Aug. 11, 1964 E. HAGMAIER ETAL 3,144,576

SPARK PLUG AND METHOD OF MANUFACTURE

Original Filed May 28, 1954

FIG.1

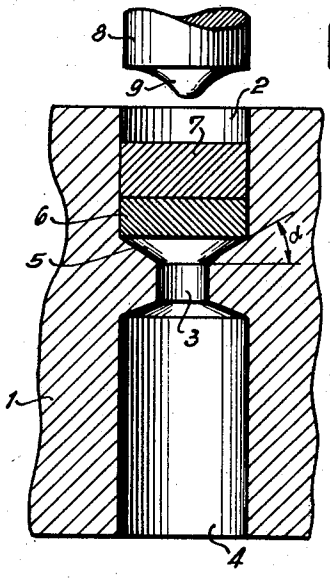


FIG.1a

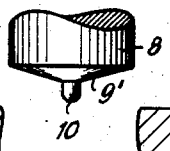


FIG.2

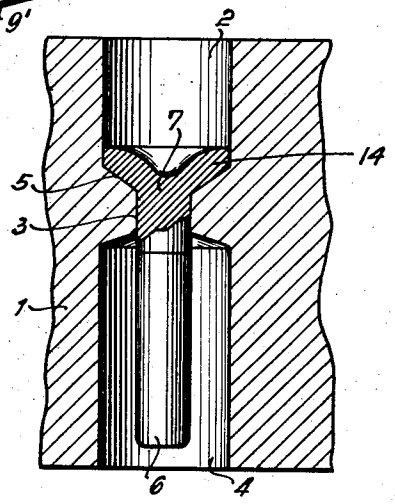


FIG.3

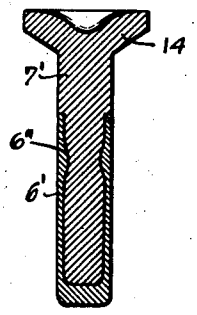


FIG.4

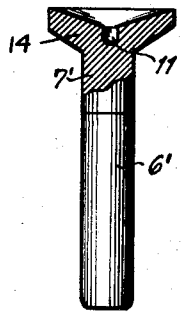


FIG.5

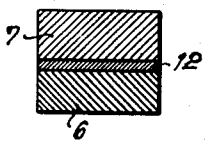
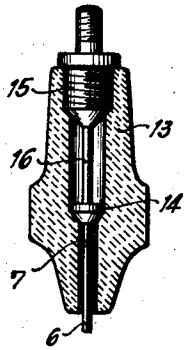


FIG.6



INVENTORS:
EUGEN HAGMAIER,
LOTHAR LEINERT AND
PAUL RIETHMÜLLER
BY:

United States Patent Office 3,144,576 Patented Aug. 11, 1964

3,144,576

SPARK PLUG AND METHOD OF MANUFACTURE

Eugen Hagmaier, 15 Hildebrandstrasse, Stuttgart, Germany; Paul Riethmüller, 39 Klagenfurter Strasse, Stuttgart-Feuerbach, Germany; and Lothar Leinert, deceased, late of Stuttgart, Germany, by Paula Leinert, heir, 131 Reinsburgstrasse, Stuttgart, Germany

Continuation of abandoned application Ser. No. 433,250, May 28, 1954. This application Feb. 14, 1962, Ser. No. 173,861

11 Claims. (Cl. 313—141)

The present invention relates to spark plugs. More particularly it relates to an improved spark plug having an extruded composite electrode formed of high heat conductivity metal enveloped by a high-temperature metal.

This application is a continuation of copending U.S. S.N. 433,250, filed May 28, 1954, now abandoned.

Hence, one of the objects of this invention is to provide an improved spark plug.

Another object of the present invention is to provide an extremely reliable and inexpensive new process involving the manufacture of the improved spark plug.

Still another object of the present invention is to provide an apparatus useful in the manufacture of spark plugs.

A further object of the present invention is to provide an improved spark plug electrode and a method of forming it.

A still further object of the invention is to provide a composite billet useful for extruding into a composite spark plug electrode.

With the above objects in view, the present invention involves making an improved spark plug by placing in a die, having a pressure chamber provided with a converging end and having an outlet passage of a smaller cross section than said chamber communicating with the center of the converging end, at least two metallic plates respectively of different metals of different hardness with the harder of said plates located nearer to the converging end of the chamber than the softer of the plates, cold extruding said plates through the outlet passage into a composite wire in such a manner that the harder plate is formed into a tube having a closed end and an opposite open end and so that the softer plate forms a core extending into and surrounded by the tube, and assembling the wire as a center electrode in a spark plug.

