

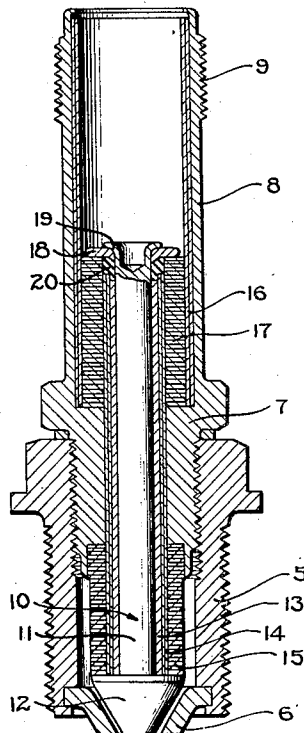
May 9, 1944.

T. TOGNOLA

2,348,427

SPARK PLUG AND METHOD OF MAKING THE SAME

Filed July 9, 1940



INVENTOR
Tullio Tognola
BY
F. Bascom Smith
ATTORNEY

UNITED STATES PATENT OFFICE

2,348,427

SPARK PLUG AND METHOD OF MAKING
THE SAMETullio Tognola, Sidney, N. Y., assignor to Bendix
Aviation Corporation, South Bend, Ind., a cor-
poration of Delaware

Application July 9, 1940, Serial No. 344,507

16 Claims. (Cl. 123—169)

This invention relates to ignition means for use in internal combustion engines or the like, and more particularly to spark plugs and methods of making the same.

It is universally conceded that the ignition system of an internal combustion engine is the most unreliable part thereof, and further that the spark plugs constitute the weakest link in an ignition system. One of the chief difficulties heretofore encountered in providing satisfactory spark plugs, particularly those of the radio-shielded type, which will function satisfactorily and efficiently for extended periods of operation, has resulted from an inability to render the plugs gas-tight. The leakage of hot gases of combustion through or along the conducting and insulating parts of a spark plug causes excessive heating of the former and the deposition of conducting material along or carbonization of the insulation. These defects in turn promote the occurrence of electrical leakage or flash-overs which disable the spark plug or render it highly inefficient. Another serious disadvantage of prior spark plugs resides in the fact that serious damage thereto often results during operation by reason of the different coefficients of expansion of the various component parts thereof. Still another disadvantage in spark plugs heretofore provided resides in the fact that moisture may penetrate the minute spaces between parts thereof and cause electrical losses. In an effort to render spark plugs tight against gas leakage and the entrance of moisture, the insulation is often over-stressed and damaged during assembly without the knowledge of the person effecting the assembly and in such manner that the damage is not detectable by inspection.

Accordingly, one of the objects of the present invention is to provide a novel spark plug wherein the above disadvantages are substantially obviated.

Another object of the invention is to provide a novel constructed spark plug wherein novel means are employed for preventing gas leakage along the center electrode and insulation therefor.

Still another object is to provide a novel method for constructing spark plugs for internal combustion engines.

A further object is to provide novel means in a spark plug whereby the effects of the different coefficients of expansion of the various parts of the plug are minimized, if not entirely eliminated.

A still further object is to provide a novel spark plug wherein moisture cannot accumulate at vital

points as it does in the spark plugs heretofore provided.

The above and further objects and novel features of the invention will more fully appear from the following detailed description when the same is read 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 intended as a definition of the limits of the invention, reference for this latter purpose being had primarily to the appended claims.

The drawing consists of a single figure showing a sectional side elevation view of one form of spark plug made in accordance with the invention.

Only one embodiment of the invention is illustrated, by way of example, in the form of a radio-shielded spark plug wherein the center electrode is insulated from the grounded metallic parts of the plug by mica insulation. It will be understood, however, that other types of shielded and unshielded spark plugs and plugs employing ceramic and other kinds of suitable insulation may also be constructed in accordance with the invention.

In the form illustrated, the novel spark plug comprehended includes a metallic shell or body member 5 adapted to be threaded into an opening in an engine cylinder (not shown) and having a ground electrode 6 mounted in the lower end thereof in any suitable manner well-known in the art. An exteriorly threaded nut or body member 7 engages internal threads in the upper end of shell 5 and is provided with a shielding extension or barrel 8. The upper end of said barrel is exteriorly threaded at 9 for connection with a shielding conduit surrounding a high tension supply cable (not shown) in a manner well understood in the art, said cable being adapted to extend into barrel 8 for electrical connection with the center electrode to be hereinafter described.

