

June 24, 1958

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2,840,628

SPARK PLUG

Filed May 2, 1952

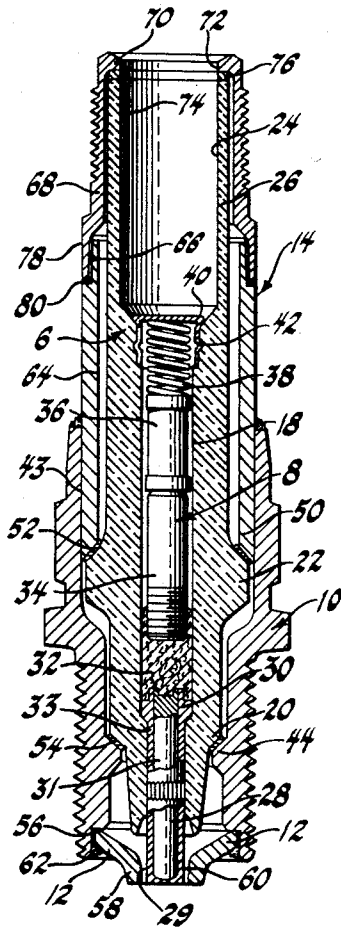


Fig. 1

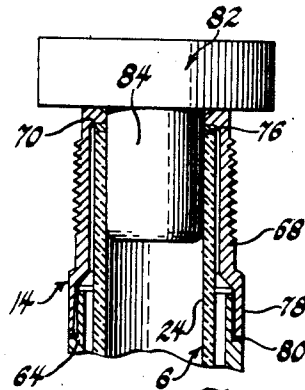


Fig. 2

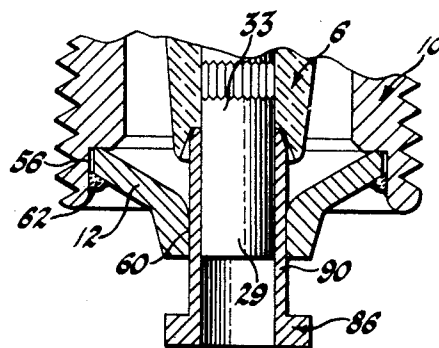


Fig. 3

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SPARK PLUG

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Application May 2, 1952, Serial No. 285,688

5 Claims. (Cl. 174—35)

This invention relates to spark plugs and to a method for making same. More particularly, this invention relates to a method for assembling the various spark plug parts, i. e., the insulator, the insulator shield, the ground electrode, etc., which results in a more efficient and durable spark plug, less susceptible to damage by insulator breakage and by other causes, and which at the same time effects a reduction in manufacturing costs.

Spark plugs, of the type to which this invention relates, consist of a tubular insulator having a centerbore which carries a central electrode or centerwire, an outer metal shell and insulator shield assembly surrounding and supporting the insulator and carrying at its base a ground electrode having a surface in spaced relation to the lower end of the central electrode to form a spark gap therebetween.

In the manufacture of spark plug parts, such as insulators, electrodes, etc., as well as in the assembly of these parts, there are bound to occur small and often undetectable inaccuracies such as slight differences in sizes and/or shapes of the parts. To eliminate these inaccuracies in a high production method would prohibitively increase the costs of manufacture. These unavoidable inaccuracies, even though small, are often quite detrimental to the durability and operating efficiency of the finished spark plug.

The principal type of inaccuracy which occurs in spark plug production and the inaccuracy to which this invention chiefly relates is that of involving the size and shape of the ceramic insulator. Regardless of the method by which the ceramic spark plug insulators are produced, it is obvious that there are bound to be minor variations in the size and shape, these variations often being undetectable to the eye. During the firing of the ceramic insulators, for example, it often occurs that certain of the articles are warped, even if only to a very small extent. It is also quite obvious that to eliminate these small variations by precision manufacturing methods would prohibitively increase the cost of the insulators. In many types of spark plugs, such variations or slight inaccuracies are unimportant and have no effect whatsoever on the durability of the finished article. This is true of certain types of spark plugs used on automobiles and similar automotive vehicles. However, with some spark plug designs, these variations are quite detrimental. Where, for example, a cloverleaf ground electrode is used, variations in the insulator size and/or shape can result in a non-uniform spark gap size. The conventional method for precluding this effect is to utilize an additional step in the manufacturing process after assembly of the plug to assure consistent spark gap size. Such methods will be hereinafter discussed in greater detail. Suffice it to say, at this point, that these methods increase the cost of production and do not completely eliminate the harmful effects of the inaccuracies.

