# United States Patent

**Podiak et al.**

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## [54] SPARK PLUG SEAT


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[73] Assignee: **Champion Spark Plug Company,** Toledo, Ohio



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[52] **U.S. Cl.** ..... **29/25.12**

[51] **Int. Cl.** ..... **F23q 3/70,** H01t 13/00

[58] **Field of Search** ..... 29/25.12, 510, 520; 313/144



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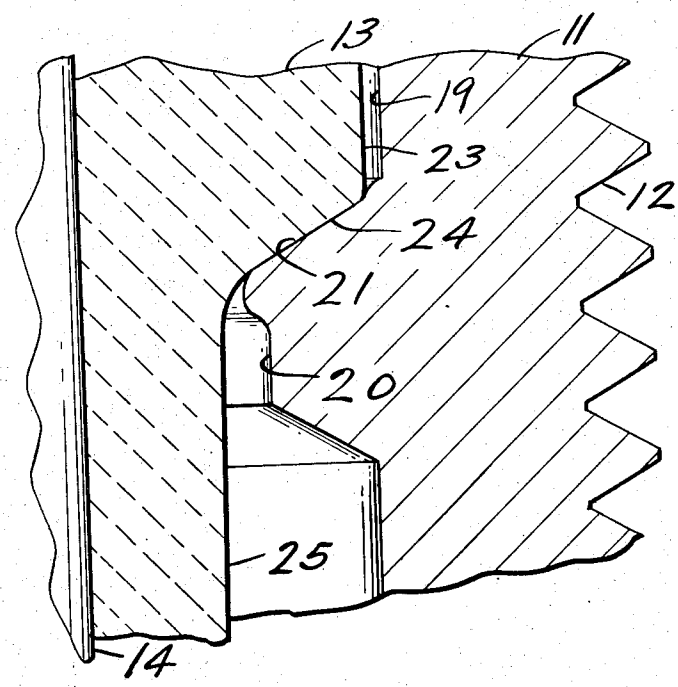
[57] **ABSTRACT**

A method for forming a gasketless seat between an insulator and a shell in a spark plug. A downwardly facing shoulder is formed on the insulator to define an angle within a range between 20° and 45° to a plane perpendicular to the insulator axis. An upwardly facing shoulder is formed within a reduced opening in the shell to define an angle within a range between 0° to a plane perpendicular to the shell axis and 5° less than the insulator shoulder angle. The insulator is then inserted into the shell opening until the downwardly facing shoulder on the insulator abuts the upwardly facing shoulder within the shell opening. In completing assembly of the spark plug, the insulator is forced into the shell to deform the shell shoulder by cold working it against the insulator shoulder, thereby forming a thermally conducting seat between the shell and the insulator.


**7 Claims, 3 Drawing Figures**



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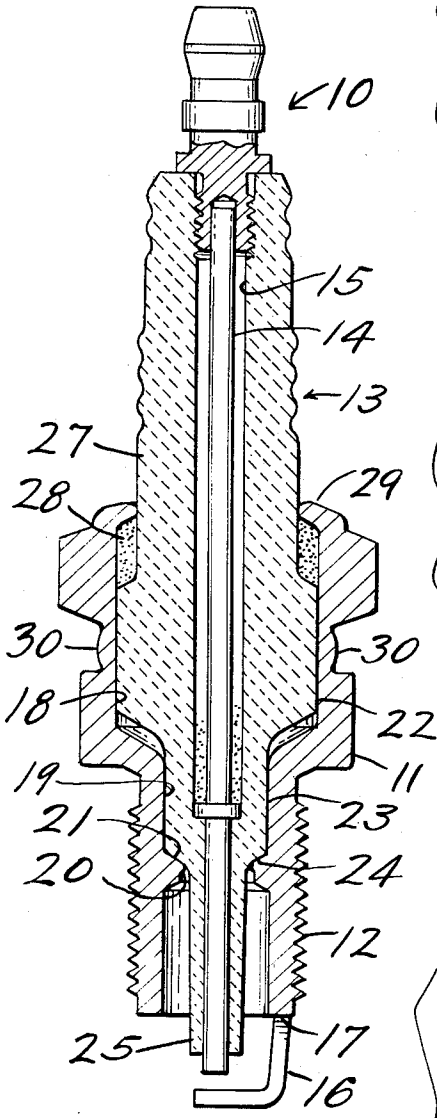


