Nov. 8, 1938. R. T. HURLEY 2,136,052

IGNITION DEVICE

Filed July 16, 1936

Fig 1

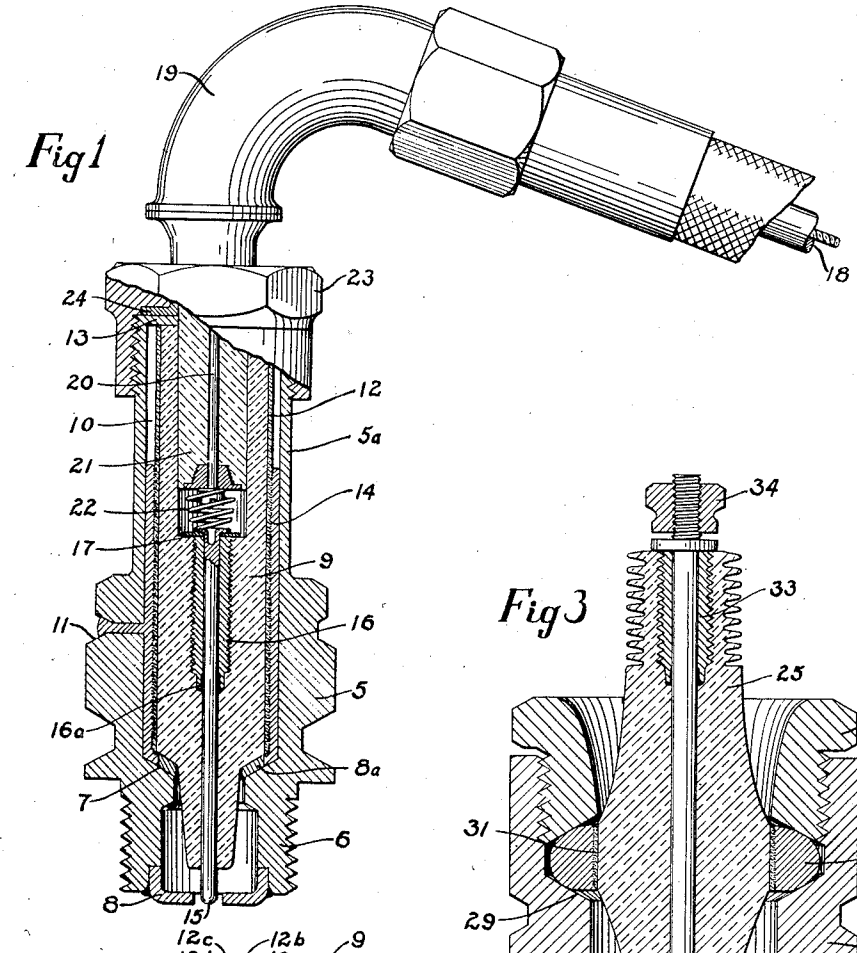


Fig 2

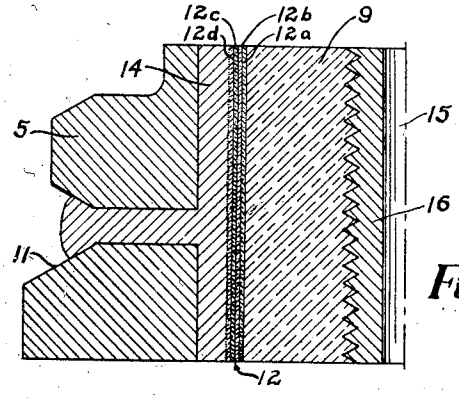


Fig 3

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Patented Nov. 8, 1938 2,136,052

UNITED STATES PATENT OFFICE

2,136,052

IGNITION DEVICE

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Application July 16, 1936, Serial No. 90,846

17 Claims. (Cl. 123—169)

This invention relates to ignition apparatus, and more particularly to spark plugs adapted for use in internal combustion engines.