Another type of spark plug which is greatly injured by insulator inaccuracies is that in which an insulator shield

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is used. The shield, generally made of metal, is secured to the metal outer shell and surrounds the upper end of the insulator to protect it against cracking, etc. Such structure is commonly used on aircraft spark plugs. In this type of spark plug, insulator inaccuracies or deformities often result in undesired contact between the shield and the insulator and lead to spark plug failure due to the cracking of the insulator by way of the pressure or stress exerted.

It is an object of this invention to provide a spark plug having means incorporated therein to compensate for inaccuracies in the manufacturing process and thus less susceptible to insulator cracking and other failures. Another object of this invention is the provision of a spark plug of the type having a shield surrounding a portion of the insulator in which contact between the insulator and shield is precluded. Another object of the invention is to provide a method for assembling spark plugs which compensates for variations in insulator size and/or shape, and which thus results in a more durable spark plug. Still another object of this invention is the provision of a spark plug manufacturing process whereby precision spark plugs of increased durability can be produced at lower cost.

These and other objects of the invention are carried out by the provision, during manufacture of the plugs, of novel positioning and centering means for the various spark plug parts to assure a precision fit.

Other objects and advantages of the invention will appear more clearly from the following description of preferred embodiments and from the accompanying drawings, in which Figure 1 shows a side view in section of a spark plug embodying the invention; Figure 2 shows the top portion in section of the spark plug shown in Figure 1, and having a centering gauge of the type used in this invention inserted therein; and Figure 3 shows the bottom portion enlarged and in section of the spark plug shown by Figure 1 and having an electrode-positioning gauge of the type used in this invention inserted thereon.

Referring now to the drawings, Figure 1 shows an embodiment of the type spark plugs to which this invention relates, and consists of an insulator 6, a centerwire 8, a metal shell 10 surrounding and supporting the insulator and carrying a ground electrode 12, and a shield 14 secured to the metal shell and surrounding the upper portion of the insulator 6.

The insulator 6 has a centerbore 18 of varying diameter for reception of the centerwire structure, and is provided with external annular shoulders 20 and 22 to secure the insulator in the shell. The upper end 24 of the insulator centerbore is of increased diameter for reception of the electrical connector conductor from the ignition system. This increase in the diameter of the centerbore 18 results in a reduced wall thickness at the upper end of the insulator as shown at 26.

In the particular embodiment shown, the centerwire comprises a composite metal firing tip 28, the lower end 29 of which extends to the exterior of the insulator and the upper end of which is headed as shown at 30, and is in contact with a conducting seal 32. The firing tip 28 consists of a soft metal core 31 and a heat resistant metal sheaf 33. A centerwire screw 34 having a bottom threaded portion embedded in the conducting seal 32, a cartridge-type resistor 36 which is held in contact with the top of the centerwire screw by the spring 38, and a split contact cap 40, which holds the spring 38 compressed against the resistance cartridge 36, completes the centerwire structure. The split cap 40 is snapped into the centerbore by the cooperation of a shoulder 42 with a groove provided in the wall of the centerbore. It is to be understood that any suitable centerwire structure can be used, that

shown and described being only for purposes of illustration.

The insulator is secured within the metal shell by means of the shoulders 20 and 22 which cooperate with an internal annular shoulder 44 on the shell and with the lower edge 50 of the shield respectively. The lower end of the shield 14 fits snugly and concentrically within the upper portion of the shell as shown at 43 and is welded or otherwise suitably secured thereto. Metal gaskets 52 and 54, which are positioned between the respective insulator shoulders 20 and 22 and the shell and shield assembly, assure a tight and secure fit of the parts.