FIG-1-

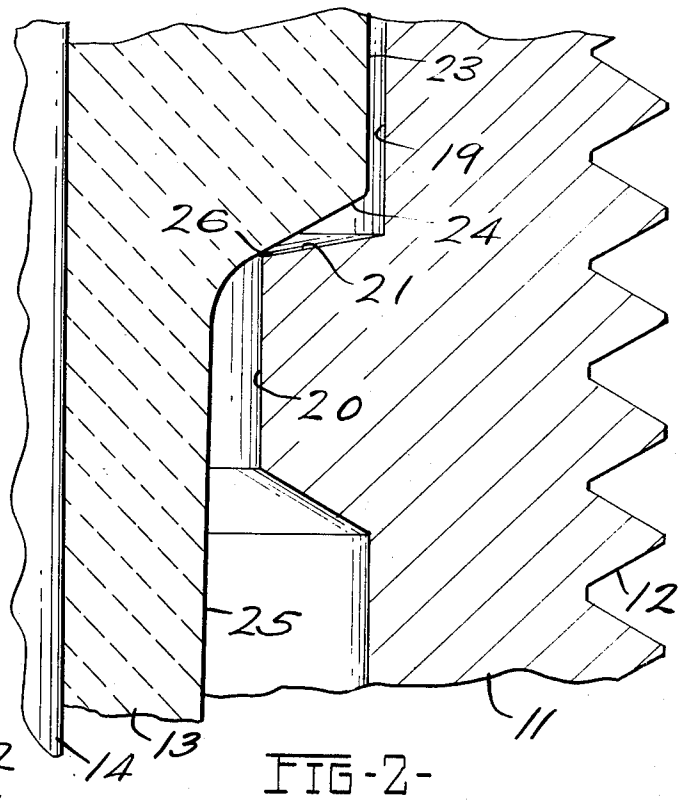


FIG-2-

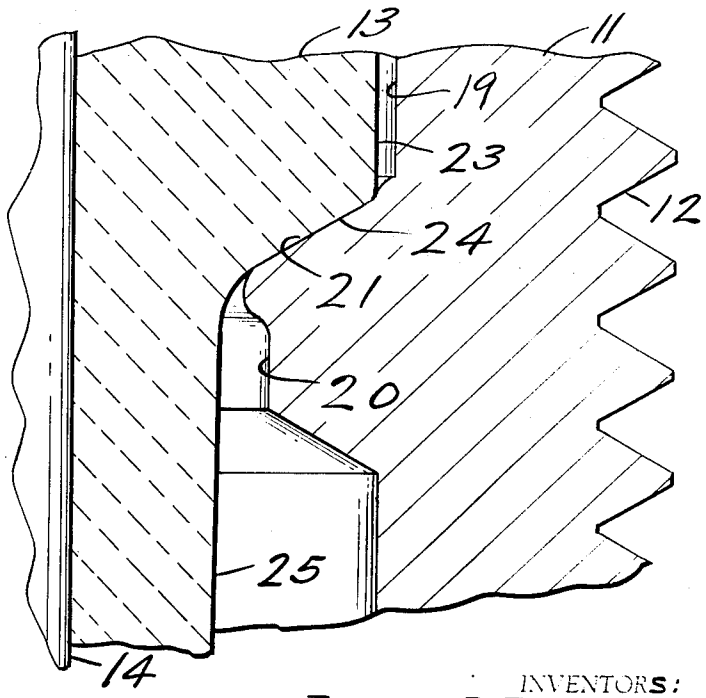


FIG-3-

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# SPARK PLUG SEAT

## BACKGROUND OF THE INVENTION

The present invention relates generally to spark plugs for internal combustion engines, and more particularly to a gasketless seat for spark plugs and a method for forming the seat.

