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Glow plug for diesel engines particularly of motor vehicles, with a tubular sheath having a diameter reduction at the closed end.

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US-A- 4 112 577
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Description

The present invention refers to a glow plug for diesel motors of motor vehicles of the type including a tubular metal sheath closed in its tip and having a diameter reduction in conjunction with the closed end, carried out by means of a compression. Said sheath holds an electric resistance element including one or more coils compacted within an insulating powder.

The electric element is joined, on one side, to the closed sheath end and, on the other side, to the current feeding wire, said element having the aim to glow a part of the sheath near the closed end.

As it is well-known, the reduction of sheath diameter in conjunction with the closed end or glowing side has the aim of accelerating the sheath heating in the above mentioned zone for reducing the motor pre-heating times.

The glow plugs having a resistance element formed by two coils joined in series, one of these coils being welded to the closed sheath end and forming the heating coil, and the other coil being joined to the current feeding wire and forming the control coil of the feeding current. The sheath section with a reduced diameter surrounds substantially the heating coil and is joined by a connection section, on one side, with the glow plug ogive and, on the opposite side, with the remaining sheath section having a greater diameter.

From GB-A-2 058 216 it is known a glow plug having the resistance element formed by a single coil and a sheath section with reduced diameter surrounding the end part of the heating coil.

In these glow plug types the diameter reduction in conjunction with the sheath end is obtained by means of a radial squashing of the interested section, usually made up by means of a cylindrical hammering.

In this manner the heating times of the sheath are shortened both by the effect of sheath approach to the heating coil, and, owing to a better insulating powder compaction increasing the heat transmission from the coil towards the sheath.

Although the cylindrical hammering operation for getting the diameter reduction causes a reduction of the thickness of the hammered sheath, this reduction is increased in particular in conjunction with the connection section with greater diameter sheath, then causing a critical zone subject to a quick erosion.

A scope of the present invention is to supply a glow plug that has the following advantages:

- a) a better reliability both during the preheating phase and during the motor running;
- b) a heat concentration on tip and finally
- c) a better profile of the closed sheath end.

The above mentioned and other scopes are obtained by means of a glow plug of the type specified in the introduction part of the description, characterized in that the sheath has, in conjunction with the

closed end, a conical swaging going towards the tip, obtained by means of a conical compression, preferably by means of a hammering, whose radial and axial components establish a radial and axial mechanical deformation of the closed sheath end, and in that said swaging is applied to an initially cylindrical part of the sheath and a curved part almost corresponding to the whole length of its initially hemispheric end (ogive); said swaging causing an increasing of the thickness of the swaged wall starting from the connection zone joined with the cylindrical part towards the closed sheath end (K3) and being made after the initial cylindrical compaction that interests the whole length of the sheath while the coil or coils and the insulating powder are already inserted into the sheath.

Using the conical swaging according to the invention it is got, on one side, an increasing thickness of the swaged sheath wall with the advantage of having a sheath section having a greater resistance to the thermochemical erosion that occurs both during the preheating phase and during the motor running phase and, on the other side, a high compaction of the insulating powder until the ogive end with the advantage of making better the heat transmission also in conjunction with the turns near the closed sheath end.

Further the temperature along the whole coil surrounded by the conical swaged sheath becomes uniform, as the thickness increase of the swaged sheath wall corresponds to a reduction of powder thickness included between sheath and coil, with the advantage of avoiding the formation of critical points along the coil filament, that is points submitted to overheating and therefore to breakage due to fusion.

Therefore using the conical swaging according to the invention, the sheath reliability is increased with following longer duration of the glow plug. Finally the conical swaging makes better the configuration of the closed end of the same sheath with the advantage of getting a better turbulence into the combustion chamber or prechamber with following reduction of gas oil consumptions and exhaust gases.