The novel features which are considered as characteristic for the invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof, will be best understood from the following description of specific embodiments when read in connection with the accompanying drawings, in which:

FIGURE 1 fragmentarily illustrates in section an extrusion die constructed in accordance with the present invention and shown in association with a pressing member and a pair of metal plates which are to be extruded by the pressing member through the outlet passage of the die;

FIGURE 1*a* fragmentarily illustrates a pressing member of a slightly different configuration from that of FIGURE 1;

FIGURE 2 illustrates the material after it has been extruded in the die and before removal thereof from the die;

FIGURE 3 shows a longitudinal section of an article manufactured according to the process of the invention;

FIGURE 4 shows partly in section an article formed according to the process of the invention with the pressing member of FIGURE 1*a*;

FIGURE 5 illustrates a variation according to which a layer of soldering material is located between the two metal plates which are to be extruded; and

FIGURE 6 is a sectional longitudinal view through a spark plug showing a base section of a center electrode formed according to the process of the invention mounted within the spark plug.

Referring now to the drawings, it will be seen that the die 1 is formed with a pressure chamber 2 having a converging bottom end 5 communicating with an outlet passage 3 located at the center of the converging bottom end 5 of the chamber 2, this outlet passage 3 further communicating with a bore portion 4 which has a diameter larger than that of outlet passage 3, the latter having a diameter which is smaller than that of the chamber 2. The converging bottom end 5 of the chamber 2 which interconnects the latter with the outlet passage 3 is preferably conical and forms with a horizontal plane, as viewed in FIGURE 1, an angle of approximately 30°, that is, the conical surface 5 makes with the vertical axis of the chamber 2 an angle of approximately 60°.

According to the embodiment of FIGURE 1 a plate 6 is introduced into the pressure chamber 2 and an upper plate 7 preferably made of copper is located over the lower plate 6 preferably made of nickel. This lower plate 6, if made of nickel, has a thickness which is approximately one-third of its diameter. Also, the lower plate 6, if made of nickel, may be provided wtih a copper coating which improves the joint between the two plates during extrusion thereof and which also reduces the friction between a nickel plate and the die.

The pressing member 8 of FIGURE 1 has at its bottom working face a substantially conical projection 9. This projection serves to curve the plates before the lower plate 6 flows through the outlet passage 3. The shape of the projection 9 is carefully designed so as to influence in a desired manner the manner in which the plates flow into each other during extrusion thereof in accordance with the properties of the materials of the plates.

The pressing member of FIGURE 1*a* is provided at the center of its conical working face 9′ with a projecting pin portion 10 which serves to form the lower plate 6 into a third tubular part 6′ having a relatively thin closed bottom end, so that the soft core 7′ extends almost up to the free bottom end of the finished member.

After the extrusion process is completed the plates 6 and 7 are transformed into the shape shown in FIGURE 2 with an enlarged, substantially conical top section 14. The form of the converging bottom end 5 of chamber 2 and the outlet passage 3, according to the invention, assures that when nickel is used for the lower plate 6 and copper for the upper plate 7, the nickel will have the construction shown in FIGURE 3 wherein adjacent the top end of the tubular nickel shell surrounding the copper core 7′, there is a thickened portion 6″ of the tubular member 6′, so that in this way the copper core is securely joined to the nickel shell.

The finished extruded part is pressed out of the die 1 in a conventional manner by a known ejector member or it may simply be drawn out by the pressing member 8 against which the extruded part lightly clings.

The member shown in FIGURE 3 is formed with the pressing member and die of FIGURE 1 while the member shown in FIGURE 4 is formed with the pressing member of FIGURE 1*a* and the die 1 of FIGURE 1. With the embodiment of FIGURE 4 a depression 11 is formed by the projection 10 of the pressing member in the top end 14 of the extruded part. When this part is

used as an electrical conductor the depression 11 serves to aid in the fastening of a second electrical conductor to the member shown in FIGURE 4.

As is shown in FIGURE 5, it is possible to locate between the plates 6 and 7 a layer 12 of a metallic solder, such as, for example, an alloy of lead, tin and/or bismuth, which serves the purpose of improving the flow of the two materials into each other and improving the joint therebetween. This intermediate layer 12 can be loosely located between the plates 6 and 7 or can be joined with one or the other of these plates, for example, by soldering or welding or by galvanizing.

The thickness of the plates 6 and 7 will depend upon the flow characteristics of the metals. When using nickel as the lower plate and copper as the upper plate the thickness of the nickel plate is preferably at a maximum of one-half of the thickness of the copper plate and not more than one-half of its diameter. The thinner the nickel plate the thinner will be the thickness of the wall and floor of the tube to which the nickel plate is extruded.

