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R. J. L. DUTTERER
SPARK PLUG CONSTRUCTION

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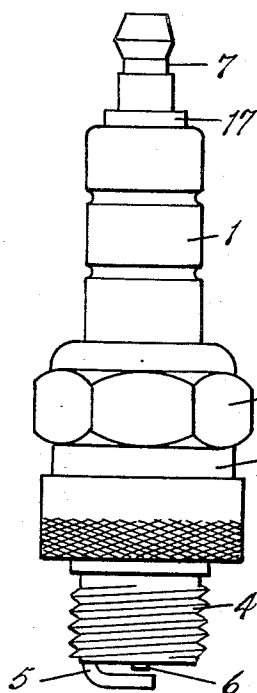


Fig. 1.

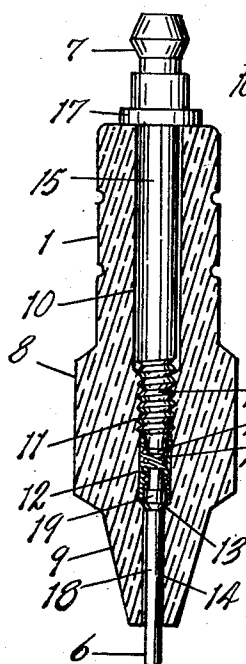


Fig. 2.

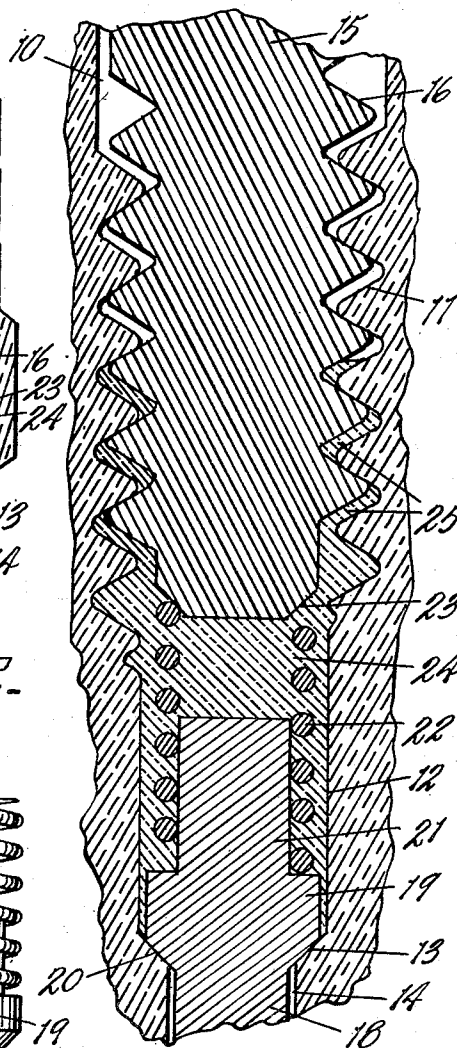


Fig. 3.

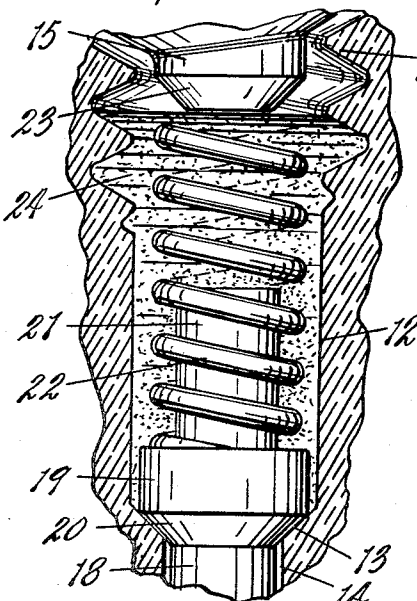


Fig. 4.

