Sept. 19, 1933. G. M. PAULSON 1,927,500

MANUFACTURE OF SPARK PLUGS

Original Filed July 15, 1929

Fig. 2.

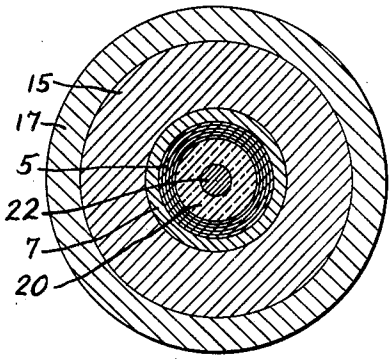


Fig. 1.

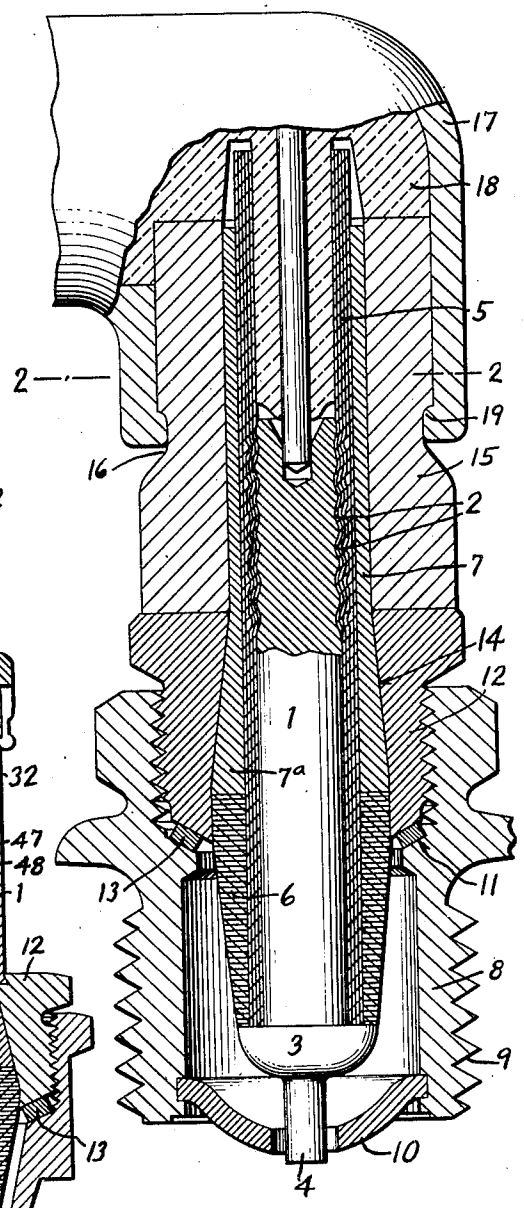


Fig. 3.

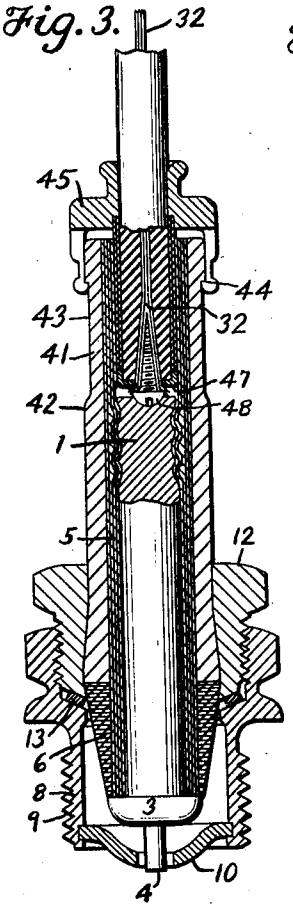
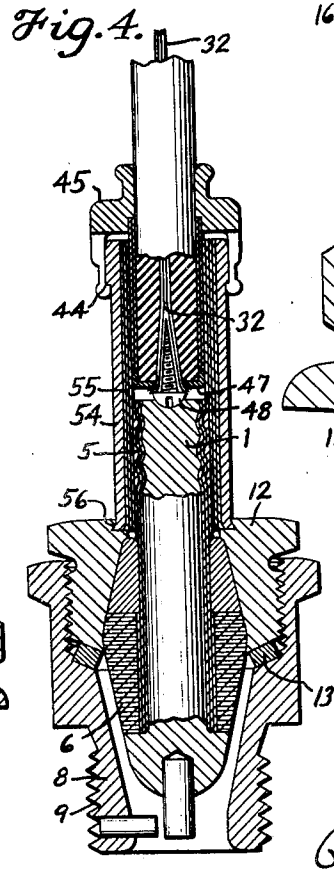


Fig. 4.



