June 16, 1942. S. H. STUPAKOFF 2,286,515

SPARK PLUG AND METHOD OF MAKING THE SAME

Filed Sept. 11, 1940

Fig. 1.

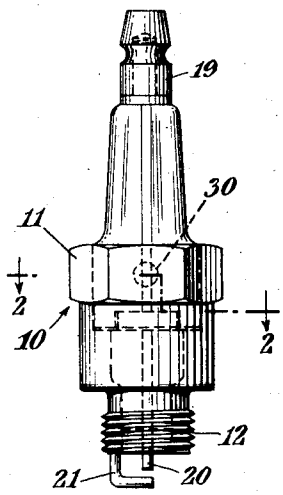


Fig. 2.

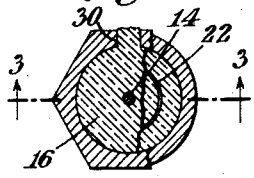


Fig. 3.

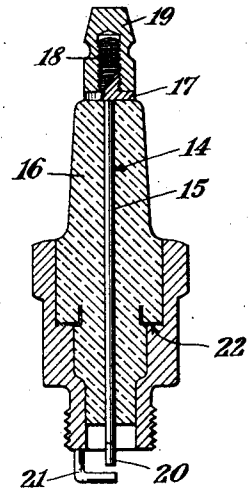


Fig. 4.

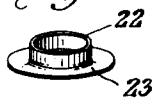


Fig. 5.

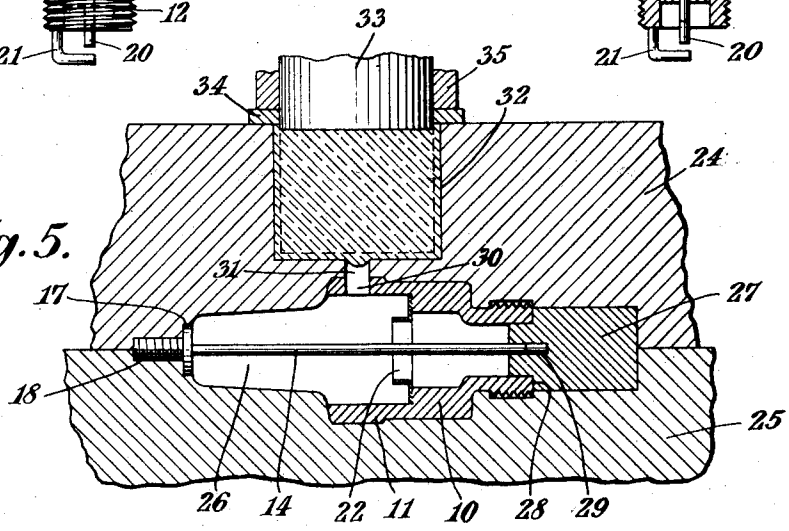


Fig. 6.

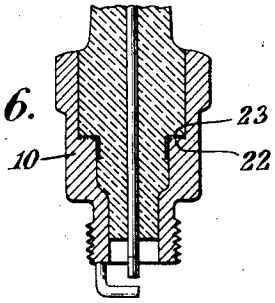
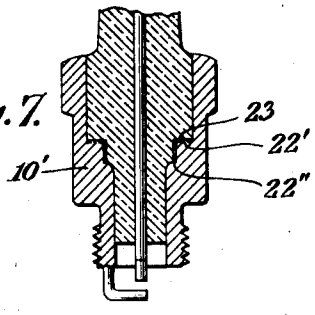


Fig. 7.



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SPARK PLUG AND METHOD OF MAKING THE SAME

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Application September 11, 1940, Serial No. 356,240

18 Claims. (Cl. 123—169)

This invention relates to spark plugs, and to methods of making the same.

The kind of spark plug to which the invention pertains is that wherein an electrode-carrying main outer metal body or jacket and through which is extended the central electrode, is separated from the latter by an insulator made of a material, such as glass, which has a coefficient of thermal expansion lower than the metal of which the jacket is made.