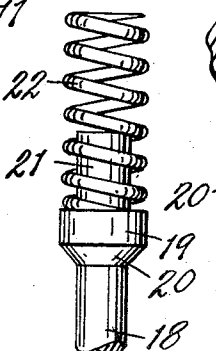


Fig. 5.

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SPARK PLUG CONSTRUCTION

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9 Claims. (Cl. 123—169)

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This invention relates to improvements in spark plug construction.

This application is a continuation in part of my copending application for Spark Plug and Method of Manufacture Therefor, Serial No. 728,421 filed February 14, 1947, Patent Number 2,634,716 issued April 14, 1953.

The principal objects of this invention are:

First, to provide a spark plug which is particularly easy to assemble.

Second, to provide a spark plug which can be manufactured with varied but accurately controllable operating characteristics.

Third, to provide a spark plug which is particularly durable, especially in the performance of its central seal and current conducting elements.

Fourth, to provide a novel form of seal and electrical connection between the sections of a sectional center electrode of a spark plug.

Fifth, to provide a spark plug in which the center insulated electrode may be formed of inexpensive base metals without endangering the seal of the center electrode or the insulator to breakage.

Sixth, to provide a coiled metallic intermediate connector between the sections of a sectional electrode, which connector forms a positive and continuous electrical connection between the electrode sections and which is protected and restrained against deterioration and movement by a solidified seal that also seals the central bore of the insulator in which the electrode is mounted.

Other objects and advantages of my invention will be apparent from a consideration of the following description and claims.

The drawings, of which there is one sheet illustrate a highly practical form of my spark plug.

Fig. 1 is an elevational view of the completed spark plug.

Fig. 2 is a longitudinal cross-sectional view through the insulator of the spark plug illustrating the center or insulated electrode in elevation.

Fig. 3 is an enlarged fragmentary cross-sectional view through the insulator and center electrode of the spark plug in finished assembled condition.

Fig. 4 is an enlarged fragmentary longitudinal cross-sectional view through the insulator illustrating the sections of the center electrode in partially assembled position within the insulator.

Fig. 5 is an enlarged fragmentary elevational view of the lower section of the center electrode with the spiral intermediate connector mounted thereon.

Spark plug manufacturers have recognized for some time that different internal combustion engines require spark plugs having different operating characteristics. Not only must the insulated center electrode of the spark plug provide continuous electrical contact for the passage of ignition current therethrough and be sealed to the insulator to prevent the escape of combustion

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gases along the center electrode, but the center electrode must dissipate heat through the insulator of the spark plug at different predictable rates in order that the temperature of the inner tip of the center electrode will remain at the desired level during operation. A spark plug which does not dissipate sufficient heat from its center electrode may become so overheated in some engines as to cause pre-ignition. Such a plug is designated as a hot plug. A plug which dissipates a large amount of heat from its center electrode will have an inner tip that is so cool in some engines that partially burned fuel and oil collects on the tip and fouls the plug. Such a plug is designated as a cold plug. My present invention is directed toward providing a standard form of spark plug having standardized major elements which can be easily and inexpensively manufactured and assembled to have predeterminable operative characteristics ranging from the above described hot plugs to cold plugs.

Fig. 1 illustrates the principal elements of my plug which includes an insulator 1 of insulating ceramic material retained within a metallic sleeve 2. The sleeve 2 is provided with a nut-like head 3 and a threaded inner tip 4 for mounting the same in an engine as is common practice. The sleeve carries a grounded electrode 5 that cooperates with a center or insulated electrode extending through the insulator. The insulated electrode includes an inner tip 6 cooperative with the grounded electrode, and an outer terminal tip 7 adapted to receive a connector wire from the distributor of an engine.

