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(54) **Glow plug having two spirals for diesel engines of motor vehicles.**

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EP-A- 0 098 035
DE-A- 3 421 950
US-A- 4 549 071

(56) References cited :
PATENT ABSTRACTS OF JAPAN, vol. 6, no. 89 (M-132), 27th May 1982, page 124 M 132; & JP-A-57 26 326 (NIPPON TOKUSHU TOGYO K.K.) 12-02-1982
PATENT ABSTRACTS OF JAPAN, vol. 6, no. 157 (M-150), 18th August 1982, page 67 M 150; & JP-A-57 73 326 (NIPPON TOKUSHU TOGYO K.K.) 08-05-1982

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Description

The present invention relates to glow plugs for diesel engines of motor vehicles of the type comprising a hollow metal body, a current feeder and a tubular metal sheath, which is secured to the inside of said body and closed at the tip, in which sheath a portion of the current feeder and two series connected electrical wire coils, one for heating and the other one for controlling the supply current, are inserted and embedded in an insulating powder, said control coil being inserted into the sheath zone which is surrounded by said body for a portion higher than one half of its length, preferably from 50 to 70% of its length.

As it is known, during the preheating time of the engine, the heating coil performs the function of causing the sheath to glow to sufficiently heat the combustion chamber or precombustion chamber, into which the sheath projects in order to facilitate the starting of the engine, particularly at low ambient temperatures. On the other hand, the control coil performs the function of limiting the intensity of current that flows into the two coils when the temperature increases, in order to avoid the overheating and therefore the burnout of one or both coils.

To obtain this result, the control is made of a filament having a PTC characteristic i.e. a very high positive temperature coefficient of resistance whereas the heating coil is made of an alloy of higher resistivity whereby, during the preheating time, the control coil, that is at ambient temperature, has a low electrical resistance for allowing the passage of a high supply current into the heating coil and thus a temperature increase of the sheath is achieved ; but, owing to the temperature increase of the control coil, this increase being caused substantially by the thermal influence of the heating coil, an increase of its electrical resistance and therefore a reduction of the supply current occurs, resulting in the control of the maximum sheath temperature, that is kept within the pre-established limits.

The well-known glow plugs of this type show heating curves of the sheath usually included between two limit curves : the upper curve (see A of Figure 3) tending, in steady state, to a maximum pre-established temperature, usually amouting to about 1100°C, and the other lower curve (see B of Figure 3) usually tending, in steady state, to about 1000°C.

Therefore, the heating curves of known double coil glow plugs are included in the temperature range defined by the above mentioned limit curves with a large temperature tolerance that, in steady state, amounts to about :

$$\Delta°C = 100°C\ (1100 - 1000).$$

This is due to the fact that the coils are directly connected by a welded joint and so positioned with respect to the glow plug body that the heating coil thermally influences the control coil since the beginning of current supply period and that the heating of said control coil is influenced by various parameters, such as the filament diameter of the coils, turns pitch of the coils, winding diameter of the coils, relative distance between the coils, powder compactness, etc., which change from one glow plug to any other glow plug owing to the unavoidable manufacturing tolerances of coils and/or assembly of the same ones into the sheath.

Therefore, when the heating curves are very near to the lower limit curve, the starting of the engine can be irregular or prevented when the ambient temperatures are under 0°C and this occurs because the sheath reaches the temperature necessary for the ignition of the air/gasoil mixture only after a preheating time longer than the nominal foreseen time.

A glow plug of the type including a tubular sheath containing two electrical coils connected in series is disclosed by the Japanese Patent Specification JP-A-57-26326.

To shorten pre-heating time while also suppressing the maximum temperature to low value, the control coil is disposed so that 50 to 75% of its length is positioned into the body of glow plug. However, also in this glow plug the coils are directly connected with one another so that the heating coil thermally influences the control coil, whereby the drawbacks for the mixture ignition at start of the engine due to the variable temperature tolerances of the heating curves of the sheath are not eliminated.

The main object of the present invention is that of reducing the tolerance range of heating curves of the sheath of dual coil glow plugs of the above mentioned type with the aim of ensuring a better control of maximum steady temperature and so reducing the preheating times of the engine, particularly when the ambient temperature is near or under 0°C.