In U. S. patent to me No. 2,103,759, there is disclosed a method of employing a material like glass, instead of porcelain or the like, for the making of the insulator. A feature of said method is the use in special relation to the glass, of a metal or alloy whose coefficient of thermal expansion can be matched to glass, such, for instance, as the alloy Kovar. As explained in my U. S. Patent No. 2,103,759 "Kovar" is an alloy of the type disclosed in U. S. Patent No. 1,942,260, and this alloy is commercially available under the trade-mark "Kovar."

The use of a material like glass for the insulator but in a different way than as explained in said patent, and of a metal or alloy like Kovar substantially according to the teachings of said patent so far as is concerned the useful functioning of said metal when encircled by glass and when interposed between the jacket and glass, is the basis of the present invention. (Hereinafter, for brevity, Kovar merely will be mentioned and claimed, but then as inclusive of Kovar or the like, that is, of any metal or alloy having a coefficient of thermal expansion which can be matched to glass; and hereinafter also, likewise for brevity, glass merely will be mentioned and claimed, but then as inclusive of any suitable transparent material. A transparent material for the insulator is highly desirable, for the reason that when the insulator is transparent one can determine by the light which diffuses upwardly through the insulator just how the cylinder is firing without removing the plug from the engine.)

In the particular way described in detail in said patent as the then recommended procedure in carrying out the method forming the subject-matter thereof, the glass insulator is a preformed tubular one, and the auxiliary member, made of Kovar, is of ring form. In carrying out the present invention, a Kovar member in this form is still preferred; but the insulator is a solid mass of glass cast in situ, in the metal jacket, for instance as taught in U. S. Patent No. 1,731,280 to Warren, and preferably thus cast after preassembly of the Kovar member and the jacket in such manner that at least a part of said member is extended into the interior of the jacket, so that the molten glass entered into the jacket solidifies in part against the metal of the jacket and in part against a portion of the Kovar member in the jacket.

Thereby the very important objects are obtained of effecting a large reduction in the cost of manufacture of a plug made in accordance with the aforesaid patent to me while retaining important advantages thereof, this because the glass insulator is cast in place in the jacket; and of providing mechanically a much sturdier plug, this because the insulator is a solid block of glass instead of a fragile tube.

By the present invention, as in said patent to me, the Kovar member is preferably non-integral with the jacket and is permanently fused, as by welding, to the jacket, so as to set up a permanent gas-tight seal between the jacket and the Kovar member; but by the present invention the Kovar member is preferably wholly contained in the jacket when thus joined thereto, thereby to have said member completely embedded in the glass insulator.

In carrying out the present invention, thereby to provide a solid glass insulator instead of a tubular one as recommended in said patent to me, a borosilicated glass having about the same thermal coefficient as called for by said patent has been successfully used, to provide not only a gas-tight plug but a very inexpensive and rugged one having sufficiently high resistance to thermal shock and enough electrical resistance between its jacket and its central electrode to warrant its adoption in service.

The invention will be more clearly understood from the following description, when taken in connection with the accompanying drawing, which illustrates embodiments of the invention as now preferred, but it will be understood that this drawing and description are merely by way of illustration, since the scope of protection contemplated is to be taken from the claims appended.

In said drawing:

Fig. 1 shows, in side elevation, one form of spark plug according to the invention.

Fig. 2 is a transverse section, taken substantially on the line 2—2 of Fig. 1.

Fig. 3 is a longitudinal section, taken substantially on the line 3—3 of Fig. 1.

Fig. 4 is a perspective view, showing, on an en-

larged scale, a Kovar ring member which is in the form of an eyelet.

Fig. 5 is a vertical sectional view, taken through a means for molding the glass insulator.

Fig. 6, partially broken away at the top, is a view similar to Fig. 3, showing a different embodiment.

Fig. 7 is a view similar to Fig. 6, showing still another embodiment.

