Sept. 29, 1959 M. MALLORY 2,906,908

SPARK PLUG

Filed April 19, 1957

FIG. 1

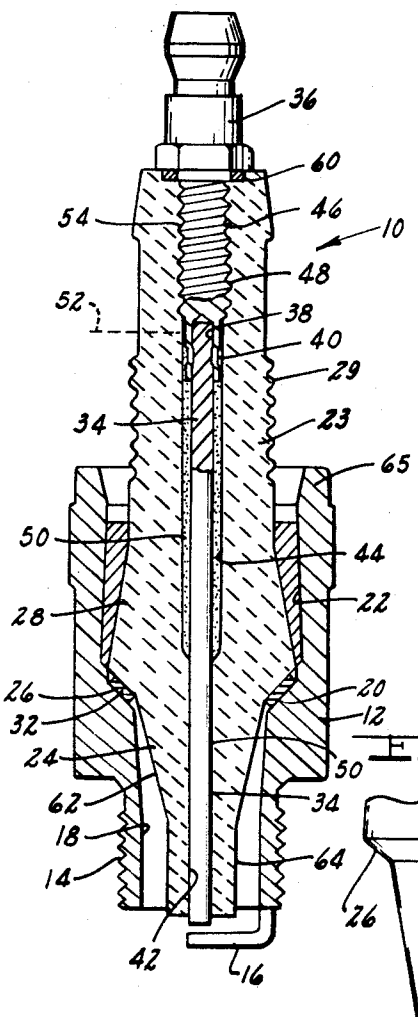


FIG. 3

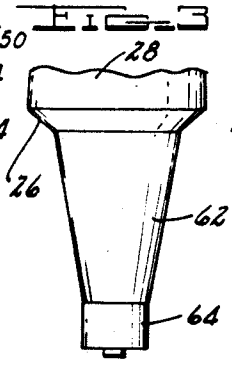
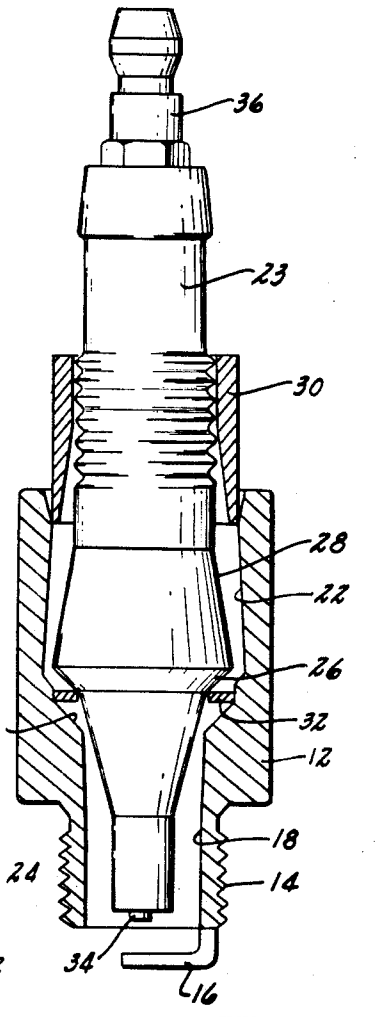


FIG. 2



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SPARK PLUG

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7 Claims. (Cl. 313—144)

This invention relates to spark plugs for use in internal combustion engines.

Objects of the invention are to provide a spark plug wherein,

(1) The insulator body has extensive pressure engagement with an annular metallic element carried by the shell, thereby promoting rapid heat transfer between the insulator body and shell,

(2) The center electrode has contact along its entire length with cement carried within the insulator body, thereby promoting rapid heat transfer between the electrode and insulator body,

(3) The joint between the center electrode and insulator body is sealed along the entire electrode length so as to provide maximum protection against leakage,

(4) The joint between the insulator body and shell is sealed by means of an annular "wedged in" metallic element in such manner that the sealing action and heat transfer are increased at high operating pressures and temperatures, thereby eliminating the need for preheating of the plug during its assembly,

(5) The plug design is such that the plug can be manufactured by low cost processes while still maintaining close control of the plug operating characteristics,

(6) The nature of the plug manufacturing process gives such close control over the plug operating characteristics as to permit formation of plugs in different heat ranges by varying a single characteristic of the plug insulator body, thereby enabling the manufacture of an entire line of plugs with the same machinery.