Extending through a central bore in nut 7 and electrically insulated therefrom is a center electrode 10 comprising a spindle or stem 11 and a head portion 12, the latter being positioned in spark gap relation with respect to ground electrode 6. Spindle 11 of the center electrode preferably has a drive fit in a copper or soft metallic sleeve 13 which may be considered as a part of the center electrode and is, in turn, surrounded by a mica sleeve or cigarette 14 having a tight fit in the smallest part of the bore through member 7. If desired, sleeves 13 and 14 may be assembled and then expanded slightly into firm engagement

with member 7 by forcing the slightly larger center electrode spindle through the same. Surrounding the lower portion of spindle 11 between a shoulder in nut 7 and head 12 of the center electrode is a stack 15 of mica washers. It will be understood, however, that other types of insulation may be employed for spacing electrode head 12 from nut 7.

The upper portion of stem or spindle 11 is surrounded by an insulating sleeve 16 which lines barrel 8 and a second stack 17 of mica washers or other suitable insulation which is interposed between a shoulder in member 7, 8 and a clamping washer 18. The upper counter-bored end of stem 11 is peened outwardly as at 19 into engagement with washer 18, and serves to hold the center electrode assembly in assembled relation with stacks 15 and 17 under compression.

Novel means are provided for preventing gas leakage from the engine cylinder along stem 11 and sleeves 13 and 14 and for preventing the accumulation of moisture in spaces, such as between liner 16 and insulation 17, which would promote flash-overs or other electrical leakage from washer 18, for example, to grounded member 7. Said means, as shown, are constituted by an electrical insulating compound or resin in which spindle 11 and the insulating parts surrounding the same are substantially embedded. Only a portion of this insulating material is illustrated in the drawing at 20 in an annular space surrounding the upper end of spindle 11. By means of the novel method to be hereinafter described, the compound is also caused to fill the spaces or voids in and around insulation 14, 15, 16 and 17 and around spindle 11, 13, which spaces result from the clearances allowed for assembly of the parts and from any imperfections in the materials. The compound in the minute spaces last referred to is not illustrated in the drawing because the exact structure differs in each plug and the dimensions thereof are, as a whole, too small for relatively accurate indication. For example, in one commercial embodiment of the invention there is clearance at the time of assembly of approximately .0025" between washers 17 and liner 16. These clearances are even smaller in the completed structure, i. e., after spindle 11 has been installed and the insulating parts have been compressed. The insulating compound also fills any spaces or cracks in the mica insulation which might result during assembly of the same.

The insulating material employed for filling the spaces in the center electrode assembly, as above described, is preferably a high heat resisting material which may be inserted into the plug in liquid form and thereafter set by the application of heat or otherwise. One suitable resin which has been successfully used is made from cashew nut shell oil in accordance with the teachings of U. S. patents issued to Mortimer T. Harvey. One preferred material of this character is obtained by taking the undistillable part of raw cashew nut shell oil, such as the residue obtained in following the teachings of Patent No. 2,157,126 and polymerizing the same under acid conditions, such as with sulphuric acid in the manner disclosed in Patent No. 2,128,247. A small percentage of xylol or other suitable solvent or thinning agent may be added to the resin thus obtained to produce the desired viscosity. The resin or compound may be placed in the plug in liquid form, a viscosity comparable to that of 250 S. A. E. oil being suitable. If linseed oil is used as a thinner, the desired viscosity and properties may be obtained by adding about 45 per cent linseed oil to the resin and bak-

ing the mixture for about 15 hours at 200° F. This liquid compound may be set by proper baking without appreciable shrinkage, if any, to a relatively hard, yet pliable and yieldable substance which is an excellent insulator and capable of resisting high temperatures.