Another object of the present invention is to manufacture the double coil by an automated process for reducing the production cost of the glow plugs.

The above mentioned objects are achieved with a glow plug of the type as specified in the preamble of the specification, characterized in that the heating coil and the control coil are connected with one another by means of an apposite or proper electrically conductive spacer element having a low thermal conductivity and a length of some millimeters sufficient to obtain a substantial thermal insulation between said coils, whereby the control coil is no more thermally influenced by the heating coil heat and its temperature is substantially that caused by the supply current flowing through it.

Owing to the thermal insulation between the coils a substantial elimination of the influence of the parameters of the heating coil onto the heating of the control coil is achieved, whereby the heating curves of glow plugs according to the invention are a function only of the control coil parameters and, accordingly, these curves are situated in a very reduced temperature range, that is kept near and under the upper limit curve and, in steady state, the temperature tolerance is reduced of about 50% of the temperature tolerance of the heating curves of known glow plugs. Thus it is assured that the lower heating curves of the sheath during the pre-established current supply period of the coils reach the ignition temperature also when the ambient temperature is near to 0°C.

Further, as the connection of the coils is obtained by means of an intermediate element, the manufacturing of the double coil can be carried out advantageously using simple automatic systems, avoiding in this manner the costly Laser or plasma welding processes, that were required until to-day for connecting directly the two ends of coils.

To give an idea of the complexity of these known processes, it is sufficient to remember, for instance, that the Laser welding requires that the two ends of coils to be connected are kept perfectly side by side and that said ends terminate at the same level during the welding process.

The glow plug according to the present invention will become apparent from the following description of a preferred embodiment shown, by way of example, in the annexed drawings, in which :

Figure 1 shows in longitudinal section the end tip of a two coil glow plug according to the invention;
Figure 2 shows, again in longitudinal section, another embodiment of the glow plug according to the invention ;
Figure 3 shows the behaviour versus time (t) of the heating temperature (Tc) of sheaths of conventional glow plugs (curves A, B) and of sheaths of glow plugs according to the invention (curves A, C) ; and
Figure 4 shows the behaviour of the temperature (Tc) required for the sheath of the glow plugs for ensuring the mixture ignition, at start-up, when the external ambient temperature (Ta) changes.

Referring now to the Figures 1 and 2, the glow plug comprises a hollow metal body 1, a current feeder 2 and a tubular metal sheath 3, which, at one end, is secured to the inside of body 1, at the other end, protrudes from the body and is closed at its tip.

The sheath portion having the length Lg protruding from the body 1 forms the glow tube that ends in the combustion chamber or pre-combustion chamber of a Diesel engine.

To the inside of the sheath 3, compacted in an insulating powder 4 such as MgO, are inserted from its open end, the end of the current feeder 2 and two series-connected electrical wire coils 5 and 6 : the first coil 5 performs the function of heating the sheath for bringing the latter to glow and so promote the start of the engine, while the second coil 6 performs the function of controlling the current supply flowing across the coils in order to prevent the coils reaching inadmissible high temperatures. The control coil 6 is inserted for about 2/3 of its length (2/3 Lc) into the sheath zone that is surrounded by the body 1. The opposite ends of the two coils 5, 6 are connected respectively to the sheath tip and to the end of the current feeder 2.

According to the invention the other two ends of coils 5 and 6, that is ones marked 5a and 6a, are connected with one another by means of a spacer element 7 or 8, that is electrically conductive and has a low thermal conductivity.

The element 7 or 8, that is made of stainless steel (Ni-Cr alloy) and has a length Ld of some millimeters, gives a spacing between the two coils and thus ensuring a substantial thermal separation of the same coils.

The heat transmission from the heating coil 5 to the control coil 6 is obstructed because, on one hand, the direct transmission towards the control coil is prevented by the presence of the spacer element 7 or 8, having a low thermal conductivity and, on the other hand, the indirect heat transmitted towards the control coil is dissipated towards the combustion chamber through the sheath 3 and towards the engine head through said sheath and the plug body 1.