As is more particularly illustrated in Fig. 2 the insulator 1 includes a central portion 8 of thickened cross-section or diameter and a tapered inner end 9 that extends inwardly through the tip 4 of the sleeve. Throughout this description the elements of the spark plug will be oriented by reference to their usual position with respect to the cylinder of an engine. Thus the tip of the insulated electrode 6 is disposed inwardly of the cylinder, while the terminal 7 is disposed outwardly of the cylinder. The insulator 1 defines a center bore 10 extending therethrough, the bore being provided with a threaded portion 11 which is desirably positioned entirely within the thickened portion 8 of the insulator. Inwardly of the threaded portion 11 the bore 10 provides a cavity 12 which is also located within the thickened portion 8 of the insulator. The inner end of the cavity 12 terminates in an inwardly tapered shoulder 13 merging with an inner portion 14 of the central bore of reduced diameter.

The insulated center electrode of the spark plug includes an outer rod-like section 15 on which the terminal tip 7 is formed. The inner end of the outer section 15 is threaded as at 16 to threadingly engage the threaded portion 11 of the insulator. It is pointed out that the threads in the insulator bore are of substantially greater diameter than the threads on the outer electrode

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section so that a loose engagement is obtained between the threaded elements. A collar 17 on the outer end of the outer electrode section engages the outer end of the insulator to limit the movement of the outer electrode section into the insulator.

The inner tip 6 of the insulated electrode consists of the inner end of a pin-like inner electrode section 18 that extends through the reduced portion 14 of the central bore in the insulator. The inner electrode section is provided with a collar 19 having an inwardly tapered under edge 20 which seats upon the tapered shoulder 13 at the bottom of the cavity 12 in the insulator. Above the collar 19 the inner electrode section is provided with an outwardly extending centering projection 21. It will be noted from Figs. 2 and 3 that the inner end of the outer electrode section 18 is spaced substantially from the outer end of the centering projection 21 in the assembled positions of the electrode sections.

Electrical continuity in the insulated electrode is provided between the inner electrode section 18 and the outer electrode section 15 by a spirally coiled metallic connector section 22. The spiral connector 22 is guidingly received around the centering projection 21 of the inner electrode section and projects outwardly therefrom. It is desirable that the gauge of wire used in the spiral connector and the diameter of the centering projection 21 be such that the spiral connector 22 is spaced substantially inwardly from the walls of the cavity 12 as illustrated. In its uncompressed condition the spiral connector 22 projects outwardly substantially beyond its final position as will be noted by a comparison of Figs. 3 and 4. The outer electrode section is provided with a tapered inner end 23 which centeringly engages the outer end of the spiral connector as the outer electrode section is threaded into the insulator, and compresses the spiral connector into positive electrical contact with each of the inner and outer electrode sections. The compression in the spiral connector 22 also serves to firmly seat the inner electrode section within the bottom of the cavity 12.

In assembling the above described standard elements of my spark plug I prefer to fit the spiral connector 22 on the centering projection 21 on the inner electrode section, and drop the two elements as a sub-assembly into the bore of the insulator. Desirably the spiral connector has sufficient gripping engagement with the projection 21 so as not to become disengaged therefrom. After the inner electrode section and spiral connector are in place I inject a predetermined and measured amount of a semi-fluid or plastic sealing material 24 into the cavity 12 and around the connector 22. The sealing material is desirably a chemically setting ceramic cement including a silicate of soda binder, and desirably has a coefficient of expansion approximating the coefficient of expansion of the insulator 1, although this is not of great importance, as the sealing material is located within the thickened portion 8 of the insulator where the insulator has the greatest strength and ability to resist any tendency of the sealing material to crack the insulator.

After the sealing material 24 is in place the outer electrode section 15 is threaded into the insulator as above described to contact and compress the spiral connector 22. In so doing the inner tip of the outer electrode section wipingly engages the outer end of the spiral connector in a rotary motion to obtain good electrical con-

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tact therewith. The inner tip of the outer electrode section also penetrates and displaces a quantity of the sealing material 24 upwardly between the loosely engaged threads on the insulator and the outer electrode section as is indicated at 25 in Fig. 3.