Spark plugs generally comprise a ceramic insulator-electrode assembly suitably mounted in a hollow, tubular metal shell. The shell usually has a reduced opening between its lower or threaded end and its opposed upper end which forms an outwardly facing shoulder. The insulator is received by an enlarged diameter portion of the opening in the upper end of the shell. A small metal gasket is usually placed between the upwardly facing shell shoulder and a cooperating downwardly facing shoulder on the insulator to form a seal and an effective heat transfer path between the insulator and the shell.

In one known type of spark plug, the ceramic insulator is provided with a flange portion which closely engages the sidewall surfaces of the enlarged portion of the opening through the shell. The flange portion is spaced below the upper end of the shell to define an annular pocket. A resilient powdered sealing material, such as talc, is tightly compacted into the annular pocket and the outer end of the shell is crimped over the compacted material. The shell is then axially compressed and collapsed at a thin-walled portion located above the upwardly facing shell shoulder. As the shell collapses, the gasket between the insulator shoulder and the shell shoulder is deformed to form a seal and a good heat transfer path.

The small metal gasket, which is located between the insulator and shell shoulders, has been the source of a number of problems, as well as an added expense, in manufacturing spark plugs. The small physical size of the gasket has created material handling problems, and, in some instances, a defective spark plug will be manufactured because of improper placement of the gasket.

## SUMMARY OF THE INVENTION

According to the present invention, the need for a gasket in a spark plug is eliminated by providing the upwardly facing shell shoulder and the cooperating downwardly facing insulator shoulder at different angles to a plane perpendicular to the axis of the spark plug. It has been found that spark plugs may be formed without a gasket if the downwardly facing insulator shoulder forms an angle with a plane perpendicular to the insulator axis within a range between 20° and 45° and the upwardly facing shell shoulder forms an angle within a range between 0° with a plane perpendicular to the shell axis and 5° less than the insulator shoulder angle. If other shell and insulator shoulder angles are used, the insulator may crack during assembly or during subsequent use. The spark plug is assembled in a conventional manner, except for the elimination of the gasket. The insulator is inserted into the shell until the cooperating insulator and shell shoulders abut, forming a continuous line contact around the insulator shoulder. The angle difference between the shell and insulator shoulders acts to center the insulator within the shell. In the preferred assembly method, a resilient sealing material is then compacted between the insulator and the shell, the shell is crimped over the compacted sealing material, and the shell is axially collapsed at a thin-walled section by cold pressing. As the shell is collapsed, the upwardly facing shell shoulder is deformed by cold working against the insulator shoulder, thus forming a seal and a good heat transfer path between the shell and the insulator.

Accordingly, it is a primary object of the invention to provide a method of manufacturing a gasketless spark plug.

Another object of this invention is to provide a novel gasketless seat between a spark plug shell and insulator.

Still another object of the invention is to reduce the cost of materials in a spark plug.

Other objects and advantages of the invention will become apparent from the following detailed description of a preferred form thereof, reference being made to the accompanying drawings.



## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a cross-sectional view of a spark plug constructed according to the instant invention;

FIG. 2 is an enlarged fragmentary sectional view showing the spark plug shell and insulator shoulders prior to deforming the upwardly facing shell shoulder by cold working; and

FIG. 3 is an enlarged fragmentary sectional view of the spark plug shell and insulator shoulders subsequent to deforming the upwardly facing shell shoulder by cold working.

## DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to FIG. 1, a spark plug **10** manufactured in accordance with the instant invention is shown in section. The spark plug **10** generally comprises a hollow metallic shell **11** having a threaded lower end **12** for engaging an internal combustion engine, an insulator **13** positioned within the hollow shell **11**, and an electrode **14** axially positioned within a bore **15** through the insulator **13**. A ground electrode **16** is welded to the lower end **17** of the shell **11** for defining a spark gap with the electrode **14**.

The spark plug shell **11**, which is preferably formed from a mild steel, has a generally tubular shape with a reduced axial opening comprising a large diameter upper opening **18**, a smaller diameter lower opening **19** and a restricted portion **20** within the smaller diameter opening **19**. The restricted portion **20** is shaped to define an angled upwardly facing shoulder **21** for forming a seat for a cooperating shoulder on the insulator **13**.