The bottom of the shell 10 has an annular indentation 56 in which there is secured the ground electrode 12. This electrode is of the cloverleaf type, that is, it has a plurality of inwardly extending arms 58, the inner surfaces 60 of which are in spaced relationship with the lower end of the firing tip 28 to provide a plurality of spark gaps. To secure the ground electrode to the shell a weld or a braze, as shown at 62, may be used.

Before proceeding with a more detailed description of the shield and of the ground electrode, as well as of the method of assembling these parts, it will be helpful for a full and complete understanding of this invention to now discuss the difficulties which arise in conventional spark plugs of the general type shown and hereinafter described, because of slight deformities and inaccuracies in the insulator.

The more common type of insulator deformity is a warp or a bend which may occur during firing and which may be imperceptibly slight. It is obvious, upon study of Figure 1, however, that even a very slight warp will result in non-concentricity between the upper portion of the insulator and the shield. Very often this results in actual contact between the upper part of the insulator and the shield, thus producing a stress on the insulator such as results in insulator failure due to cracking. It has been found that even the slightest contact between the shield and insulator is quite harmful since, during handling as well as during operation, any impact, shock or vibration to which the shield is subjected is transmitted to the insulator and results in cracking.

The second harmful effect of a slightly warped or bent insulator is that which results in spark gap imperfection. In order to attain peak spark plug efficiency, each of the plurality of spark gaps must be of identical size and each individual spark gap must be of uniform size. Referring again now to Figure 1, it will be seen that if the insulator is slightly warped the central electrode firing tip 29, instead of being perfectly concentric with the outer shell 10, will be at a slight angle. To compensate for this, the conventional practice is to form the cloverleaf electrode with an opening larger than the spark gap size would require, secure this cloverleaf electrode in position by brazing to the outer shell or by turning or crimping the lower edge of the shell inwardly and over the edge of cloverleaf and then, with a feeler gauge in position, mechanically bend the individual arms 58 of the cloverleaf inwardly until the correct spark gap size is attained. This method is disadvantageous for two reasons. First, since it requires an additional and time-consuming production step, it is costly. Secondly, it does not completely correct for the insulator deformity since, even after adjustment of the spark gap, there is usually a lack of parallelism between the spark gap surface of the central electrode and the spark gap surfaces 60 of the ground electrode. After bending the arms 58 inwardly, the correct sized gap might only be accomplished at one point rather than along the entire vertical surface 60.

The structure and process of the present invention may now be more fully described and will be better understood in view of the preceding discussion of conventional structures and manufacturing methods.

The shield 14 is constructed in two separate sections. The lower section 64, which is secured to the shell as previously described, has a circumferential recess 66 at its upper end. The upper section 68 has an inwardly turned annular flange 70, the inner edge 72 of which is flush with the interior surface 74 of the insulator. Thus, the diameter across the upper opening of the shield is substantially the same as the diameter of the upper end 24 of the insulator bore. A soft metal gasket 76 fills the space between the top of the insulator and the flange 70. The lower end 78 of the upper shield section 68 is of increased diameter and fits over the top of the lower shield section and is welded, brazed or otherwise suitably secured thereto as shown at 80. The sections 64 and 68 are secured together in such manner as will assure substantial concentricity between the shield and the insulator. Thus, if the insulator is warped, the junction 80 between the shield sections will define that angle which is required to maintain the upper shield section 68 substantially concentric or out of contact with the insulator.

The method for accomplishing this shield structure can be best explained with reference to Figure 2. The insulator 6 and the lower shield section 64 are first secured to the shell 10 (as shown in Figure 1) by conventional means. Then the upper shield section 68 along with the gasket 76 are positioned on the insulator, the lower end 78 of the upper section fitting over the lower shield section. A centering plug 82 having a reduced portion 84 with a diameter about the same as that of the interior of the upper end 24 of the insulator and also the same as that of the upper opening in the shield is inserted into the shield and insulator as shown. With the centering plug 82 positioned, the upper shield section 68 is secured to the lower shield section 64 by welding, brazing or by other suitable means. After the parts are thus secured, the centering plug 82 is removed. With such a process, contact between the shield and the insulator is precluded and substantial concentricity is assured, irrespective of variations in the shape of the insulator.