The plates 6 and 7 can be separately placed into the pressure chamber 2 of the die, or, prior to being placed in the die these plates can be joined together by soldering or welding. Furthermore, the plates can be extruded and placed in the die cold or also in a heated state. Thus, while cold extrusion is preferable, one or both of the plates may be heated to between 400° C. and 500° C. or to 800° C. When placing the plates in cold condition into the die, it may be of advantage to heat the die at least in a portion thereof, preferably in the portion surrounding the outlet passage 3. Thus, for example, the die may be formed with openings into which electrical heating resistances are located or through which steam may flow. The term "cold extrusion" is used in this specification and claims to cover extrusion at room temperature and above, but considerably below the fusion temperatures of the plates.

As is shown in FIGURE 6, the process of the invention may be used to form pin-shaped members forming the base section of the center electrode of a spark plug which includes the outer insulating body 13 which carries the center electrode comprising the extruded article 6', 7', a terminal member 15 and a connecting rod 16. The enlarged section 14 formed at the top of the extruded article rests against an inside shoulder of the insulating body 13 and is joined to the connecting rod 16 which engages the terminal member 15, said rod 16 extending into the depression 11 shown in FIGURE 4.

It will be understood that each of the elements described above, or two or more together, may also find a useful application in other types of processes for extruding pin-shaped members differing from the types described above.

While the invention has been illustrated and described as embodied in processes for extruding bimetallic pin-shaped members, it is not intended to be limited to the details shown, since various modifications and structural changes may be made without departing in any way from the spirit of the present invention.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can by applying current knowledge readily adapt it for various applications without omitting features that, from the standpoint of prior art, fairly constitute essentially characteristics of the generic or specific aspects of this invention and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the following claims.

What is claimed is:

1. A method of making a spark plug, said method comprising the steps of forming at least one plate of each of at least two metals of different hardness, the harder of said plates having a thickness which is small in comparison to its width, placing said plates in an extrusion die pressure chamber having a convergent end communicating with an outlet passage of relatively small cross-sectional area in comparison to that of the chamber, disposing the harder of said plates nearer said outlet passage, pressing said plates through said outlet passage in such a manner as to cause the initial pressing force against said plates to occur at about the center thereof, said plates being thereby cold extruded into a composite wire, the harder plate being formed into a tube having a closed end and an open end, the other plate being formed into a core extending to adjacent the bottom of and surrounded by said tube, and assembling said wire as an electrode in a spark plug.

2. A method of making a spark plug, said method comprising the steps of forming at least one plate of each of at least two metals of different hardness, the harder of said plates having a thickness which is small in comparison to its width and which is small in comparison to that of the other plate, placing said plates in a die pressure chamber having a convergent end communicating with an outlet passage of relatively small cross-sectional area in comparison to that of said chamber, disposing the harder of said plates nearer to said outlet passage, pressing said plates through said outlet passage with a punch having a projecting portion at about the center of its working face such that it initiates movement of the center portion of said end plates toward said outlet passage prior to contacting the peripheral portion of said plates, said plates being thereby cold extruded into a composite wire, the harder plate being formed into a tube with a closed end and an opposite open end and the other plate being formed into a core extending to adjacent the bottom of and surrounded by said tube, and then assembling the composite wire as an electrode in a spark plug.

3. A method of making a spark plug, said method comprising the steps of forming one plate respectively of copper and of nickel, the nickel plate having a thickness which is small in comparison to its width and which is small in comparison to that of the other plate, placing said plates in a die pressure chamber having a convergent end communicating with an outlet passage of relatively small cross-sectional area in comparison to that of said chamber, disposing the nickel plate nearer to said outlet passage, pressing said plates through said outlet passage with a punch having a projecting portion at about the center of its working face such that it initiates movement of the center portion of said plates toward said outlet passage prior to contacting the peripheral portion of said plates, said plates being thereby cold extruded into a composite wire, the nickel plate being formed into a tube with a closed end and an opposite open end and the copper plate being formed into a core extending to adjacent the bottom of and surrounded by said nickel tube, and then assembling the composite wire in a spark plug insulator as a center electrode in a spark plug.

4. A method of making a spark plug, said method comprising the steps of forming at least one plate of each of at least two metals of different hardness, the harder of said plates having a thickness which is small in comparison to its width and which is small in comparison to that of the other plate, forming a composite billet of said plates, a harder of the plates being at one end thereof, placing said billet in a die pressure chamber having a convergent end communicating with an outlet passage of relatively small cross-sectional area in comparison to that of said chamber, disposing the harder end of said billet nearer to said outlet passage, pressing said billet through said outlet passage with a punch having a projecting portion at about the center of its working face such that it initiates movement of the center portion of said billet toward said outlet passage prior to contacting the peripheral portion of the billet, said billet being thereby cold extruded into a composite wire, the harder end of the billet being formed into a closed ended tube having a core intimately metallurgically and mechanically bonded there-

to, and then assembling said composite wire as an electrode in a spark plug.