A novel method for fabricating the above-described spark plugs is also comprehended, said method comprising the steps of first wrapping mica sleeve 14 tightly around copper sleeve 13, sufficient sheet mica being used to provide a tight sliding fit in the bore of nut 7. After placing liner 16 in barrel 8, sleeves 13 and 14 are inserted in member 7, 8 to a point somewhat below their final positions. Insulating washers 15 and 17 or other suitable insulators, such as ceramic sleeves or the like, are then placed around sleeve 14 and in barrel 8. With the parts of the center electrode assembly thus loosely assembled, the same are placed in a closed chamber from which the air may be evacuated in any suitable manner. After the air has been withdrawn from all the spaces between the various parts of the spark plug assembly, a quantity of the liquid compound referred to above is introduced into barrel 8 and caused to run by force of gravity and atmospheric or greater applied pressure into the spaces between the parts surrounding tube 13.

When the loosely assembled parts are thoroughly saturated with or surrounded by the liquid compound, the same are removed from the vacuum chamber and sleeve 13, 14 is moved to its final position in member 7, 8. While holding said sleeve in the desired position, stem 11 of center electrode 10 is forced therethrough, the outer diameter of said stem being somewhat greater than the inner diameter of copper sleeve 13 so that sleeve 14 is slightly expanded into firm engagement with the bore of member 7. Washer 18 is then put in place and the parts are pressed together to compress stacks of washers 15 and 17 while the end 19 of stem 11 is spun outwardly by means of a suitable tool. During the axial compression of stacks 15 and 17, the spaces containing material 20 are reduced in size and number, the excess compound being squeezed out of the assembly. This provides double assurance that the center electrode assembly is, in effect, a solid unit.

After the excess compound is removed, the compound impregnated assembly or unit is placed in an oven and baked at predetermined temperatures for predetermined periods of time to cause the liquid compound to set as a solid which will effectively prevent the passage of gases and resist the high temperatures to which the plug is subjected during engine operation. The baking temperature should be kept at all times below the boiling point of the compound, which boiling point raises as the compound gradually dries and sets. When using the cashew nut shell oil compound heretofore mentioned, it has been found suitable to bake the impregnated spark plug unit at a temperature of approximately 200° F. for approximately 39 hours, at 300° F. for 9 hours, at 400° F. for 20 hours, and finally at 500° F. for 20 hours, all of said temperatures and times being approximate and by way of example.

In some instances it may be sufficient to dip the loosely stacked insulating washers 17 or other suitable insulating means in the liquid insulating material just prior to assembling said washers in the spark plug. When the parts are compressed and secured in final position, the excess liquid fills substantially all voids around the upper end of spindle 11, and the excess material is squeezed out

or downwardly into the other parts of the assembly.

There is thus provided a novel spark plug and novel method for making the same, said spark plug being so constructed so as to obviate any leakage of gases therethrough from the engine cylinder and the consequent danger of electrical leaks from the center electrode to the grounded portions of the plug. The latter is also constructed so as to prevent the accumulation therein of moisture between the various parts thereof resulting from the condensation of gases of combustion from the engine cylinder, atmospheric condensation or other sources. Additionally, the novel method comprehended renders it possible to manufacture the novel spark plugs at a relatively low cost and without danger of damaging the insulation during fabrication.

Although only one embodiment of the invention is illustrated and described, it is to be expressly understood that the invention is not limited thereto. For example, spark plugs employing other types of insulating materials, such as porcelain or other ceramics, may embody the invention and be fabricated in accordance with the method of the invention. The invention may also be incorporated in unshielded spark plugs. Various 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 is had primarily to the appended claims.

What is claimed is:

1. In a spark plug, a tubular shell, a ground electrode mounted on said shell, and a center electrode assembly supported by said shell for cooperation with said ground electrode comprising a tubular body member, a center electrode disposed in said body member and means surrounding said center electrode for insulating the latter from said member, said insulating means including a polymer derived from cashew nut shell oil which is solid and yet pliable when set.

2. In a spark plug, the combination of a tubular body member, an elongated electrode disposed in the bore of said member, means for insulating said electrode from said member, and a solid cashew nut shell oil product filling minute spaces in and between said insulating means and said electrode, said product being yieldable and resilient when set and adapted to retain these properties when subjected to high temperatures.

3. A spark plug comprising a body, a ground electrode mounted in said body, a center electrode supported in said body in cooperative relation with said ground electrode, and electrical insulating means surrounding said center electrode comprising a yieldable filler of solid polymerized residue of distilled cashew nut shell oil.