Using the manufacturing solution suggested by the present invention, the heating cumin of glow plugs vary in a temperature range very reduced in comparison with the temperature range of conventional glow plugs. The comparison is shown in Figure 3, where the limit curves A and B define the temperature tolerance range of known glow plugs, while the curves A and C define the temperature tolerance range, represented in dotted lines, of glow plugs made in accordance with the invention.

Indeed, it can be noticed from the graph, that the upper limit curve A tends to 1100°C temperature, that is the maximum pre-established temperature the sheath must not exceed, in steady state, to avoid compromising the coils life, while the other two lower limit curves B and C, related, respectively, to known glow plugs and to glow plugs according to the invention, in steady condition, tend, the first one to 1000°C temperature, that is the minimum temperature the sheath must reach for assuring at start the mixture ignition even at very low ambient temperatures and within acceptable preheating times and the second one to a higher temperature of 1050°C.

Therefore, in steady condition, the temperature tolerance of the glow plugs is Δ'°C = 50°C that is one half of the Δ°C temperature tolerance of the conventional glow, plugs of them same type.

Thus the control of the temperature reached by the sheath in steady state is obtained that is not higher than 1100°C and not lower than 1050°C.

Tests made on a glow plug comprising :

– one control coil 6 having a length Lc of about 20 mm and being inserted into the body by more that 2/3 of its length, that is about 15 mm ;

– one heating coil 5 having a length Lr of about 6 mm ;

– one sheath 3 projecting from the body for about 25 mm, and

– one spacer tubular element 8 having a length Ld of 14 mm and a section of about 3 to 4 mm^2, i.e. an outside diameter (O/D) of about 2 to 3 mm, have shown that the sheath heating curve after twelve seconds (12″) from departure begings to be stabilized remaining within the tolerance range of temperature comprised between 1100°C and 1050°C even after 30″ which is the supposed pre-established period for the feeding current of the coils.

In more detail, the sheath temperature during the first supply period of the coils, up to about 12", undergoes a very quick increase with a very high temperature gradient of about 90°C/1″ and thus the heating curve is very steep and this happens as, during this period, a minimum control (regulation) of the supply current is carried out by the control coil 6. Indeed, owing to the substantial thermal insulation of the control coil 6, a substantial increase of its resistance does not occur.

In the immediately successive period, from 12″ up to 30″, the sheath temperature undergoes a very low increase with a very low temperature gradient of about 2°C/1″ and this occurs because, during this second period, a supply current regulation (reduction) is carried out by the control coil which has undergone in the meantime to a temperature increase and thus its resistance was increased under the action of the current flowing through it and not as a consequence of the heating coil thermal influence which is negligible.

Therefore, during this second period, the heating curve of the sheath is promptly stabilized under the maximum pre-established temperature value (1100°C), the temperature range being a function of the only control coil parameters.

The sheath temperature was measured with the aid of an IR optical pyrometer placed near the sheath end and under the following test conditions :

Supply Voltage = 11 Volt

Plug body temperature : 20°C ± 5°C.

It has been also ascertained that, changing the length Lg of the sheath portion projecting from the body between 20 and 30 mm and with a spacer tubular element 8 having a length comprised between 8 and 18 mm, the heating curve of the sheath, within reasonable times, entered and remained stabilized within the above mentioned tolerance range (Δ°C = 50°C).

In a more general way, it can be concluded that satisfactory results are obtained with a glow plug having : a spacer tubular element 8 showing a length Ld predominant in comparison with the transversal dimension, Ld being comprised between 8 and 18 mm and O/D comprised between 2 and 3 mm ; a control coil 6 of a length Lc ; a heating coil 5 of a length Lr, the length ratio Lc/Lr being higher than 3 (i.e. Lc/Lr > 3) ; and a sheath 3 protruding from the body 1 for a length Lg comprised between 20 and 30 mm. Further it was noticed that the spacer element 7 or 8, which, as above said, has a low thermal conductivity, preventing the heat transmission from the heating coil towards the control coil causes a temperature increase at the sheath end.

More particularly, it was noticed that the hottest part of the sheath is located at a distance included from 1 to 1.5 mm from the end of the sheath, differently from what occurs in known two coil glow plugs in which the hottest part is located at a distance of about 3 mm from the end.