5. A method of making a spark plug, said method comprising the steps of placing in a die, having a pressure chamber provided with an outlet passage of less than about one-half the cross-sectional area of the chamber and a convergent section communicating the chamber with the passage, at least two metallic plates respectively of different metals of different hardnesses with the harder of said plates located nearer to said end than the softer of said plates, cold extruding said plates with a pressing member having a generally conical working face corresponding to said converging end for first extruding the harder of said plates and then both of them concurrently through said outlet passage into a composite wire in which the relatively harder metal is disposed around the concurrently extruded softer metal, enveloping the end thereof with a closed ended tube of the hard metal, and assembling the wire as an electrode in a spark plug.

6. A method of making a spark plug, said method comprising the steps of forming a plate of each of two metals of different hardness, the thickness of the harder plate not being greater than one-half its width and not greater than one-half the thickness of the other plate, welding said plates together to form a composite billet, placing said billet in a die having a pressure chamber provided with a conically converging end which makes an angle of approximately 60° with the longitudinal axis of the pressure chamber to communicate the pressure chamber with an outlet passage, disposing the harder portion of the billet nearer said converging end, said converging end communicating said pressure chamber with an outlet passage of relatively small cross-sectional area compared to said chamber, pressing said plates through said outlet passage with a pressing member having a working face generally corresponding to said converging end to cause the initial pressing force against said plates to occur at about the center thereof, said plates being thereby cold extruded into a composite wire, the harder metal being disposed around the concurrently extruded softer metal, enveloping the end thereof with a closed ended tube of the harder metal, and assembling said wire as an electrode in a spark plug.

7. A method of making a spark plug, said method comprising the steps of forming a cylindrical composite cold extrusion billet having a copper portion axially disposed from and metallurgically bonded to a nickel portion, the thickness of the nickel portion being not greater than about one-half its diameter and not greater than about one-half the thickness of the copper portion, placing said billet in a cylindrical die pressure chamber which has a conically converging end making an angle of about 60° with the longitudinal axis of the pressure chamber, communicating the pressure chamber with a circular outlet passage of a diameter less than about one-half that of the pressure chamber, disposing the nickel portion of said composite billet nearer said converging end, pressing said plates through said outlet passage with a pressing member having a projecting portion at about the center of its working face such that said pressing member initiates movement of the central portion of said billet toward said outlet passage prior to contacting the peripheral portion of said billet, said billet being cold extruded into a composite wire, the nickel being formed into a tube with a closed end and an opposite open end and the copper being formed into a core extending to adjacent the bottom of and surrounded by said tube, and supporting said wire in a spark plug insulator as a spark plug center electrode.

8. In a spark plug, an electrode, said electrode comprising a closed ended tube of a relatively high-temperature, oxidation-resistant metal, a core in said tube of a relatively softer metal having a higher heat conductivity and between said core and said tube the substantially uniform intimate bond obtained by concurrently cold extruding said core and said tube metal.

9. In a spark plug, an insulator adapted to support a center electrode and a center electrode supported by said insulator, said electrode being a composite body including a relatively high-temperature, oxidation-resistant metal closed ended tube, a core in said tube of a relatively softer metal having a higher heat conductivity, said electrode being a cold extruded wire formed by the pressing of at least two plates of different hardness, the harder of which is adjacent the extrusion aperture and has a thickness which is less than one-half its width.

10. In a spark plug, an electrode having a high heat conductive metal core and an imperforate outer covering on said core of a closed ended tube of relatively harder metal, an intimate bond between said core and said tube secured by extruding a composite billet of said metal through an aperture which cold flows a plate of the relatively harder metal around a concurrently extruded core metal, enveloping an end of said core with an imperforate metal cover.

11. In a spark plug, an insulator adapted for supporting an electrode and supported by said insulator an electrode having a high heat conductive metal core and an imperforate covering on said core of a closed ended tube of relatively harder metal which has been intimately secured to said core with a metallurgical bond by extruding a bonded composite billet of said metal through an aperture in an extrusion die pressure chamber with a pressing member having a projecting portion on about the center of the working face thereof which initiates movement in about the center of said composite billet to cold flow said harder metal around concurrently extruded core metal, enveloping the end of said core with an imperforate metallurgically bonded metal cover.

References Cited in the file of this patent

UNITED STATES PATENTS

1,311,261	Braselton	July 29, 1919
1,347,874	Rich	July 27, 1920
2,431,853	Wischhusen	Dec. 2, 1953

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,144,576 August 11, 1964

Eugen Hagmaier et al.

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 4, line 26, strike out "end".

Signed and sealed this 9th day of February 1965.

(SEAL)
Attest:

ERNEST W. SWIDER
Attesting Officer

EDWARD J. BRENNER
Commissioner of Patents