The adaptability of ceramic materials, such as porcelain, for use as means for mounting the center electrode of a spark plug and for insulating said electrode from the metallic body or grounded portion of the plug, has long been known to the art. Spark plugs heretofore provided employing ceramic materials have not, however, been suitable for use in heavy duty engines, such as in aircraft engines, because the same have not been capable of withstanding the intense heat and wide temperature changes to which they are subjected. This difficulty has been due in part to the low heat conductivity from the ceramic portion of the plug to the metallic parts thereof, and in part to detrimental effects resulting from the fact that the various parts of the plug have different coefficients of thermal expansion. The low heat conductivity has been enhanced in these plugs at running temperatures by a film of hot gases of combustion which escape from the cylinder through a space between the ceramic and metallic portions of the plug, said space being created by reason of the different coefficients of expansion of the two materials. Spark plugs employing mica insulation have proved durable in heavy duty engines, but ceramic plugs possess the distinct advantage that flash-overs, such as occur in mica plugs and result in inefficient operation, are substantially avoided.

It is accordingly an object of the present invention to provide a novel spark plug in which ceramic materials are employed as insulation.

Another object of the invention is to provide a novel ceramic spark plug which is so constructed that leakage of gases therethrough is minimized.

A further object is to provide a novel spark plug wherein heat conduction from the center portions thereof to the outer air-cooled parts is greatly enhanced, thereby substantially increasing the rate of heat dissipation and prolonging the life of the plug.

Still another object is to provide a novel method of fabricating a spark plug in which ceramic insulation is employed.

A still further object is to provide a spark plug in which the detrimental effects of the different rates and extent of expansion and contraction of the various materials employed due to temperature changes is minimized.

Another object is to provide a novel spark plug which may be reliably and efficiently used in heavy duty engines during long periods of constant use without danger of failure.

The above and further objects and novel features of the invention will more fully appear from the following detailed description when the same is taken in connection with the accompanying drawing. It is to be expressly understood, however, that the drawing is for the purpose of illustration only and is not designed as a definition of the limits of the invention, reference being primarily had for this latter purpose to the appended claims.

In the drawing, wherein like reference characters refer to like parts throughout the several views,

Fig. 1 is a side elevation, partly in section and with parts broken away, showing one form of the invention embodied in a radio shielded spark plug;

Fig. 2 is a detail sectional view on an enlarged scale of a portion of the spark plug illustrated in Fig. 1; and

Fig. 3 is a side elevation, partly in section, of a second embodiment of the invention.

One embodiment of the invention is illustrated, by way of example only, in Fig. 1 as being embodied in a radio shielded spark plug suitable for use on aircraft engines. In the form shown, said spark plug comprises a tubular metallic body 5 having external threads 6 adjacent the lower end thereof, whereby the same may be threaded into a suitable opening in an internal combustion engine cylinder (not shown). Said body is preferably constructed of a metal having a high melting point. An internal shoulder 7 is provided in body 5 for supporting a center electrode and insulation assembly to be fully described hereafter, and one or more electrodes 8 are soldered to the lower end of the body and extend radially and inwardly from the inner periphery thereof. Shoulder 7 is preferably angular, the upper surface thereof being tapered downwardly from the inner wall of the body. If desired, the upwardly extending cylindrical or barrel portion 5a of body 5 may be formed separately and threaded into the lower portion of the body, a common practice in the art today.

Heretofore ceramic insulating bodies carrying the center electrode of a spark plug have been supported by an internal shoulder in the body and held therein by means of a gland nut threaded into said body and engaging an external shoulder on the insulator. In this type

of plug, the ceramic insulator does not have firm engagement with the body and gland nut except along comparatively narrow annular surfaces which engage gaskets interposed between said insulator and body for the purpose of preventing gas leakage. Heat conduction between surfaces which merely engage each other is always low and is particularly low when the surfaces are not firmly engaged, thus leaving an appreciable air space between the same. Furthermore, when a plug of the above type is heated during use, the expansion of the metallic parts of the plug is greater than that of the insulation, thereby permitting leakage of hot gases which in escaping form a heat insulating film between the insulator and the metallic body. The heat conduction from the insulator is not only thus materially reduced but the surface of the insulator which is subjected to heating by the hot gases is materially increased. Overheating and failure of the ceramic insulator invariably results when plugs of the above type are employed in heavy duty engines.