Further characteristics and advantages of the glow plug forming the object of the invention shall appear better in the following description referred to annexed drawings that show, as an indicative and unlimiting example, a preferred embodiment of the invention. In drawings:

Figure 1 shows, in partial view and axial section, the end of a conventional sheath with a sole diameter for glow plugs, in which an electric resistance element is embedded into a compacted insulating powder;

Figure 2 is a view similar to the view of Figure 1, showing a conventional sheath with two diameters;

Figure 3 shows, in view and partial section, a sheath ending in tip with a conical swaging ac-

cording to the invention;

Figure 4a-b-c shows, in three machining phases, the operation of conical swaging made onto a sheath by means of a hammering, starting from the cylindrical sheath of Figure 1.

Making now reference to the Figure 1 it is shown, by the reference G, a tubular metal sheath closed in its tip, in which it is inserted a resistance element S welded, on one side, to the closed end K1 of the sheath and, on the other side, to the current feeding wire (not represented). The resistance element S is formed by a coil embedded in a compacted insulating powder, such as MgO.

In a known manner, the powder is usually compacted by means of a cylindrical hammering made onto the sheath after the welding of the coil S into the ogive K1 and the following introduction of the insulating powder into the sheath.

The Figure 2 shows the sheath with two cylindrical sections G1 and G2, the end section G2 having a minor diameter and connected by a connection section, on one side, to the sheath section with greater diameter G1 and, on the opposite side, to the ogive K2. For getting this sheath form, it is made, in known manner, a first cylindrical hammering of the whole sheath length and in the following a further cylindrical hammering of the sole end part G2. By a further hammering the thickness of the sheath part with reduced diameter is not kept constant along the whole section G2 and with value equal to the initial thickness of the sheath G1, but this thickness is reduced and, in particular, in conjunction with the connection section included between the two cylindrical sections G1, G2, it passes indicatively from the value $\underline{a}$ to the value $\underline{a'}$ lower than $\underline{a}$, forming so a critical annular zone that is subject to a quick wear due to the thermochemical erosion.

The heating sheath according to the invention shown in Figures 3 and 4c has the closed sheath end ending with a conical swaging G3 made by means of a compression or squashing suitable for causing a mechanical deformation both in radial and axial direction onto the interested sheath part.

The swaging interests an initially cylindrical section of the sheath G1 indicatively represented by TC, and an end section indicatively represented by TE slightly shorter than the whole length L of the original hemispheric part (ogive) of Figure 1. Therefore the sheath according to the invention has the hemispheric end part K3 practically reduced in the bottom thereof. By the conical swaging it is got an increasing thickness of the wall of swaged sheath G3 and a temperature uniformity for the whole length of the coil section S surrounded by the swaged sheath G3.

Indicatively the thickness of the sheath G3 increases from the value $\underline{b}$ that is the initial value of the cylindrical section G1 to the value $\underline{b'}$ greater than $\underline{b}$, that is the value of the sheath end G3. In this manner

it is obtained a swaged sheath part having a resistance to the thermochemical erosion more and more increasing as the sheath protrudes more to the inside of the combustion chamber or prechamber, where the temperatures are higher, and also a greater resistance to the erosion caused by the heating of coil during the feeding phase or during the preheating phase of the glow plug.

Normally the thickness of the swaged sheath G3 increases linearly when moving towards the sheath tip. The temperature uniformity of the coil is obtained as the increase of the thickness of swaged part G3 corresponds to a reduction of the distance between the coil and the sheath, as indicated in Figure 3, where $\underline{t}$ indicates the powder thickness in the connection zone between G1 and G3 and $\underline{t'}$, inferior than $\underline{t}$, indicates the thickness in conjunction with the sheath end.

Further the new configuration of the sheath end in the inside of the combustion chamber or prechamber causes also a better turbulence and therefore a better combustion of the air-gas oil mixture.

The operative phases of the conical swaging made by means of a hammering are represented in the Figure 4, where 4a indicates the initial or start position of the cylindrical sheath, 4c indicates its final position and 4b an intermediate position.

The reference M indicates the hammers and the reference AR indicates a mechanical stop or sensor, installed in prefixed axial position, that establishes the length T of the swaging, as indicated in Figures 3 and 4c. The horizontal and vertical arrows of Figure 4a-b indicate respectively the radial ahead and back movement of the hammers and the progress of the sheath downwards. Then the conical compaction is obtained starting from the ogive tip towards the cylindrical part G1 of the sheath.