George M. Paulson INVENTOR

BY Harry A. Yerkes, Jr. ATTORNEY

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MANUFACTURE OF SPARK PLUGS

George M. Paulson, New York, N. Y., assignor to The B. G. Corporation, New York, N. Y., a corporation of New York

Original application July 15, 1929, Serial No. 378,221. Divided and this application September 10, 1930. Serial No. 480,862

1 Claim. (Cl. 29—155.51)

This application is a division of my copending application Serial No. 378,221, filed July 15, 1929.

The present invention relates to spark plugs and the manufacture thereof and has particular reference to the manufacture of spark plugs intended for exceptionally severe service, such as aircraft motor plugs.

The service conditions imposed on plugs used in airplane motors is exceptionally severe, as the high compression ratios employed and the use of air cooling result in extreme combustion chamber and cylinder temperatures, the effects of which the plugs must be able to withstand. Furthermore, plugs intended for this service must be formed to withstand extreme vibration and relatively sudden and wide temperature variations without the parts thereof tending to loosen. It is also desirable for plugs intended for such service to be of relatively compact form.

In accordance with the present invention I provide an improved method of manufacturing spark plugs by means of which plugs capable of withstanding the severe conditions of aircraft service above enumerated may be produced.

The method contemplated by the invention may be used in the manufacture of plugs of various kinds and types and its nature and the several detailed objects thereof may best be understood by a consideration of the following description of the several examples illustrated in the accompanying drawing.

In the said drawing:

Fig. 1 is a vertical section on an enlarged scale of a preferred form of plug;

Fig. 2 is a section taken on the line 2—2 of Fig. 1;

Fig. 3 is a vertical section, enlarged, of another form of plug; and

Fig. 4 is a vertical section of a third form of plug.

Referring now to Fig. 1, the plug comprises a cylindrical central spindle 1, preferably made from steel having a high heat-conducting characteristic, the upper portion of which is preferably corrugated by a series of circumferential grooves 2 and the lower end of which terminates in an enlarged semi-spherical head 3 from which the center electrode 4 projects. The head 3 is preferably of special non-scaling steel welded to the spindle, and the electrode 4 of an alloy such as manganese-nickel especially adapted to withstand erosion due to the spark arc.

The spindle 1 is surrounded by a mica insulating tube 5, which it will be noted extends for a considerable distance above the upper end of the spindle. The lower end of the mica sleeve is surrounded by a number of mica washers 6, which are held in place between the shoulder formed by the enlarged spindle head 3 and an annular cylindrical brass sleeve 7, the lower end of which is enlarged to form the conical portion 7^a.

The usual steel shell 8, threaded exteriorly at 9 and provided with a suitable electrode 10, is formed with a conical gasket seat 11, between which and the coupling nut 12 the soft copper gasket 13 is placed to form a gas-tight seal. The lower conical portion 7^a of sleeve 7 fits the correspondingly tapered bore 14 in nut 12, and the upper cylindrical portion of sleeve 7 is surrounded by the brass barrel 15. Barrel 15, it will be noted, extends above the top of spindle 1, as do tube 5 and sleeve 7, the portion above the spindle having a smaller outer diameter than that surrounding the spindle. A circumferential groove 16 is located between the portions of different diameter.

The mica tube 5 is rolled on spindle 1, preferably with sufficient pressure to cause it to press into grooves 2. Mica washers 6 are then slipped over the tube, followed by sleeve 7, the latter being then forced into the conical bore 14 of nut 12 with sufficient force to form a tight joint. The barrel 15 is then placed over the upper end of sleeve 7 and an annular die drawn over the lower and larger diametered portion of the barrel to compress it, and with it sleeve 7 and tube 5. A tremendous lateral pressure is thus exerted, forcing the insulation into the spindle grooves and causing the metal in sleeve 7 and barrel 15 to take a permanent set which binds the several elements tightly and permanently together. It will be apparent to those skilled in the art that with a properly proportioned die, sufficient lateral pressure may be exerted to bind the elements together without the aid of the spindle grooves to prevent longitudinal movement.

In ordinary, or unshielded, spark-plugs, in which the spindle extends above the top of the plug to receive a nut, it is simple to lock the parts in assembly. In the kind of spark-plug to which the present invention relates a more difficult problem is presented. It is essential that the parts of the plug remain in tight and solid assembly notwithstanding the high temperatures and pressures and the great vibration to which the spark-plugs are subjected in aviation engines particularly. The forces tending to cause slipping or loosening are especially severe when the spindle is insulated in the highly effective man-

ner shown in the drawing, that is to say by mica wrapped about the spindle and by a stack of mica discs held under compression between the head of the spindle and a shoulder afforded by some part of what may be termed the body of the spark-plug. This mica has a relatively large coefficient of expansion and when highly heated exerts a very great force tending to pull the spindle downward in the plug. This loosening force is to be resisted without the aid of a top nut or the like, and that is accomplished by providing for a tremendous inward compression of a sleeve or barrel which extends above the upper end of the spindle, or of two metal elements surrounding the upper part of the spindle and its wrapped insulation. This permanent compression or distortion of the metal enclosure must extend over an appreciable length in order to be adequate as the sole locking of this assemblage. The portion compressed by a die-drawing operation should be cylindrical, or virtually cylindrical, and should be of substantial length for effective results.