The amount of sealing material thus displaced and forced upwardly in the insulator bore is of course determined by the quantity of sealing material originally introduced into the cavity 12. The presence of the sealing material between the insulated center electrode and the wall of the insulator of course increases the rate of radiation of heat from the electrode to the insulator, and by increasing the amount of sealing material and the distance through which it rises along the threads 11 I am able to increase the rate of heat dissipation from the spark plug. Thus a great amount of sealing material provides a cooler spark plug, while the reduced amount of sealing material provides a hotter spark plug. It will be noted that the penetration of the outer electrode section into the sealing material also forces the sealing material uniformly around the outer end of the inner electrode section and the spiral connector 22.

It will be noted that the inner electrode is of such a diameter that there is substantial clearance between it and the wall of the bore below the shoulder. The beveled shoulders of the bore and of the inner electrode section result in an effective centering of the inner electrode section in the bore and also close engagement to insure that the sealing material is not forced between the shoulders and between the body portion of the inner electrode and the insulator bore which should be kept free from the sealing material. The intermediate electrode section being of springable material, such as the coil spring illustrated, forces the connecting shoulders together when the outer electrode section is threaded into engagement with the internal threads of the insulator bore and this also insures a good electrical conducting contact between the intermediate and inner and outer electrode sections.

The sealing cement embeds the portion of the inner electrode section above the shoulder of the bore and keeps the inner electrode centered. It also embeds the intermediate electrode section and the lower end of the outer electrode section so that no relative movement of these parts can take place after the sealing cement has set. As stated, a self-setting sealing mixture is desirably used which eliminates the necessity for applying heat to set the sealing mixture. The loose engagement of the outer electrode section with the threads of the insulator bore is desirable not only from the standpoint of tolerances in manufacture and difficulty in securing accurate threads in the molded insulator body but it also permits the sealing mixture forming an effective seal between the outer electrode and the insulator and insures that the outer electrode is effectively retained.

Attention is called to the fact that the dimensions of the insulator, the inner electrode section, and the outer electrode section are not particularly critical to the performance of the finished spark plug, as the performance is controlled largely by the amount of sealing material in the plug. It is therefore possible to economically manufacture the standardized elements of the plug within reasonably accurate limits, and without expensive tolerance controls and inspections. The assembly of the elements of the spark plug is

relatively simple and can be carried out without the use of heat or expensive jigs and apparatus.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent is:

1. A spark plug comprising an insulator having a central bore therethrough, said bore having an inner portion of reduced diameter with an outwardly facing beveled shoulder around the outer end thereof, said bore being internally threaded in outwardly spaced relation to said shoulder, an inner electrode section disposed in the reduced portion of said bore and having a beveled shoulder seated upon the outwardly facing shoulder of said bore, the diameter of the inner electrode being such that there is substantial clearance between it and the bore below the said shoulder, the said inner electrode section having a centering projection extending outwardly from its said shoulder and spaced from the wall of the bore, a coiled initially springable metallic intermediate electrode section having its inner end sleeved upon said centering projection and centered thereby, an outer electrode section having loose threaded engagement with the threads of said bore and compressibly engaging the outer end of said springable intermediate section and urging the shoulder of said inner section upon said beveled shoulder of said bore and centering the inner section in the reduced portion of said bore, and a self-setting cementitious mixture filling the said bore between said inner and outer sections and embedding said intermediate section, said mixture surrounding the inner end of said outer section and extending outwardly between at least a portion of the threads of the outer section and the bore.

2. A spark plug comprising an insulator having a central bore therethrough, said bore having an inner portion of reduced diameter with an outwardly facing shoulder around the outer end thereof, said bore being internally threaded in outwardly spaced relation to said shoulder, an inner electrode section disposed in the reduced portion of said bore and having a shoulder seated upon the outwardly facing shoulder of said bore, the said inner electrode section having a centering projection extending outwardly from its said shoulder and spaced from the wall of the bore, a coiled initially springable metallic intermediate electrode section having its inner end sleeved upon said centering projection and centered thereby, an outer electrode section having loose threaded engagement with the threads of said bore and compressibly engaging the outer end of said springable intermediate section and urging the shoulder of said inner section upon said shoulder of said bore, and a self-setting cementitious mixture filling the said bore between said inner and outer sections and embedding said intermediate section, said mixture surrounding the inner end of said outer section and extending outwardly between at least a portion of the threads of the outer section and the bore.