The temperature increase at the sheath end has the advantage of positioning the more incandescent part of the sheath in the zone closest to the fuel (gasoil) jet and therefore causing a quicker and complete ignition of air/gasoil mixture.

What above said shows that the preheating times of glow plugs are reduced and this is particularly important when the ambient temperature descends to values near or under 0°C.

Further the graph of Figure 3 shows the reduction of preheating times : in fact the curve C reaches the temperature of 1000°C in a time lower than 30 sec and the temperature of 850°C in 6-7 sec instead of respectively 30 sec and 6-8 sec that are the times required for reaching the same temperature with a heating according to the curve B.

For a better understanding of the graphic of Figure 3, the Figure 4 shows the behaviour of the temperature Tc required to the sheath for causing the ignition of the mixture when the ambient temperature Ta changes.

It can be noticed that, when Ta decreases, the heating temperature Tc increases passing, for example, from a heating temperature of about 800°C at an ambient temperature of + 10°C to a heating temperature of about 1100°C for an ambient temperature of–20°C. Therefore, the lower the ambient temperatures are, the longer the preheating times are. That is the times required for raising the sheath temperature to the necessary value for causing the mixture igntion are increased.

The Figure 1 shows a spacer element consisting of a shaped pin 7, while the Figure 2 shows a spacer element consisting of a tubular or drilled element 8. The connection of the ends or terminal turns 5a and 6a of coils 5 and 6 with :he spacer element 7 is made by means of conventional electrical resistance welding, while the connection of these turns 5a and 6a with the tubular element 8 is made by squashing or radially compressing the ends of the tubular element after the terminal turns 5a, 6a of two coils 5, 6 have been inserted into the inside of said ends. However it is apparent that any other electrical or mechanical anchoring system can be used according to practical exigences.

Therefore it is possible to automate the connecting operations of parts and obtain double coils using an automated process that, as it is well-known, is more quick and economic than the welding process by Laser or plasma technics, that were used up to this time for connecting directly the two coil ends.

Claims

1. A glow plug for diesel engines of motor vehicles of the type comprising a hollow metal body (1), a current feeder (2) and a tubular metal sheath (3) which is secured to the inside of said body and closed at the tip, in which sheath a portion of the current feeder and two series-connected electrical wire coils, one for heating (5) and the other one (6) for controlling the supply current, are inserted and embedded into an insulating powder, said control coil being inserted into the sheath zone surrounded by the glow plug body (1) for a portion higher than one half of its length (Lc), preferably included from 50 to 70% of its length, characterized in that the heating coil (5) and the control coil (6) are connected with one another by means of an opposite or proper electrically conductive spacer element (7, 8) having a low thermal conductivity and a length (Ld) of some millimeters sufficient to obtain a substantial thermal insulation between said coils, whereby the control coil is no more thermally influenced by the heating coil heat and its temperature is substantially that caused by the supply current flowing through it.

2. A glow plug according to claim 1, characterized in that the spacer element comprises a pin element (7).

3. A glow plug according to claim 1, characterized in that the spacer element comprises a tubular element (8).

4. A glow plug according to claims 1 and 2, characterized in that the connection of the terminal turns (5a, 6a) of the coils (5, 6) with the pin element (7) is achieved by means of an electric welding.

5. A glow plug according to claims 1 and 3, characterized in that the connection of the terminal turns (5a, 6a) of the coils (5, 6) with the tubular element (8) is achieved by a mechanical anchoring, such as squashing of the tubular element ends to the inside of which said terminal turns have been previously introduced.