Other objects of this invention will appear in the following description and appended claims, reference being had to the accompanying drawings forming a part of this specification wherein like reference characters designate corresponding parts in the several views.

In the drawings:

Fig. 1 is a vertical sectional view through one embodiment of the invention,

Fig. 2 is a view of the Fig. 1 embodiment with its component parts in a partially assembled condition, and

Fig. 3 shows the lower portion of an insulator body which can be utilized interchangeably with the Fig. 1 insulator body.

Before explaining the present invention in detail, it is to be understood that the invention is not limited in its application to the details of construction and arrangement of parts illustrated in the accompanying drawings, since the invention is capable of other embodiments and of being practiced or carried out in various ways. Also, it is to be understood that the phraseology or terminology employed herein is for the purpose of description and not of limitation.

In Fig. 1 there is shown a spark plug **10** comprising an annular metallic shell **12** provided with the usual ground terminal **16** and external threads **14** for securement of the plug on the engine cylinder head (not shown). Shell **12** is internally contoured to provide a lower bore **18**, outwardly extending shoulder **20**, and upper bore **22**.

Bore **22** has an inward upward taper of about three degrees with respect to the shell axis.

Positioned within shell **12** is a porcelain insulator body **23** which includes a lower body portion **24**, a shoulder-forming portion **26**, and an upper body portion **28**. Body portion **28** has an inward upward taper of about ten degrees with respect to the shell axis. The extreme upper end of body **23** is provided with ribs **29** which increase the insulator surface over which a charge must travel in order to short circuit around terminal **16**.

In order to secure insulator body **23** within shell **12** there is provided a ring **30** of aluminum. This ring could be formed of copper or other soft metal, it being essential that its material be relatively soft and deformable so as not to crack the porcelain insulator body during assembly or use in the engine.

Initially ring **30** is formed with an annular wall which begins to taper at a point about one third of the way down from its upper end as shown in Fig. 2. Prior to assembly of ring **30** into shell **12** insulator body **23** is positioned on a soft copper gasket **32** as shown in Fig. 2. Shell **12** is fixedly positioned in a fixture (not shown) and vertical pressure is applied downwardly on the upper edge of ring **30** to force said ring down into the space between body portion **28** and tapering bore **22**. A suitable fluid-actuated press having an annular pressure pad (not shown) may be employed to provide the pressure on ring **30**. As the lower end of ring **30** strikes body portion **28** it is cammed outwardly toward its Fig. 1 "wedged in" position between surfaces **28** and **22**. Part of the mechanical force applied to ring **30** is transmitted to gasket **32** so as to deform it to its Fig. 1 inclined position against the surface of shoulder **20**.

In the Fig. 1 position insulator body **23** is rigidly positioned within shell **12** without any tendency to shift axially during operation. At high engine temperatures (during the firing stroke) metallic ring **30** tends to expand so as to more tightly pressure against walls **22** and **28**. As a result the heat within the insulator body can be rapidly dissipated to shell **12**. Additionally, the joint along the surface of body portion **28** is insured of an extremely tight and extensive seal during the firing stroke. The utilization of ring **30** to retain the insulator body in the shell (in lieu of the conventional "spinning over" of the shell's upper edge) eliminates the need for preheating of the plug during its assembly, such preheating being necessary in the conventional construction in order to give the insulator body a tight fit during service in the engine. Ring **30** is of soft material so that the insulator body does not crack in service.