A novel method and means are provided by the present invention for obviating the above difficulties and disadvantages encountered in ceramic plugs heretofore produced. In the embodiment of the invention shown in Fig. 1, a tubular ceramic insulator 9, made of porcelain or other suitable substance and having a reduced inside diameter at the lower end thereof, is supported in body 5 on shoulder 7, a soft metallic gasket 8*a* being interposed between said shoulder and a tapered external shoulder on the insulator. The upper end of the latter extends to a point adjacent the upper end of barrel 5*a*, which is turned inwardly to form a flange 13 that engages the top of the insulator for holding the same in the body and in firm engagement with gasket 8*a*.

For the purpose of enhancing heat conduction from insulator 9 to the air-cooled outer walls of body 5, 5*a* and to obviate the leakage and accumulation of hot gases of combustion between said insulator and body, novel heat conducting and sealing means are provided. As illustrated, the outside diameter of that portion of insulator 9, which extends above shoulder 7, is somewhat less than the inside diameter of body 5, 5*a*, thereby forming an annular space or chamber 10 which communicates with the exterior of the plug through one or more openings 11 in the wall of body 5. The outer surface of insulator 9, which forms the inner wall of annular chamber 10, is glazed in any suitable manner, for example, by spraying a mixture of pulverized glass and water thereon and then firing the same in a kiln to form one or more coats or films of glaze 12. For a purpose to appear hereafter, a plurality of films of glaze 12*a* to 12*d* may be applied to insulator 9, the inner film 12*a* (Fig. 2) having a coefficient of thermal expansion comparable to that of ceramic insulator body 9. The coefficients of expansion of layers 12*b*, 12*c*, and 12*d* increase progressively in the order named and that of layer 12*d* is comparable to the coefficient of expansion of the metal to which the same is fused in a manner to be next described.

After securing the glazed insulator 9, 12 in body 5, 5*a* in the manner above described or in any other suitable manner to provide a chamber 10, said chamber is filled or partially filled with a comparatively soft, plastic metal having high heat conductivity and adapted to be fused or welded to the glazed insulator and to have a close, firm engagement with the walls of body 5, 5*a*. In the form shown, a liner 14, of some suitable metal, such as aluminum or copper, is provided. The metal is preferably placed in chamber 10 in flaked or powdered form, hereinafter referred to as pulverized, either through openings 11 or through the upper end of the body, before the margin of barrel 5*a* is turned inwardly to form the holding flange 13. The assembled plug is then baked, the temperature being raised to a point such that the flaked or powdered metal is melted and the glazed coatings 12 are rendered soft or tacky. The metal and glaze are thus caused to fuse or weld together and form a composite mass through which heat conduction is accelerated. The metal liner 14 thus formed also assumes a firm engagement with the walls of body 5, 5*a*.

Gas leakage through the plug is thus substantially eliminated, thereby removing one of the chief causes of poor heat conduction from the insulator to the body of the plug and, at the same time, providing a structure through which heat conduction is extremely good. Furthermore, the provision of a plurality of coats of glaze having progressively increasing coefficients of thermal expansion ranging from the coefficient of expansion of insulator 9 to that of metal liner 14 prevents the adjacent layers of materials from breaking away from one another due to excessive differences in changes of lengths of said materials when the plug is subjected to wide temperature changes in use.

Liner 14 may also be provided by pouring molten metal, such as aluminum, copper, or alloys thereof, into chamber 10 through opening 11, the temperature of the metal being such that the outer surface of glaze film 12 is rendered tacky by contact therewith, thereby causing a fusing of the metal and glaze. When the latter method is employed, insulator 9, 12 is preferably coated, before assembly of the body and insulator, with a thin metallic coating which may be fused or welded to glaze coating 12 by applying the same thereto in molten form while the glaze is sufficiently heated to become tacky. Thus, when the molten metal is poured through opening 11, it is only necessary that the temperature of the same be sufficient to cause fusion or welding between the same and the previously applied metal coating.