Referring to the construction illustrated in Figs. 1 through 4, 10 designates the metal jacket, having a head portion 11 polygonally shaped for engagement by a wrench, and a threaded extension 12 to be entered in a cylinder of the engine. A central electrode 14 has its main length, this length marked 15 and made of Kovar, encased in an insulator 16 which is a solid mass of glass cast in situ, so as to fill the interior of the jacket down to a point some distance above the bottom of the latter, and so as to extend up above the top of the jacket as a substantially conical extension the flat top of which lies against the underside of a disk 17 which is integral with a threaded stud 18 for taking a nut-like terminal 19.

The central electrode 14 is shown as made up of three separate pieces, these being the said main length 15 of Kovar, an upper fitment including the disk 17 and the stud 18 of any suitable metal or alloy less expensive than Kovar, and a lower sparking tip 20 of any suitable metal or alloy better adapted than Kovar to constitute a sparking point. These three pieces which here make up the central electrode are permanently joined into a unitary structure, as by welding the squared off upper end of the part 15 to the disk 17, and the squared off lower end of the part 15 to the squared off upper end of the tip 20.

Any suitable type of electrode for sparking coaction with the central electrode can be provided, such as the one shown at 21, projected from the inner end of the threaded extension 12 of the jacket.

The hollow within the jacket 10, which extends from end to end thereof, is annularly flatly shouldered at 22, and on this shoulder is seated a Kovar eyelet 23. The eyelet is positioned on the shoulder 22 so that the horizontal flange of the eyelet rests on said shoulder, and this flange is welded to the shoulder. Since in the form of the invention now being described the entirety of the eyelet will be embedded in the glass as soon as the insulator is cast in place in the jacket, welding of the horizontal flange of the eyelet to the shoulder 22 will be performed before the glass insulator is cast. The welding is continuous all around the eyelet.

Referring to Fig. 5, the jacket 10, having welded therein the eyelet 23, is shown as held in a mold including separable parts 24 and 25, establishing between them a cavity 26 shaped at its extreme left end to receive the disc 17 and the stud 18 of the central electrode 14. The opposite end of this cavity is shaped to receive a metal plug 27. To the left of the location for this plug, the cavity 26 is shaped to receive the jacket 10, and to the left of the location for the jacket, the cavity is shaped to form the conical extension of the insulator beyond the jacket. The end of the plug 27 adjacent to the jacket is reduced in diameter to fit snugly within yet readily removably from the interior of the jacket, and the plug has an annular shoulder 28 to abut against the inner end of the jacket when the parts are arranged as illustrated. This reduced end of the plug 27 has a cylindrical recess 29 for seating the sparking end of the central electrode 14. The cavity 26 furthermore is so shaped, relative to the shaping of the jacket 10, that with the mold part 24 removed, and with the plug inserted in the jacket and the center electrode inserted in the plug, this temporary assembly of jacket, plug and center electrode can be laid in the part of the cavity 26 formed in the mold part 25 in such way as to insure maintenance of such assembly and to settle the center electrode in the jacket coaxial with the latter and at the same time in a way to locate a round opening 30 in the jacket, normal to one of the flat faces of its wrench-taking part 11 as indicated in Fig. 1, in registry with a molten glass supply port 31 in the mold part 24 when that part is replaced on the mold part 25 as shown. As will be understood, these mold parts are in any suitable way tightly clamped together, before admission of molten glass. The mold just described is substantially of the same general type as described in the aforesaid U. S. patent to Warren; which patent is owned by the assignee hereof, who is also the assignee of the aforesaid patent to me. The molten glass supply port 31 is at the bottom center of a molten glass feed cup 32, served by a descending plunger 33 carrying compression rings 34 and 35. As the parts are shown, this plunger has descended just far enough to cause a little of the molten glass to begin entry into port 31.

After setting of the glass, the plug is completely made; except for, preferably, the subsequent addition of the electrode 21, and except for breaking off the stem of glass in the opening 30 where the latter protrudes beyond the exterior of the part 11 of the jacket, should it so protrude after opening of the mold and removal of the plug therefrom, and except for grinding the glass smooth and flush with said part 11, if such finish is desired.

