 94 which projects into the

open lower end of top piece 86. This piece has a bore 91 in which a headed center electrode 92 is sealed with its head projecting from the boss 94 and engaging the electrode 78 when the pieces are assembled as shown.

This construction permits reduction of the length of the insulator to approximately that of a conventional spark plug due to the increased capacity secured from top end 88. A cap 84 with a terminal 85 fits over the end of the insulator and is soldered to the electrode 82. However the end wall 88 completely insulates cap 84 from electrode 78 thereby eliminating the spark-over problem.

Although but four embodiments of the present invention have been illustrated and described, it will be apparent to those skilled in the art that various changes and modifications may be made therein without departing from the spirit of the invention or from the scope of the appended claims.

We claim:

1. A spark plug comprising: an insulator having a bore; a center electrode mounted in said bore; a ground electrode gapped from said center electrode; a terminal supported by said insulator; an electrical element connected between said terminal and said center electrode; a resilient high voltage insulating material surrounding said element thereby isolating it from said insulator to prevent voltage breakdown and protecting said element against vibration and moisture.

2. The combination according to claim 1 in which said material comprises mica saturated with a fluorchemical.

3. The combination according to claim 1 in which said material comprises cured silicone rubber.

4. A spark plug comprising: a metal shell having a ground electrode; an insulator having a bore mounted in said shell; a center electrode mounted in said bore and gapped from said ground electrode; a ceramic slug in said bore having capacitor electrodes on opposite ends; one of said electrodes being connected to said center electrode; a conductive ribbon connected to the other of said electrodes; a terminal mounted on said insulator and connected to said ribbon; and resilient high voltage insulating material around said slug.

5. The spark plug according to claim 4 in which said terminal has a central bore, said ribbon passing through said central bore and conductively connected to said terminal at the top end thereof.

6. The spark plug according to claim 4 in which said first mentioned capacitor electrode is connected to said center electrode by a threaded screw secured to said electrode.

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