3. A spark plug comprising an insulator having a central bore therethrough, said bore having an inner portion of reduced diameter with an outwardly facing beveled shoulder around the outer end thereof, said bore having internal projections in outwardly spaced relation to said shoulder, an inner electrode section disposed in the reduced portion of said bore and having a shoulder seated upon the outwardly facing shoulder of said bore, the diameter of the inner electrode being such that there is substantial clearance

between it and the bore below the said shoulder, the said inner electrode section having a centering projection extending outwardly from its said shoulder and spaced from the wall of the bore, a coiled initially springable metallic intermediate electrode section having its inner end sleeved around said centering projection and centered thereby, an outer electrode section having projections coacting with the projections of said bore in axially overlapping relation, said outer electrode section compressibly engaging said springable intermediate section and urging the shoulder of said inner section upon said shoulder of said bore and centering the inner section in the reduced portion of said bore, and a sealing mixture filling the said bore between said inner and outer sections and embedding said intermediate section.

4. A spark plug comprising an insulator having a central bore therethrough, said bore having an inner portion of reduced diameter with an outwardly facing shoulder around the outer end thereof, said bore having internal projections in outwardly spaced relation to said shoulder, an inner electrode section disposed in the reduced portion of said bore and having a shoulder seated upon the outwardly facing shoulder of said bore, the said inner electrode section having a centering projection extending outwardly from its said shoulder and spaced from the wall of the bore, a coiled initially springable metallic intermediate electrode section having its inner end engaged with said centering projection and centered thereby, an outer electrode section having projections coacting with the projections of said bore in axially overlapped relation, said outer electrode section compressibly engaging said springable intermediate section and urging the shoulder of said inner section upon said shoulder of said bore, and a sealing mixture filling the said bore between said inner and outer sections and embedding said intermediate section.

5. A spark plug comprising an insulator having a central bore formed therethrough and having a thickened intermediate section adapted to be received in a metal shell, said bore having an inner portion of reduced diameter with an outwardly facing shoulder around the outer end thereof and located within the thickened intermediate section of the insulator and substantially inwardly from the outer end of said thickened portion, threads formed around a portion of said bore and spaced outwardly from said shoulder and within the thickened portion of the insulator, an inner electrode section projecting through the inner reduced portion of said bore and having a collar seated against said shoulder, a centering projection on said inner electrode section extending outwardly from said collar and spaced from the wall of said bore, an outer electrode section extending into said bore from the outer end thereof, the inner end of said outer electrode section being spaced from said centering projection, a coiled metallic connector section sleeved around said centering projection and compressed between the collar on said inner electrode section and the inner end of said outer electrode section, said connector being spaced from the wall of said bore, threads formed around said outer electrode section and engaging the threads in said bore, the threads in said bore being of greater diameter than the threads on said outer electrode section whereby a loose threaded engagement is obtained therebetween, and a sealing mixture including a

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chemically setting cement filling said bore between said inner and outer electrode sections and surrounding said connector section, said sealing mixture extending outwardly between the threads on said outer electrode section and the threads in said bore.