The center electrode within insulator body **28** takes the form of a cylindrical rod **34** which is preferably formed of nickel alloy in order that it can be secured onto the lower end of steel terminal **36** by a low cost clinching operation. Terminal **36** is provided with a bore **38** which receives the upper end of rod **34**, after which the terminal and rod are clinched at **40**. The electrode and terminal are secured together before their assembly into the insulator body.

Prior to insertion of the electrode-terminal assembly into the insulator body the internal bores **42**, **44** and **46** in the insulator body are filled with two cements. Bore **42** is slightly greater in diameter than rod **34**, and bore **44** is about one tenth inch greater in diameter than rod **34**. Bore **46** is threaded to mesh with threads **48** formed on terminal **36**. Bores **42** and **44** are filled with a relatively porous, high viscosity cement **50** to the level of imaginary line **52**. The walls of threaded bore **46** are then sprayed with a second cement **54** which is of relatively low viscosity.

Cement **50** is compounded from 70% Sauereisen filler No. 32 and 30% Sauereisen binder No. 32, both the filler

and binder being standard items manufactured by the Sauereisen Cement Company of Pittsburgh, Pennsylvania. The ratio of filler to binder may however be varied from the specified ratio, especially when mixed or used at high or low room temperatures, and when allowed to stand for extended periods after mixing.

Cement 54 is compounded from kaolin and silicate of soda solution (Type N, manufactured by Philadelphia Quartz Company and distributed by Ecclestone Chemical Company of Detroit, Michigan). The kaolin and silicate of soda are compounded by adding one volumetric part silicate of soda to three volumetric parts loosely packed kaolin (i.e., as it comes from the package with no packing or tamping). The proportion of kaolin to silicate of soda may however be varied within limits and still obtain satisfactory cement characteristics.

When cement 50 is poured into bores 42 and 44 its high viscosity, together with the small diameter of bore 42 (about one sixteenth inch), prevents any appreciable liquid flow out of the lower end of bore 42. Downward insertion of rod 34 into bores 42 and 44 expels some of cement 50 out of the lower end of bore 42; however, enough of the cement remains to completely line the walls of bores 42 and 44.

Additionally, rod 34 cooperates with cement 50 to seal bore 42 and put the cement in bore 44 under pressure; as a result there are no large void spots within the cement. Insertion of terminal 36 into bore 46 is accompanied by a slight expelling of cement 54 upwardly out of bore 46 past aluminum gasket 60.

After threads 48 are meshed with threads 46 (as shown in Fig. 1) the terminal-electrode assembly is placed in an oven at elevated temperatures (in excess of 100° F.) for several hours to cure cements 50 and 54.

In service, cements 50 and 54 provide a seal along the entire length of the electrode-terminal assembly, as well as an extensive heat path for dissipation of electrode heat into the insulator body.

Cements 50 and 54 are purposely made of different materials because of their different locations within the insulator body. Cement 50 is a relatively porous material, which in the liquid state is of high viscosity in order that it can be retained under pressure in bores 42 and 44 during insertion of rod 34 into the insulator body. The porosity of cement 50 allows its filler particles to move or shift slightly in service during electrode temperature increase without cracking the porcelain insulator body. Cement 54 is a light material having relatively small size filler particles. The clearance spaces between threads 46 and 48 are relatively small but the character of cement 54 is such that it does not crack the porcelain insulator body during high temperature service conditions. A cement having large size filler particles would not be practicable for use in threaded bore 46.

It will be noted that the lower body portion 24 of insulator 23 includes a conical section 62 and a cylindrical section 64. The upper end of section 62 has a diameter corresponding with the internal diameter of gasket 32 so as to automatically seat body 24 in a central position prior to pressing in of ring 30.

The length of section 64 determines rate of plug cooling and hence the operating temperature of the plug. The longer the length of section 64 the higher will be the plug operating temperature. The Fig. 3 insulator body has a lower operating temperature than the Fig. 1 insulator body and can be employed interchangeably therewith. This "interchangeability" is due to the high rate and close control of the heat transfer action through ring 30 and cements 50, 54. Each plug therefore has a precise "heat transfer" characteristic; as a result variation in the length of section 64 can be employed to provide a complete line of plug "heat ranges."