It is suitable that the swaging length T interests, as said, a wide part TE of the initial length L of the ogive and further is extended also to a certain cylindrical section TC of the sheath, also this section being exposed to the thermochemical erosion with the aim of increasing its thickness.

In practice this length T is a compromise between the exigences of reliability of the glow plug and the optimization of the combustion of the air-gas oil mixture.

Usually T is approximatively 2L and TE is approximatively 2/3 L.

The thickness $\underline{b'}$ of the swaged sheath part G3 is normally 25-30% greater than the thickness $\underline{b}$ of the sheath before the conical compaction operation is made.

After having made this operation, the swaged sheath part substantially shows the form of a truncated cone and the amplitude $\underline{\alpha}$ of the cone angle changes according to different parameters, as for example:

- distance between the terminal coils ST for increasing the insulation therebetween;
- time necessary for getting that the sheath tip reaches 850°C;
- wished profile of the sheath end for making better the air-gas oil mixture.

Normally this angle α changes between 10° and 25°: a greater amplitude of α corresponds to a greater increment of the thickness of swaged wall.

As an example some dimensional data related to an embodiment of the glow plug according to the invention are indicated in the following:

$$\alpha = 15^\circ$$

$$b = 0,7 \text{ mm}; b' = 0,9 \text{ mm}$$

The invention was described with reference to a glow plug in which the resistance element S is formed by a coil S, but it is clear that the invention can be applied also to glow plugs in which the element S is formed by two or more coils connected with one another.

The preceding description was made with reference to a sole typical example of a conical swaging obtained by means of a hammering; but it is obvious that the hammering can be replaced by a rolling or any other machining that is suitable for causing a radial and axial deformation of the interested sheath end part.

In any case, as indicated in Figure 4, the conical compaction is obtained starting from the hemispheric ogive tip towards the cylindrical part of the sheath and occurs after the sheath has reached the cylindrical compaction on its whole length, while the resistance element and the insulating powder are already embedded within the same sheath.

Claims

1. A glow plug for a diesel engine comprising: a tubular metal sheath (G) closed at one end by a rounded tip (K3), said tubular sheath (G) containing an electric resistance element (S) comprising at least one coil embedded into a compacted electrically insulating powder (MgO), said resistance element (S) being spaced apart from said tubular sheath (G), said resistance element (S) being electrically connected to the rounded tip (K3) of the sheath and to a current feeding wire respectively; said tubular sheath (G) comprising a cylindrical section (G1) having an outer diameter, and an end section (G3) of reduced diameter, characterized in that said end section (G3) of reduced diameter of the tubular sheath (G) comprises a conical swaging section having a wall tapering towards the rounded tip (K3), said tapering wall of the conical swaging section (G3) having a thickness increasing from a connection zone with the cylindrical portion (G1) of the sheath, to-

wards said rounded tip (K3).

2. A glow plug according to claim 1, characterized in that the thickness of the tapering wall of said conical swaging section (G3) increases substantially in a linear mode.
3. A glow plug according to preceding claims, characterized in that the angular amplitude (α) of the conical swaging section (G3) is included between 10° and 25°.
4. A glow plug according to claim 1 characterised in that the spacing between said resistance element (S) and the tapering wall of the conical swaging section (G3) is decreasing from said connection zone to said tip (K3) of the sheath (G).