Referring to the form of the invention shown in Fig. 6, the plug here shown is in all respects similar to the plug of Fig. 3, and is one made as described in connection with Figs. 3 and 5, except that the Kovar eyelet 23 is arranged with its neck depending, instead of upstanding as in Fig. 3. The arrangement of Fig. 6 is preferred over that of Fig. 3, as eliminating or minimizing the creation of small checks in the glass, sometimes obtained when the glass is flowed into the jacket of the plug in a direction such that the glass moves therein along a path causing it to be struck head-on by an edge portion of the Kovar member, which member is usually only a few thousandths of an inch thick. It is most convenient to admit the glass through a port in the jacket at about the location of the port 30 of Fig. 1, so that the glass flows in the jacket toward and past the shoulder 22; and whereas in the case of Fig. 3, the molten glass thus admitted moves in a path so as to be struck head-on by the upper edge portion of the neck of the eyelet, in Fig. 6 the molten glass thus admitted moves in a path so as to slip freely past said edge portion, now at the bottom of the eyelet and close against a cylindrical interior of the jacket below the shoulder 22.

The form of the invention shown in Fig. 7 even better attains the advantage last discussed. Here, it will be noted, with the Kovar member still the eyelet 23, and arranged as in Fig. 6 on a shoulder 22' exactly like the shoulder 22 of

Fig. 6, the jacket, marked 10', has its interior so shaped that a second and lower shoulder is provided, at 22'', for having squarely abutted thereagainst the lower edge portion of the depending neck of the eyelet, and beyond the locus of the bottom of the eyelet this shoulder 22'' is laterally downwardly curved into smooth merging with the cylindrical interior wall of the jacket therebelow.

In any form of the invention, then, due to the fact that the Kovar member welded to the jacket is thereby fused thereto annularly of the jacket, and due to the fact that the glass cast against the Kovar member is fused thereto also annularly of the jacket, a permanent gas-tight seal is provided between the jacket and the insulator; and due to the fact that the glass likewise is fused encirclingly of a part of the central electrode made of Kovar, a permanent gas-tight seal is at the same time provided between the central electrode and the insulator—all exactly as in the aforesaid patent to me, but according to a method of manufacture which is very much less expensive than that of said patent and provides a mechanically strong and rugged plug.

It is to be emphasized that while I have stressed herein the advisability of preassembly of the Kovar member and the jacket, and by welding, and in such manner that by this preassembly the Kovar member is wholly or partially extended into the interior of the jacket, it is possible that further experimentation will show that satisfactory results can be obtained when such weld-joined preassembly is dispensed with, or when the Kovar member is wholly beyond one end of the jacket; that is, when the molten glass is to cast to form the insulator so as to solidify partially against the jacket and partially against the Kovar member, and thereafter, with the Kovar member only partially inserted in the jacket or wholly beyond an end of the same, the Kovar member is permanently fused to the jacket. As in the aforesaid patent to me stated, the terms "fused" or "fusion" are intended, particularly in the claims following, to cover a joint produced by heating and fluxing contacting surfaces, as by welding, soldering, or fluxing, to produce a permanent gas-tight connection.

As will be understood, variations and modifications other than those illustrated and described are possible within the scope of the invention as defined by the claims.

I claim:

1. A spark-plug comprising a metal jacket, a central electrode including a length of Kovar, a Kovar member permanently fused to the jacket, and a glass insulator cast in the jacket and around said electrode length and against said member and fused to the two parts last mentioned by the setting of the glass.

2. A spark-plug comprising a metal jacket, a central electrode including a length of Kovar, a Kovar member of a composition different from that of the jacket and permanently fused to the jacket, and a glass insulator cast in the jacket and around said electrode length and against said member and fused to the two parts last mentioned by the setting of the glass.

3. A spark-plug comprising a metal jacket, a central electrode including a length of Kovar, a Kovar member at least partially extended into the interior of the jacket and permanently fused to the jacket, and a glass insulator cast in the jacket and around said electrode length and against said member and fused to the two parts last mentioned by the setting of the glass.