It will be noted that the lower end portion of rod 34 extends a relatively short distance beyond the lower limit of insulator body 23. In practice this short length of exposure of the electrode (which may vary between .020 and .045 inch) causes the electrode to be out of the hot engine gases which cause burning, carboning and electrode deterioration.

It will be noted that there are more ribs 29 on body 23 than can usually be accommodated on an insulator body. The large number of ribs 29 is made possible because of the short length of ring 30 and the fact that upper end portion 65 of shell 12 is not turned radially inward to clamp the insulator body in place as in conventional constructions. Ribs 29 can be extended down into the space within end portion 65 so as to provide increased resistance to current "flash over" from terminal 36 to shell 12.

I claim:

1. A spark plug comprising an annular metallic shell internally contoured to provide a first lower bore, a shoulder extending outwardly from the upper end of said bore, and a second bore extending upwardly from said shoulder, said second bore tapering upwardly and inwardly; an insulator body extending downwardly into the shell and having an upwardly and inwardly tapering portion located within the upwardly and inwardly tapering bore; an annular body of soft metal wedged between the tapering portion and the tapering bore; an electrode extending downwardly through the insulator body; and a second electrode carried by the lower end of the shell.

2. A spark plug comprising an annular metallic shell internally contoured to provide two aligned bores of different diameters and a shoulder therebetween, the larger of said bores tapering upwardly and inwardly; an annular gasket seated on the shoulder; an insulator body having a first relatively small diameter body portion and a second relatively large diameter body portion, the juncture therebetween defining an annular abutment surface; said insulator body extending through the shell with the small diameter portion positioned within the small diameter bore and with the large diameter portion positioned within the large diameter bore, said abutment surface being seated on the gasket; the large diameter portion tapering upwardly and inwardly from the abutment surface; a ring of soft metal wedged between the tapering body portion and the tapering bore; an electrode extending through the insulator body; and a second electrode carried by the shell.

3. In a spark plug an insulator body having a lower relatively small bore; an intermediate larger bore, and an upper threaded bore; a terminal threaded into said upper bore; an electrode carried by said terminal and extending downwardly through the first two bores, said electrode having a diameter slightly less than that of the lower bore; a first porous cement of relatively high viscosity lining the wall surfaces of the lower and intermediate bores; and a second cement of low viscosity lining the wall surfaces of the threaded bore.

4. The combination of claim 3 wherein the terminal is formed with a bore in its lower end, said electrode being formed of nickel alloy and being extended into the terminal bore; the bore-forming wall of the terminal being in a radially squeezed condition so as to secure the electrode onto the terminal.

5. The combination of claim 3 wherein the second cement is comprised of kaolin and silicate of soda.

6. The combination of claim 3 wherein the electrode extends out of the insulator body between .020 and .045 inch.

7. A spark plug comprising an annular metallic shell internally contoured to provide a first lower bore, a shoulder extending outwardly from the upper end of said bore, and a second bore extending upwardly from said shoulder; said second bore tapering upwardly and inwardly; an annular gasket seated on the shoulder; an insulator body having a lower small diameter body portion and an upper large diameter body portion, the junc-

ture therebetween defining an annular abutment surface; said upper body portion tapering upwardly and inwardly from the annular abutment surface; said lower body portion including a conical section tapering from the abutment surface and a cylindrical section extending downwardly from the lower limit of the conical section; said insulator body extending into the shell with its abutment surface seated on the gasket and with its upper body located within the tapering bore; an annular body of soft metal positioned between the upper body portion and the tapering bore; a terminal carried at the upper end of the insulator body; an electrode extending downwardly from the terminal through the insulator body; cements between

the electrode-terminal assembly and insulator body; and a second electrode carried by the lower end of the shell; the claimed arrangements permitting rapid heat transfer between the first electrode, insulator body and shell.

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