Patentansprüche

1. Glühstiftkerze für einen Dieselmotor mit einer röhrenförmigen, an einem Ende durch einen abgerundeten Kopf (K3) geschlossenen Metallschutzhülle (G), die ein elektrisches Widerstandselement (S) enthält, welches wenigstens eine in ein verdichtetes elektrisch isolierendes Pulver (MgO) eingebettete Spule aufweist, wobei das Widerstandselement (S) von der röhrenförmigen Schutzhülle (G) räumlich getrennt und mit dem abgerundeten Kopf (K3) der Schutzhülle bzw. mit einem stromzuführenden Kabel elektrisch verbunden ist, wobei die röhrenförmige Schutzhülle (G) einen zylindrischen Bereich (G1) mit einem äußeren Durchmesser und einen Endabschnitt (G3) von reduziertem Durchmesser aufweist, dadurch gekennzeichnet, daß der Endabschnitt (G3) der röhrenförmigen Schutzhülle von reduziertem Durchmesser (G) einen konischen Tiefziehabschnitt aufweist, der eine gegen den abgerundeten Kopf (K3) sich verjüngende Wand besitzt, welche eine von einer an den zylindrischen Bereich (G3) der Schutzhülle anschließenden Anschlußzone in Richtung zu dem abgerundeten Kopf (K3) zunehmende Dicke hat.
2. Glühstiftkerze nach Patentanspruch 1, dadurch gekennzeichnet, daß die Dicke der sich verjüngenden Wand des konisch Tiefziehabschnitts (G3) sich in einer im wesentlichen linearen Weise vergrößert.
3. Glühstiftkerze nach vorangehenden Ansprüchen, dadurch gekennzeichnet, daß der Kegelwinkel (α) des konischen Tiefziehabschnitts (G3) zwischen 10° und 25° beträgt.
4. Glühstiftkerze nach Anspruch 1, dadurch ge-

kennzeichnet, daß der Abstand zwischen dem Widerstandselement (S) und der sich verjüngenden Wand des konischen Tiefziehabschnitts (G3) von der Anschlußzone zum Kopf (K3) der Schutzhülle (G) abnimmt 5

Revendications

- 10
1. Bougie incandescente pour moteur diesel comprenant :
- une gaine métallique tubulaire (G) fermée à une de ses extrémités par une extrémité arrondie (K3), ladite gaine tubulaire (G) comportant un élément de résistance électrique (S) comprenant au moins un enroulement noyé dans une poudre d'isolation électrique compactée (MgO), ledit élément de résistance (S) étant maintenu à distance de ladite gaine tubulaire (G), ledit élément de résistance (S) étant électriquement relié respectivement à ladite extrémité arrondie (K3) de ladite gaine et à un fil d'alimentation électrique; ladite gaine tubulaire (G) comportant une section cylindrique (G1) ayant un diamètre extérieur, et une section d'extrémité (G3) de diamètre réduit, caractérisée par le fait que ladite section d'extrémité (G3) de diamètre réduit de la gaine tubulaire (G) comporte une section conique emboutie ayant une paroi en pente inclinée vers l'extrémité arrondie (K3), ladite paroi en pente de ladite section conique (G3) ayant une épaisseur qui augmente de la zone de rattachement à la partie cylindrique (G1) de ladite gaine, vers ladite extrémité arrondie (K3). 15 20 25 30 35
2. Bougie incandescente selon la revendication 1, caractérisée par le fait que l'épaisseur de la paroi en pente de ladite extrémité conique emboutie (G3) augmente de façon essentiellement linéaire. 40
3. Bougie incandescente selon les revendications précédentes, caractérisée par le fait que l'angle d'ouverture (α) de la section emboutie conique (G3) est compris entre 10° et 25°. 45
4. Bougie incandescente selon la revendication 1, caractérisée par le fait que l'espace entre ledit élément de résistance (S) et la paroi en pente de la section conique emboutie (G3) diminue à partir de ladite zone de rattachement à ladite extrémité (K3) de la gaine (G). 50

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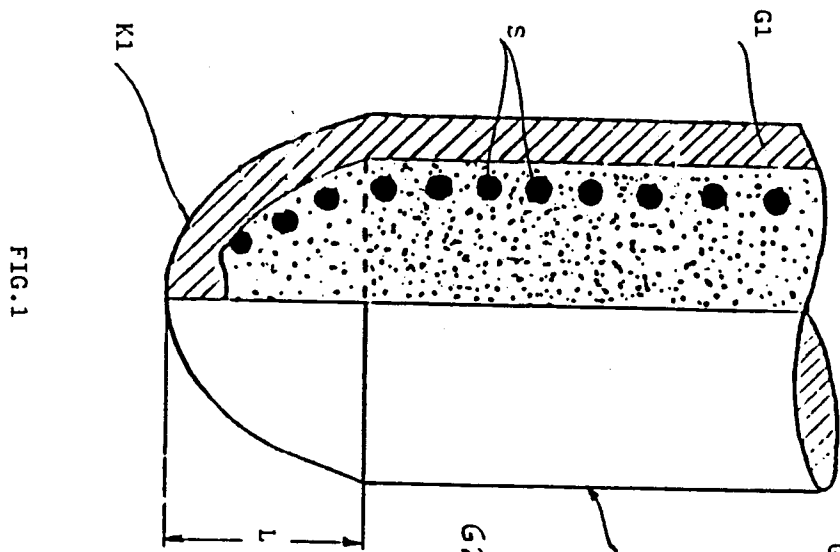