Other specific means for permanently deforming or setting the metal, such, for example, as a rolling operation, may be employed.

The assembly thus formed results in a substantially integral unit, much superior to corresponding units in prior known forms of plug, which in some instances have employed compressed metal rings to obtain a gas-tight seal, but which have relied on threaded or equivalent means for holding the elements of the unit in assembled relation.

While in the preferred form illustrated, the nut 12 and barrel 15 are separate elements, it will be understood that they may be made integral by welding, or from a single blank of the same metal heat-treated to form a hard lower threaded end and a relatively soft upper end suitable for the die-drawing process above described.

In this particular form of plug, a brass elbow 17 filled with bakelite or other insulating material 18 is fitted over the upper end of barrel 15 and held in place by the crimped end 19 fitting into the groove 16, this coupling, while holding the elbow against longitudinal displacement, permitting the elbow to be rotated about the axis of the barrel. The construction of this elbow, the terminal connection and the means providing a path for high tension current to the spindle 1 need not be described, as they form no part of the invention of this divisional application.

In Fig. 3 a modified form of plug is shown in which the terminal connection is axial with the plug. In this form the corrugated spindle 1 is surrounded by the mica tube 5, which extends above the end of the spindle and is in turn surrounded by the sleeve 41, the lower conical end of which is seated in the coupling nut 12. The upper end of sleeve 41 has a lower larger diameter 42 and a smaller upper diameter 43.

In general, the assembly of this plug is similar to that of the form shown in Fig. 1, sleeve 41 being set into nut 12 with sufficient pressure to assure a gas-tight seal. Spindle 1 and sleeve 5 are locked in place by compressing the lower larger diametered portion 42 of sleeve 41, preferably through a die-drawing operation, which will cause a flow of metal downward as well as inward to additionally insure a seal between sleeve 41 and nut 12. In this case sleeve 41 performs the function of barrel 15 shown in Fig. 1.

A brass cable terminal hub 45 is fitted tightly around the ignition cable, the braided wire center 32 of which passes through a brass washer 47, secured in place by a screw 48.

In Fig. 4, another variation is shown. In this form, the mica tube 5 around spindle 1 is not extended above the upper end of the latter, and the spindle and tube are set into the coupling nut 12 with a conical brass ring, which is sufficiently compressed to form a gas-tight seal. The coupling nut 12 is provided with an undercut recess 56 into which the lower end of brass sleeve 54 extends, this sleeve being lined with a mica tube 55. Spindle 1 is locked in position by compressing sleeve 54, preferably by a die-drawing operation, which will cause the metal of the latter to flow into the recess 56. Alternately, sleeve 54 may be attached to nut 12 by rolling its lower end into the recess 56.

If the lower end of sleeve 54 is, as shown, smaller in diameter than the shouldered portion 44, a split die may be used for the drawing operation.

From the foregoing description it will be seen that the present invention provides a form of plug which meets the severe conditions imposed on plugs in the class of service for whch it is intended, as the construction according to the invention provides a mica-insulated high-tension unit which is, after assembly, substantially integral and therefore not subject to the possibility of loosening or disassembly due to backing off of nuts because of motor vibration, as in the case with heretofore known forms of mica plugs.

The improvement of this invention relates more especially to spark-plugs of the shielded type, in which the high-tension current carrying elements of the system are entirely surrounded by a metallic shield grounded to the motor, to absorb the high frequency discharges which would affect reception of signals in an adjacent radio receiving set, such shield also serving as a protection against short-circuiting of the high-tension current by moisture from rain, snow or sleet, or by deposits of oil thrown from the engine or of salt from sea spray. The shielding of the plug is fully described in the application of which this is a division.

I claim:

In the manufacture of spark-plugs, the method which consists in surrounding the spindle with a mica insulating sleeve, providing as part of the outer structure of the plug a substantially cylindrical sleeve or barrel that surrounds the spindle and insulating sleeve and extends above the upper end of the spindle, and, by temporarily applying force around said cylindrical sleeve and lengthwise thereof, creating a broad zone of permanent and distributed compression capable of locking the spindle in the spark-plug, in the absence of other aid, without injury to the insulating sleeve.

GEORGE M. PAULSON.