The insulator **13**, which is preferably formed from a vitreous material, has a relatively large diameter central flange **22** adapted to be received by and closely engage the walls of the large diameter upper shell opening **18**. The flange **22** tapers into a reduced diameter portion **23** which is slidably received by the small diameter shell opening **19**. A downwardly facing insulator shoulder **24** separates the reduced diameter portion **23** and an insulator nose portion **25**. The downwardly facing shoulder **24** is adapted to abut and seat against the upwardly facing shell shoulder **21** in the assembled spark plug **10**. As shown in FIG. 2, the upwardly facing shell shoulder **21** and the downwardly facing insulator shoulder **24** are initially formed at different angles. When during assembly the insulator **13** is first inserted into the shell **11**, the angle difference will center the insulator **13** in the shell **11** and the abutting shell and insulator shoulders **21** and **24** will have a line contact **26** extending continuously around the insulator **13** adjacent the insulator nose **25**.

If the angles of the shell and insulator shoulders **21** and **24** are incorrect, the insulator **13** will develop cracks during assembly or during subsequent use. It has been found that the hazard of forming insulator cracks is minimized if the insulator shoulder **24** is formed at an angle within a range between 20° and 45° to a plane perpendicular to the axis of the insulator **13**. The shell shoulder **21** should be at an angle of at least 5° less than the insulator shoulder angle, but it should not extend beyond a plane perpendicular to the shell axis. In a preferred form, the insulator shoulder **24** is formed at an angle of substantially 30° to the perpendicular plane and the shell shoulder **21** is formed at an angle within the range between 10° and 15° to the perpendicular plane.

Above the flange portion **22**, the insulator **13** has a reduced diameter upper portion **27**. An annular pocket, defined between the upper reduced diameter portion **27** of the insulator **13**, the flange **22** and the wall of the upper shell opening **18**, is filled with a compacted sealing material **28**, preferably a resilient inorganic particulate material such as talc or asbestos.

A crimped rim **29** is shown in FIG. 1 at the upper end of the shell **11**. Prior to assembly, the rim **29** is opened (not shown) to pass the insulator flange **22**. The first step in assembling the

spark plug **10** is to slide the insulator **13** into the shell **11** until the downwardly facing insulator shoulder **24** contacts the upwardly facing shell shoulder **21**, as shown at point **26** in FIG. **2**. The sealing material **28** is then compacted in the annular pocket formed between the wall of the upper shell opening **18**, the insulator flange **22** and the upper reduced diameter portion **27** of the insulator **13**. Assembly is completed by crimping the rim **29** at the upper end of the shell **11** to enclose the compacted sealing material **28** and applying a high axial force to the shell **11** to collapse a thin-walled portion **30** which is located between the crimped rim **29** and the upwardly facing shell shoulder **21**. As the thin-walled portion **30** of the shell **11** is collapsed, the upwardly facing shell shoulder **21** is deformed by cold working against the downwardly facing insulator shoulder **24** to form a seal and a good heat transfer path between the insulator **13** and the shell **11**, as shown in FIG. **3**. The sealing material **28** is highly compressed to bias the downwardly facing insulator shoulder **24** against the upwardly facing shell shoulder **21**, while permitting the insulator **13** to expand and contract in an axial direction during temperature changes. It has been found that the seat formed between the deformed upwardly facing shell shoulder **21** and the downwardly facing insulator shoulder **24** is improved if the downwardly facing insulator shoulder **24** is glazed.

Although the spark plug **10** has been described as being assembled by what is known in the art as the cold press process, it will be appreciated that the spark plug **10** may be assembled by other well known techniques.