6. A spark plug comprising an insulator having a central bore formed therethrough and having a thickened intermediate section adapted to be received in a metal shell, said bore having an inner portion of reduced diameter with an outwardly facing beveled shoulder around the outer end thereof and located within the thickened intermediate section of the insulator and substantially inwardly from the outer end of said thickened portion, radial serrations formed around a portion of said bore and spaced outwardly from said shoulder and entirely within the thickened portion of the insulator, an inner electrode section projecting through the inner reduced portion of said bore and having a collar seated against said shoulder, a centering projection on said inner electrode section extending outwardly from said collar and spaced from the wall of said bore, an outer electrode section extending into said bore from the outer end thereof and having a collar engaging the outer end of said insulator, the inner end of said outer electrode section being tapered and spaced from said centering projection, a coiled metallic connector section sleeved around said centering projection and compressed between the collar on said inner electrode section and the inner tapered end of said outer electrode section, said connector being spaced from the wall of said bore, radial serrations formed around said outer electrode section and engaging the serrations in said bore, the serration in said bore being of greater diameter than the serrations on said outer electrode section whereby a loose interlocking engagement is obtained therebetween, and a sealing mixture including a chemically setting cement filling said bore between said inner and outer electrode sections and surrounding said connector section, said sealing mixture extending outwardly between the serrations on said outer electrode section and the serrations in said bore.

7. A spark plug comprising an insulator having a central bore formed therethrough, said bore having an inner portion of reduced diameter with an outwardly facing beveled shoulder around the outer end thereof, radial serrations formed around a portion of said bore and spaced outwardly from said shoulder, an inner electrode section projecting through the inner reduced portion of said bore and having a collar seated against said shoulder, a centering projection on said inner electrode section extending outwardly from said collar and spaced from the wall of said bore, an outer electrode section extending into said bore from the outer end thereof and having a collar engaging the outer end of said insulator, the inner end of said outer electrode section being tapered and spaced from said centering projection, a coiled metallic connector section sleeved around said centering projection and compressed between the collar on said inner electrode section and the inner tapered end of said outer electrode section, said connector being spaced from the wall of said bore, radial serrations formed around said outer electrode section and engaging the serrations in said bore, the serrations in said bore being of greater diameter than the serrations on said outer electrode section whereby a loose interlocking engagement is obtained therebetween, and a sealing mixture including a chemically

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setting cement filling said bore between said inner and outer electrode sections and surrounding said connector section, said sealing mixture extending outwardly between the serrations on said outer electrode section and the serrations in said bore.

8. A spark plug comprising an insulator having a central bore formed therethrough, said bore having an inner portion of reduced diameter with an outwardly facing shoulder around the outer end thereof, axially spaced radial projections formed along a portion of said bore and spaced outwardly from said shoulder, an inner electrode section projecting through the inner reduced portion of said bore and having a collar seated against said shoulder, a centering projection on said inner electrode section extending outwardly from said collar and spaced from the wall of said bore, an outer electrode section extending into said bore from the outer end thereof and having a collar engaging the outer end of said insulator, the inner end of said outer electrode section being spaced from said centering projection, a coiled metallic connector section sleeved around said centering projection and compressed between the collar on said inner electrode section and the inner end of said outer electrode section, said connector being spaced from the wall of said bore, radially projecting ribs formed around said outer electrode section and spaced between the projections in said bore in axially overlapping relation, and a sealing mixture including a chemically setting cement filling said bore between said inner and outer electrode sections and surrounding said connector section, said sealing mixture extending outwardly between the ribs on said outer electrode section and the projections in said bore.

9. A spark plug comprising an insulator having a central bore formed therethrough, said bore having an axially inner portion of reduced diameter, axially spaced radial projections formed along a portion of said bore and spaced outwardly from said reduced portion of said bore, an inner electrode section projecting through the inner reduced portion of said bore and seating therein, a centering projection on said inner electrode section extending outwardly from said reduced portion of said bore, an outer electrode section extending into said bore from the outer end thereof and having a collar engaging the outer end of said insulator, the inner end of said outer electrode section being tapered and spaced from said centering projection, a coiled metallic connector section sleeved around said centering projection and compressed between said inner electrode section and the inner tapered end of said outer electrode section, said connector being spaced from the wall of said bore, radial ribs formed around said outer electrode section and positioned between the projections in said bore in axially overlapping relation, and a sealing mixture including a chemically setting cement filling said bore between said inner and outer electrode sections and surrounding said connector section, said sealing mixture extending outwardly between the ribs on said outer electrode section and the projections in said bore.

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