FIG. 1

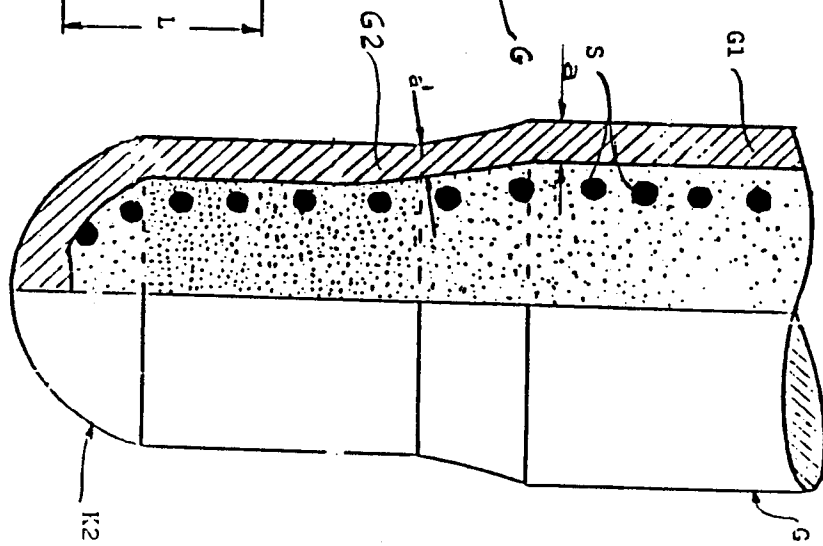


FIG. 2

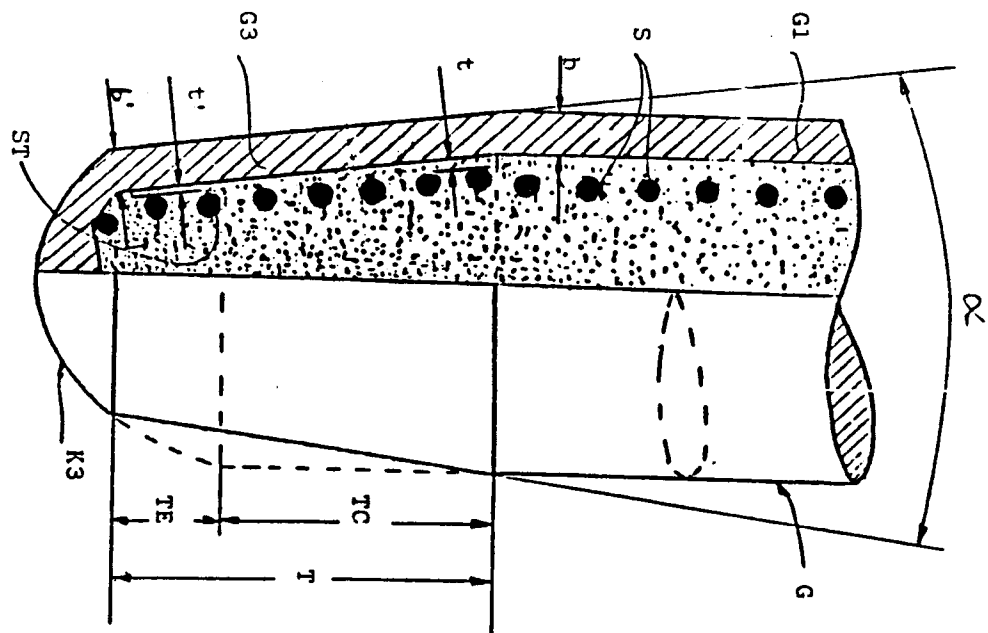