We claim:

**1.** In a spark plug, a method of forming a seat between a cylindrical insulator and a hollow tubular shell, said shell having a threaded lower end for engaging an internal combustion engine and a reduced opening extending between upper and lower ends and said insulator having a radially extending flange for slidably fitting within an enlarged diameter upper portion of said reduced shell opening, said insulator also having a downwardly and outwardly facing annular shoulder below said radially extending flange which forms an angle within a range between 20° and 45° to a plane perpendicular to the insulator axis, said method comprising the steps of:

a. forming an internal, upwardly facing annular shoulder in said shell, said shell shoulder defining an angle within a range between 0° to a plane perpendicular to the shell axis and 5° less than the insulator shoulder angle, an edge of said shell shoulder being positioned to engage the downwardly facing insulator shoulder when said insulator flange is positioned within the enlarged diameter upper portion of the shell opening;

b. sliding said insulator into the upper end of said shell until the downwardly facing insulator shoulder abuts the upwardly facing shell shoulder; and

c. applying a sufficient axial force between said insulator and said shell to plastically deform said upwardly facing shell shoulder into engagement with said insulator shoulder continuously around said insulator to provide an effective seat between said shell shoulder and said insulator shoulder.

**2.** In a spark plug, a method of forming a seat between a cylindrical insulator and a hollow tubular shell, as claimed in claim **1**, wherein said insulator shoulder defines an angle of substantially 30° to a plane perpendicular to the insulator axis, and said shell shoulder defines an angle of between 10° and 15° to a plane perpendicular to the shell axis.

**3.** In a spark plug, a method of forming a seat between a cylindrical insulator and a hollow tubular shell, as claimed in claim **1**, and further including the steps of:

a. applying a glaze to said downwardly facing insulator shoulder; and

b. firing said glaze onto said insulator shoulder prior to sliding said insulator into said shell.

**4.** In a spark plug, a method of forming a seat between a cylindrical insulator and a hollow tubular shell, as claimed in claim **1**, wherein said axial force is applied by:

a. compacting a resilient material between said insulator, said shell and said insulator flange to form a resilient body;

b. crimping the upper end of said shell against the top of said resilient body; and

c. pressing said shell by applying an axial force above and below a thin-walled portion of the shell spaced above said upwardly facing shell shoulder to axially collapse said shell at the thin-walled portion, to cause the crimped upper end to hold said resilient body in a highly compressed condition and to plastically deform said shell shoulder into continuous seating engagement with said insulator shoulder.

**5.** In a spark plug, a method of forming a seat between a cylindrical insulator and a hollow tubular shell, as claimed in claim **4**, and further including the steps of:

a. applying a glaze to said downwardly facing insulator shoulder; and

b. firing said glaze onto said insulator shoulder prior to sliding said insulator into said shell.

**6.** A method of constructing a spark plug comprising the steps of:

a. forming a hollow cylindrical insulator, said insulator having a radially extending flange and a downwardly and outwardly facing annular shoulder below said flange, said insulator shoulder defining an angle within a range between 20° and 45° to a plane perpendicular to the insulator axis;

b. positioning a center electrode within said hollow insulator;

c. forming a tubular shell, said shell having a threaded lower end for engaging an internal combustion engine and a reduced opening extending between upper and lower ends for receiving said insulator and having an internal upwardly facing annular shoulder, and edge of which is positioned for engaging the downwardly and outwardly facing insulator shoulder, said shell shoulder defining an angle within a range between 0° to a plane perpendicular to the shell axis and 5° less than the insulator shoulder angle;

d. sliding said insulator into the upper end of said shell until the downwardly facing insulator shoulder abuts the upwardly facing shell shoulder;

e. compacting a resilient material between said insulator, said shell and said insulator flange to form a resilient body;

f. crimping the upper end of said shell against the top of said resilient body; and

g. pressing said shell by applying an axial force above and below a thin-walled portion of the shell spaced above said upwardly facing shell shoulder to axially collapse said shell at the thin-walled portion, to cause the crimped upper end to hold said resilient body in a highly compressed condition and to plastically deform said shell shoulder into seating engagement with said insulator shoulder continuously around said insulator.

**7.** A method of constructing a spark plug, as claimed in claim **6**, and further including the steps of:

a. applying a glaze to said downwardly facing insulator shoulder; and

b. firing said glaze onto said insulator shoulder prior to positioning the center electrode within said hollow insulator.

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