The ground electrode 12 is secured to the shell 10 in such a manner that uniformity of gap size is attained without subsequent operations. The improved method of this invention can be best described with reference to Figure 3. After the insulator-centerwire assembly has been secured within the shell 10 the ground electrode 12 is positioned in the bore 56 in the base of the shell and a tubular feeler gauge 86, having an internal diameter about the same as that of the center electrode firing tip 29, is inserted between the firing tip 29 and the ground electrode 12. The thickness of the tube wall 90 is precisely the size of the spark gap desired. If, for example, a gap of .015 inches is desired, a feeler gauge 86 having a wall thickness of .015 inches is used. Of course it is to be understood that the ground electrode 12 is manufactured so that, in combination with the particular firing tip used, the desired size spark gap will be attained providing the proper positioning is attained. It will also be noted in Figure 3 that the outer diameter of the electrode is somewhat smaller than the internal diameter of the bore 56, thus allowing the electrode to position itself at an angle if required. With the feeler gauge 86 thus positioned, the ground electrode is welded to the shell as shown at 62 and then the gauge is removed. In Figure 3 the horizontal plane of the ground electrode 12 is shown as being substantially at right angles to the vertical axis of the shell. This will result if the insulator is not warped. However, if the insulator is deformed, it is obvious that the horizontal plane of the ground electrode will be at a slight angle to the axis of the shell. This, of course, does no harm whatsoever, it only being important that the edges 60 of the ground electrode be parallel with the edge of the firing tip and the spark gaps be of uniform size. This is accomplished with pre-

cision and with great economies by means of this invention. Once the ground electrode is secured, proper and uniform gap size is assured without subsequent production operations.

We wish to point out that, aside from the heretofore discussed difficulties, slightly deformed insulators have no harmful effect whatsoever on spark plug durability and efficiency. We wish also to emphasize that to precision-test insulators for shape and to eliminate all except those absolutely perfect would greatly increase costs of spark plug production. By means of this invention the harmful effects of slight insulator warpage, etc. are completely eliminated, with the result that precision spark plugs having increased durability and efficiency may be economically produced.

While the embodiment of the present invention as herein disclosed constitutes a preferred form, it is to be understood that other forms might be adopted, all coming within the scope of the claims which follow.

What we claim as new and desire to obtain by Letters Patent of the United States is:

1. A spark plug comprising a metal shell, a unitary elongated ceramic insulator secured within said shell and a tubular metal shield secured to said shell surrounding and immediately adjacent to the upper portion of said insulator, said shield having a lower section and an upper section, the lower end of said upper section loosely surrounding and being permanently bonded to the upper end of said lower section and providing continuous substantial concentricity between the upper section of said shield and said insulator.

2. A spark plug comprising a metal shell, a tubular metal shield secured to said shell and a tubular ceramic insulator within the said shell and having an upper portion within and immediately adjacent said shield, said shield being constructed in two axial sections having adjacent end portions fitting loosely one within the other and permanently bonded together and providing continuous substantial concentricity between the upper section of said shield and said insulator.

3. A spark plug comprising a metal shell, a tubular metal shield secured to said shell and a tubular ceramic insulator within said shell and having an upper portion

within and immediately adjacent said shield, said shield being constructed in two axial sections having adjacent end portions loosely overlapping and permanently bonded together at an angle which provides continuous substantial concentricity between the upper section of said shield and said insulator.

4. In a method for manufacturing spark plugs of the type having a metal shell, a unitary elongated ceramic insulator having one end within said shell and the other end closely surrounded by a tubular metal shield, the steps of positioning the insulator within the shell, securing a lower shield section to said shell, positioning an upper shield section over said insulator and in loose contact with said lower section, centering said upper section on said insulator and providing substantial concentricity between the upper shield section and the insulator and then permanently bonding said upper section to said lower section.

5. In a method for manufacturing spark plugs of the type having a metal shell, a centerbored unitary elongated ceramic insulator having one end secured within said shell and the other end closely surrounded by a tubular metal shield, the steps of positioning the insulator within the shell, bonding a lower shield section to said shell, positioning an upper shield section over said insulator in loose contact with and overlapping said lower section, aligning an inner surface of said upper section with the centerbore of said insulator and providing continuous substantial concentricity between said upper section and said insulator and then permanently bonding said upper section to said lower section.

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