FIG. 3

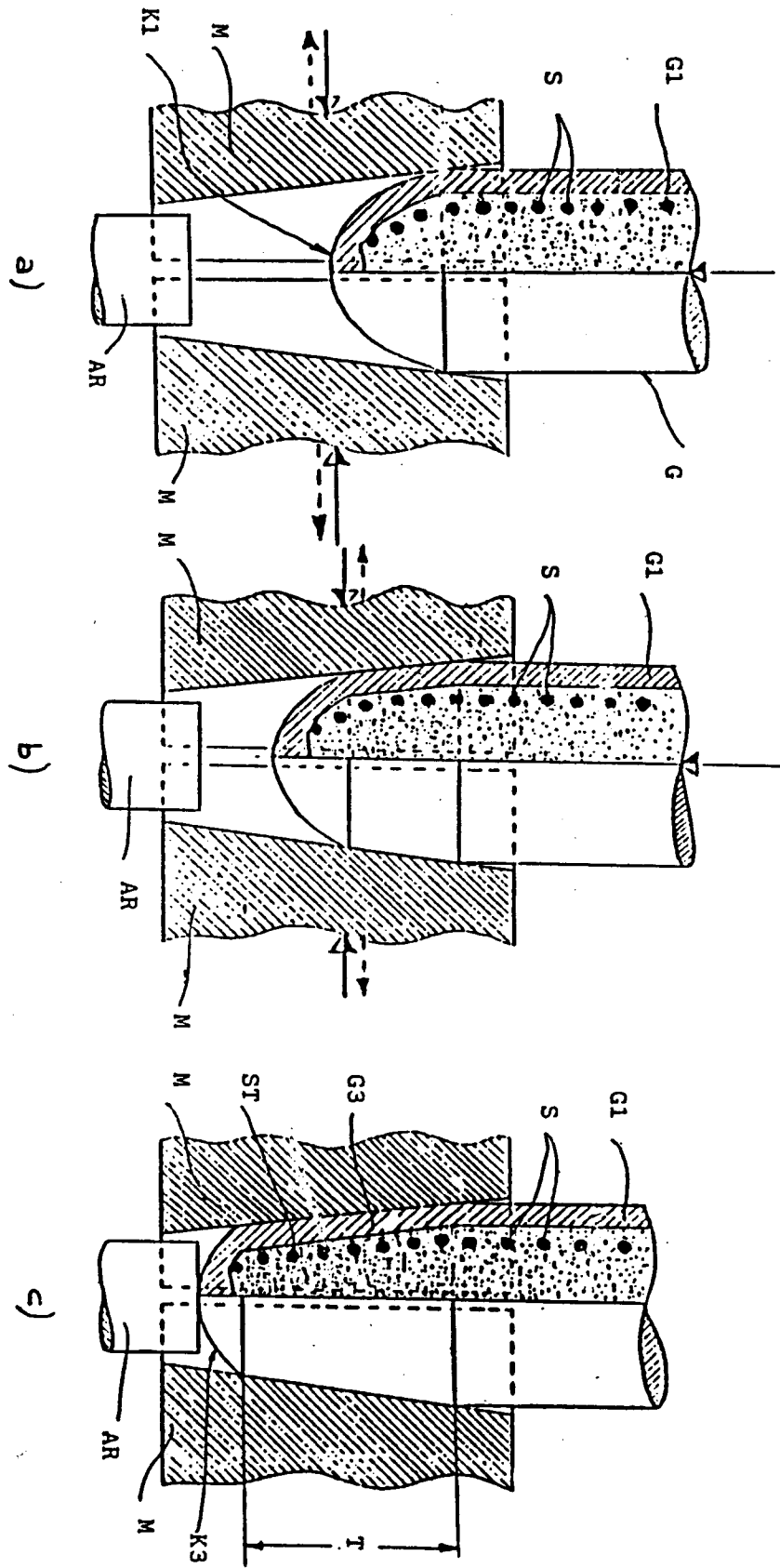


FIG. 4