Insulator 9 is provided with a central bore in which a center electrode 15 is closely fitted and cemented by means of any suitable electrode cement now employed in the manufacture of spark plugs. The lower end of electrode 15 projects below the lower end of insulator 9 and extends between grounded electrodes 8. Preferably, a metallic sleeve 16, made of copper or other suitable metal having high heat conductivity, surrounds the upper end of electrode 15 and is threaded into an enlarged bore in the central portion of insulator 9, said sleeve being silver soldered to electrode 15 at 16*a*. The extreme upper end of said electrode is counterbored and peened outwardly into engagement with a conducting washer 17 which rests on an internal shoulder in insulator 9.

Electrode 15 is adapted to be connected to a suitable source of high tension electric energy (not shown) by means of an insulated cable 18 which extends through a metallic radio shielding elbow 19 and is connected in some suitable manner to a conducting rod 20. The latter is supported in an insulating sleeve 21 that extends into the upper enlarged bore of insulator 9. The

lower end of rod 20 has electrical engagement with electrode 15 through a coil spring 22 which may be secured to the lower end of rod 20. This electrical engagement is maintained by a nut 23 which is threaded onto the upper end of barrel 5a and engages an external flange 24 on the lower end of elbow 19 to hold the latter in position.

A second embodiment of the invention is illustrated in Fig. 3, wherein a ceramic insulator 25 is mounted in a novel manner in a tubular metallic body comprising a member 26 and a gland nut 27. Body member 26 is externally threaded at the lower end thereof for mounting in an internal combustion engine cylinder and is provided with grounded electrodes 28. Nut 27 is externally threaded for cooperative engagement with internal threads provided in the enlarged bore at the upper end of member 26.

Interposed between insulator 25 and body 26, 27 and extending into the annular recess between the lower bevelled end of nut 27 and a bevelled internal shoulder or seat 29 in member 26 is a soft metallic ring 30, which is fused or welded to insulator 25. Ring 30 may be fused to the insulator in substantially the same manner as above described in connection with the embodiment of Fig. 1. One or more films of glaze 31 are first applied to an annular surface of the insulator, and the latter is then placed in a properly formed sand or clay mold. The cavity in the mold around the glazed surface, which cavity has the desired shape of ring 30, is filled with powdered or flaked aluminum or copper, for example, and the same baked or fired to melt the pulverized metal and cause the same to fuse to the glazed surface 31 which is rendered tacky by the heat. If desired, metal to form ring 30 may be poured into the mold in molten form.

Insulator 25 is supported in body 26, 27 by clamping ring between nut 27 and shoulder 29, sufficient pressure being exerted on the ring by said nut to form a gas-tight joint and one through which heat conduction is high in comparison to joints heretofore employed. Insulator 25, being thus supported, is free to expand and contract longitudinally relative to body 26, 27 during use without affecting the gas tightness of the plug but, at the same time, greatly reducing the probability of damage to the insulator that has heretofore resulted by reason of the different coefficients of expansion of the several parts of the plug and the varying rates at which the parts become heated in use, as well as the varying rates at which said parts are permitted to cool after being so heated.

Insulator 25 is provided with a central bore for receiving a center electrode 32 and an externally threaded sleeve 33 which is silver soldered to the upper end of said electrode. A nut 34 is threaded on the upper end of electrode 32 for holding an electric terminal (not shown) in engagement therewith.

There is thus provided a novel spark plug wherein gas leakage is minimized and the rate of heat conduction away from the parts subjected to the greatest heat is materially enhanced. Additionally, a spark plug is provided wherein the detrimental effects which heretofore resulted from the varying extent and rates of expansion and contraction of the several parts of the plug are obviated. The plug provided is simple in construction, the same comprising a comparatively few number of parts, and may be readily and inexpensively manufactured in either large or small quantities. A plug is also provided wherein the necessity for gaskets heretofore employed is eliminated.