4. In a spark plug, a center electrode assembly comprising an elongated center electrode and a plurality of insulating elements surrounding said center electrode, and a filler having a cashew nut shell oil base filling spaces between the parts of said electrode assembly to prevent gas leakage or moisture accumulation therebetween, said filler being pliable and resilient but non-moldable.

5. In a spark plug, a center electrode assembly comprising a tubular member, an elongated electrode disposed in the bore of said member, electrical insulating means interposed between said electrode and body member, and a solid

yieldable high-heat resisting insulating material having a polymerized oil base substantially filling minute spaces between the parts of said assembly to prevent the passage of gases therebetween.

6. In a spark plug, a center electrode assembly having a high-heat resistant solid, yet pliable, insulating material interspersed in the parts thereof, said material having a polymerized oil base.

7. In a spark plug, a center electrode assembly at least partially impregnated with a solid insulating material derived from cashew nut shell oil, said material being yieldable and resilient when set.

8. A spark plug comprising the combination of a central electrode, an insulating sleeve around said electrode, a body in which said electrode and sleeve are fixed, a barrel extending upward from said body beyond the end of said electrode to form a socket for an insulated high tension conductor, an insulating sleeve lining said barrel, insulating means occupying the space between said sleeves and bearing on a shoulder of the body, means on the upper end of said electrode confining said last-named insulating means, and a yieldable high-heat resistant insulating compound having a polymerized oil base substantially filling the spaces within said barrel between said electrode, said insulating means and said sleeves.

9. A spark plug comprising the combination of a central electrode having a spindle, a sheet mica sleeve around said spindle, a body in which said spindle and sleeve are fixed, a shielding barrel extending upward from said body above the end of the spindle, a sheet mica sleeve lining said barrel, a stack of mica washers occupying the space between said mica sleeves and bearing on said body, means on the upper end of the spindle confining said stack, and a solid insulating material derived from cashew nut shell oil filling spaces in said barrel between said washers and sleeves, said material being pliable and resilient.

10. A spark plug comprising the combination of a center electrode, an insulating sleeve around said electrode, a body member in which said electrode and sleeve are fixed, a shielding barrel extending from said body beyond the end of said electrode to form a socket, an insulating sleeve lining said barrel, insulating means in the space between said sleeves embedded in an insulating material having a cashew nut shell oil base, said material being pliable and resilient and adapted to retain these properties when subjected to high temperatures, and means on the upper end of said electrode for confining said insulating means.

11. The method of making a spark plug comprising the steps of making a tubular body member, introducing into the bore of said member an insulating sleeve surrounding a metallic tube, placing loose stacks of insulating washers around the projecting ends of said sleeve, withdrawing substantially all air from around the foregoing assembled parts, causing the spaces between said parts to be filled under vacuum with an insulating material in liquid form, inserting a center electrode in said tube, compressing said stacks of washers and securing the same in place in said body to form a unit structure, and heating said structure until said insulating material sets.

12. The method of making a spark plug which comprises the steps of loosely assembling a body member and insulating means for a center elec-

trode, placing the assembled parts in a vacuum, immersing said insulating means in a liquid insulating material while in the vacuum, introducing a center electrode in said insulating means, securing said insulating means and electrode in said body, and heating said material to reduce the same to a solid.

13. The method of making a spark plug which comprises the steps of applying a liquid insulating material to solid insulating means for a center electrode, securing said insulating means and center electrode in a body member, and heating the assembled parts to reduce said material to a solid.

14. The method of making a spark plug which comprises the steps of placing loosely assembled insulating parts for a center electrode in a vacuum chamber, immersing said parts under vacuum in a liquid insulating material having a relatively high viscosity, securing said insulating parts and a center electrode in a body member, and heat treating said material until it sets.

15. The method of making a spark plug having a center electrode assembly comprising a body member, a center electrode and insulating means interposed between said electrode and body member which comprises the steps of introducing an insulating material in liquid form into minute spaces in said assembly while the latter is in an evacuated chamber, and subjecting said assembly to heat to set said insulating material.

16. The method of making a spark plug which comprises the steps of loosely assembling parts of a center electrode assembly, placing said parts in an evacuated chamber, introducing a liquid insulating substance into the evacuated spaces bordered by the insulating means of said assembly, securing the parts of said assembly together, and treating said substance to cause the same to set.

TULLIO TOGNOLA.