4. A spark-plug comprising a metal jacket, a central electrode including a length of Kovar, a Kovar member wholly in the interior of the jacket and permanently fused to the jacket, and a glass insulator cast in the jacket and around said electrode length and against said member and fused to the two parts last mentioned by the setting of the glass.

5. A spark-plug comprising a metal jacket, said jacket having an interior shoulder, a Kovar member permanently fused at said shoulder to the jacket, a central electrode, including a length of Kovar, and a glass insulator cast in the jacket and around said electrode length and against said member and fused to the two parts last mentioned by the setting of the glass.

6. A spark-plug comprising an electrode including a length of Kovar, a metal jacket open from end to end and through which the electrode passes, a Kovar member permanently fused to the jacket, and a solid glass body supporting the electrode and insulating it from the jacket, said glass body fused to said electrode length and to said member.

7. A spark-plug comprising an electrode, including a length of Kovar, a metal jacket open from end to end and through which the electrode passes, a Kovar member having a flange, said flange permanently fused to the jacket, and a solid glass body supporting the electrode and insulating it from the jacket, said glass body fused to said electrode length and to said member.

8. A spark-plug comprising an electrode, including a length of Kovar, a metal jacket open from end to end and through which the electrode passes, a solid glass body supporting the electrode and insulating it from the jacket, the metal jacket carrying a thin flange member of Kovar, said flange member being joined to the jacket by permanent fusion of the metal of the flange member with the metal of the jacket, and said glass body being fused to said electrode length and to said member.

9. A spark-plug comprising an electrode, including a length of Kovar, a metal jacket open from end to end and through which the electrode passes, a solid glass body supporting the electrode and insulating it from the jacket, and a Kovar eyelet including an annular flange permanently fused to the jacket, said solid glass body being fused to said electrode length and to said member.

10. A spark-plug as in claim 9, in which the eyelet is wholly pocketed between the glass body and the jacket.

11. A spark-plug as in claim 9, in which the jacket intermediate its ends is internally annularly shouldered, and said flange is permanently fused to the jacket at said shoulder.

12. A spark-plug as in claim 9, in which the jacket is internally annularly shouldered, and said flange is permanently fused to the jacket at said shoulder, said eyelet including a neck portion depending below said shoulder.

13. A spark-plug as in claim 9, in which intermediate its ends the jacket has a higher internal annular shoulder and a lower internal annular shoulder, said eyelet including a neck portion dependent from said flange, said flange being permanently fused to the jacket at said higher shoulder and the rim portion at the bottom of said neck overlying said lower shoulder.

14. A spark-plug as in claim 9, in which the

jacket is internally annularly shouldered, and said flange is permanently fused to the jacket at said shoulder, said eyelet including a portion downwardly offset from said flange, and the interior of the chamber being recessed below said shoulder to receive said downwardly offset portion.

15. The method of assembling a spark-plug which includes, as one step, casting a solid body of glass about a central electrode, including a length of Kovar, and within a metal jacket and against a Kovar ring, so that, during the setting of the glass to form said body the glass is fused to said electrode length and to said ring, and, as another step, welding the Kovar ring to the jacket.

16. The method of assembling a spark-plug which includes, as one step, casting a solid body of glass about a central electrode, including a length of Kovar, and within a metal jacket and against a Kovar ring, so that, during the setting of the glass to form said body the glass is fused to said electrode length and to said ring, and, as another step, welding the Kovar ring to the jacket before said casting step.

17. The method of claim 16, in which said ring includes a thin tubular portion open at both ends and through the interior of which the molten glass is flowed longitudinally of the jacket during said casting, said tubular portion at one end terminating in an edge directed toward one end of the jacket, and said ring being arranged in the jacket, relative to the point of admission of the molten glass, so that the flowing glass approaches said edge after passing through the tubular portion.

18. The method of claim 16, in which said ring includes a portion extending downwardly of the jacket and over which the molten glass is flowed during said casting, and in which the interior of the jacket is recessed and an edge of said extension toward which the glass thus flows is entered in said recess prior to the admission of the glass.

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