Although only a single embodiment of the invention has been illustrated and described, it is to be expressly understood that the same is not limited thereto, but that various changes may be made therein. For example, the materials specified for glaze coatings 12, liner 14, and ring 30 are exemplary only and are specified merely as preferable. Also, chamber 12 may, of course, be wholly or only partially filled, as shown, with the metallic matrix constituting liner 14. Other changes may also be made in the design and arrangement of parts illustrated without departing from the spirit and scope of the invention, as will now be understood by those skilled in the art. For a definition of the limits of the invention, reference will be had primarily to the appended claims.

What is claimed is:

1. In a spark plug, a metallic body, an electrode, an insulator interposed between said body and electrode, and a metallic coating fused to the surface of said insulator and interposed between said insulator and said body.

2. In a spark plug, a tubular metallic body, an insulator supported interiorly of said body, and metallic means fused to said insulator and interposed between the same and said body.

3. A spark plug comprising a tubular body portion having an internal annular shoulder, an insulator in said body supported by said shoulder and having a portion of the surface thereof glazed, and means fused to said glazed surface and contacting said body.

4. In a spark plug, a metallic body, an insulator supported interiorly of said body and having a portion of the surface thereof glazed, and metallic means fused to said glazed surface and interposed between said insulator and said body.

5. A spark plug comprising a metallic tubular body having an internal shoulder, a tubular insulator supported on said shoulder, the outside diameter thereof being less than the inside diameter of said body, a metallic gasket interposed between said shoulder and insulator, means for holding said insulator in the body, and a metallic liner completely filling the lower portion of the annular space between said insulator and body.

6. A spark plug comprising a metallic tubular body having an internal shoulder, a tubular insulator supported by said shoulder, a coating of glaze on a portion of the surface of said insulator, and a metallic liner fused to said coating and engaging the inner walls of said body.

7. A spark plug comprising a metallic tubular body, a tubular insulator in said body, the diameter of said insulator being less than the inside diameter of said body, and a metallic liner fused to the outer surface of said insulator and engaging the inner walls of said body.

8. A spark plug comprising a metallic tubular body having an internal shoulder, a tubular insulator supported on said shoulder, the diameter of said insulator being less than the bore of said body, means for holding said insulator in the body, and a metallic liner interposed between said insulator and body, said liner being positioned therein while in molten form.

9. In a spark plug, a tubular body comprising a member having an internal shoulder and a member threaded into said first member, a tubular insulator extending centrally of said body, and a metallic ring fused to and surrounding

said insulator, said ring being clamped between said shoulder and said second-named member whereby said insulator is supported in said body.

10. In a spark plug, a tubular body comprising a member having an internal shoulder and a member threaded into said first member, a tubular insulator extending centrally of said body, and a radially extending metallic ring fused to said insulator and extending into the annular groove formed between said second-named member and said shoulder.

11. In a spark plug, a tubular body comprising a member having an internal shoulder and a gland nut threaded into said member, a tubular insulator extending centrally of said body, a coating of glaze on a portion of the surface of said insulator, and an annular metallic ring fused to said glazed surface, said ring being adapted to rest on said shoulder to support said insulator, the same being pressed against said shoulder by said nut.

12. The method of fabricating a spark plug, which includes glazing the surface of a ceramic insulator, mounting said insulator in a tubular metallic body to provide a chamber between said body and insulator, filling all or a portion of said chamber with metal, and fusing said metal to said glazed surface.

13. The method of fabricating a spark plug, which includes glazing the surface of an insulator, confining pulverized metal in contact with said glazed surface, and heating the same to fuse said metal to said glazed surface.

14. The method of fabricating a spark plug, which includes gazing the surface of an insulator, fusing a coating of metal to said glazed surface, mounting the insulator in a metallic body to provide a chamber between said body and insulator, injecting molten metal into said chamber, and permitting said molten metal to cool.

15. In an ignition device, a ceramic insulator, a glaze coating on a portion of the surface of said insulator, and a metallic coating fused to said glaze coating.

16. In a spark plug, a metallic body comprising a pair of separable members, a ceramic insulator in said body, a metallic ring fused to said insulator and adapted to be held between said members for supporting the insulator.

17. A spark plug comprising a metallic body, an insulator, and metallic means fused to said insulator for supporting the same in said body.

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