Ansprüche

1. Glühkerze für Dieselmotoren von Kraftfahrzeugen, jener Art, die einen hohlen Metallkörper (1), einen Stromzuführer (2) und eine rohrförmige Metallhülle (3) aufweisen, die an der Innenseite des Körpers befestigt und an der Spitze geschlossen ist, wobei in diese Hülle ein Abschnitt des Stromzuführers und zwei hintereinandergeschaltete elektrische Drahtspulen. und zwar die eine zum Aufheizen (5) und die andere die andere (6) zum Steuern des Speisestromes, eingeführt sind und in ein Isolierpulver eingebettet sind, und wobei die Steuerspule in jenen Bereich der Hülle, der vom Glühkerzenkörper (1) umgeben ist, mit einem Abschnitt eingeführt ist, der höher ist als die Hälfte ihrer Länge (Lc) und bevorzugt von 50 bis 70% ihrer Länge umfaßt, dadurch **gekennzeichnet**, daß die Heizspule (5) und die Steuerspule (6) miteinander mittels eines dazwischenliegenden oder besonderen, elektrisch leitfähigen Distanzelements (7, 8) verbunden sind, das eine niedrige Wärmeleitfähigkeit und eine Länge (Ld) von einigen Millimetern aufweist, die ausreicht, um eine wesentliche Wärmeisolierung zwischen den Spulen zu erhalten, wodurch die Steuerspule nicht mehr durch die Heizspule thermal beeinflußt wird und ihre Temperatur im wesentlichen jene ist, die vom Speisestrom verursacht wird, der durch sie strömt.

2. Glühkerze nach Anspruch 1, dadurch gekennzeichnet, daß das Distanzelement ein Stiftelement (7) umfaßt.

3. Glühkerze nach Anspruch 1, dadurch gekennzeichnet, daß das Distanzelement ein rohrförmiges Element (8) umfaßt.

4. Glühkerze nach den Ansprüchen 1 und 2, dadurch gekennzeichnet, daß die Verbindung der Endwindungen (5a, 6a) der Spulen (5, 6) mit einem Stiftelement (7) mittels einer Elektroschweißung erreicht ist.

5. Glühkerze nach den Ansprüchen 1 und 3, dadurch gekennzeichnet, daß die Verbindung der Endwindungen (5a, 6a) der Spulen (5, 6) mit dem rohrförmigen Element (8) durch eine mechanische Verankerung erreicht ist, etwa durch Quetschen der Enden des rohrförmigen Elements nach innen, in welche vorher die Endwindungen eingeführt wurden.

Revendications

1. Bougie de préchauffage pour moteurs Diésel de véhicules, du type comprenant un corps métallique creux (1), un conducteur d'alimentation de courant (2) et une gaine métallique tubulaire (3) fixée à l'intérieur dudit corps et fermée à son extrémité, à l'intérieur de laquelle gaine sont insérées et plongées dans une poudre isolante une portion du conducteur de courant et deux bobines de fil électrique connectées en série, l'une (5) pour le chauffage, l'autre (6) pour le contrôle d'alimentation du courant, ladite bobine de contrôle étant placée dans une zone de la gaine dont plus de la moitié et de préférence 50 à 70% de la longueur

(Lc) est entourée par le corps de la bougie de préchauffage (1), caractérisée en ce que la bobine de chauffage (5) et la bobine de contrôle (6) sont connectées l'une à l'autre au moyen d'un élément d'espacement (7, 8), convenable et approprié, conducteur de courant électrique, ayant une faible conductivité thermique et dont la longueur (Ld) de quelques millimètres est suffisante pour assurer une isolation thermique substantielle entre les bobines, de façon à ce que la bobine de contrôle ne soit plus affectée thermiquement par la bobine de chauffage et que pratiquement seul le courant qui la traverse détermine sa température.

2. Bougie de préchauffage selon la revendication 1, caractérisée en ce que l'élément d'espacement est en forme d'épingle (7).

3. Bougie de préchauffage selon la revendication 1, caractérisée en ce que l'élément d'espacement est en forme de tube (8).

4. Bougie de préchauffage selon les revendications 1 et 2, caractérisée en ce que la jonction des spires terminales (5a, 6a) des bobines (5, 6) avec l'élément en forme d'épingle (7) s'effectue par soudure autogène.

5. Bougie de préchauffage selon les revendications 1 et 3, caracterisée en ce que la jonction des spires terminales (5a, 6a) des bobines (5, 6) avec l'élément tubulaire (8) s'effectue par ancrage mécanique, tel que par écrasement des extrémités de l'élément tubulaire, à l'intérieur desquelles on a introduit au préalable lesdites spires terminales.

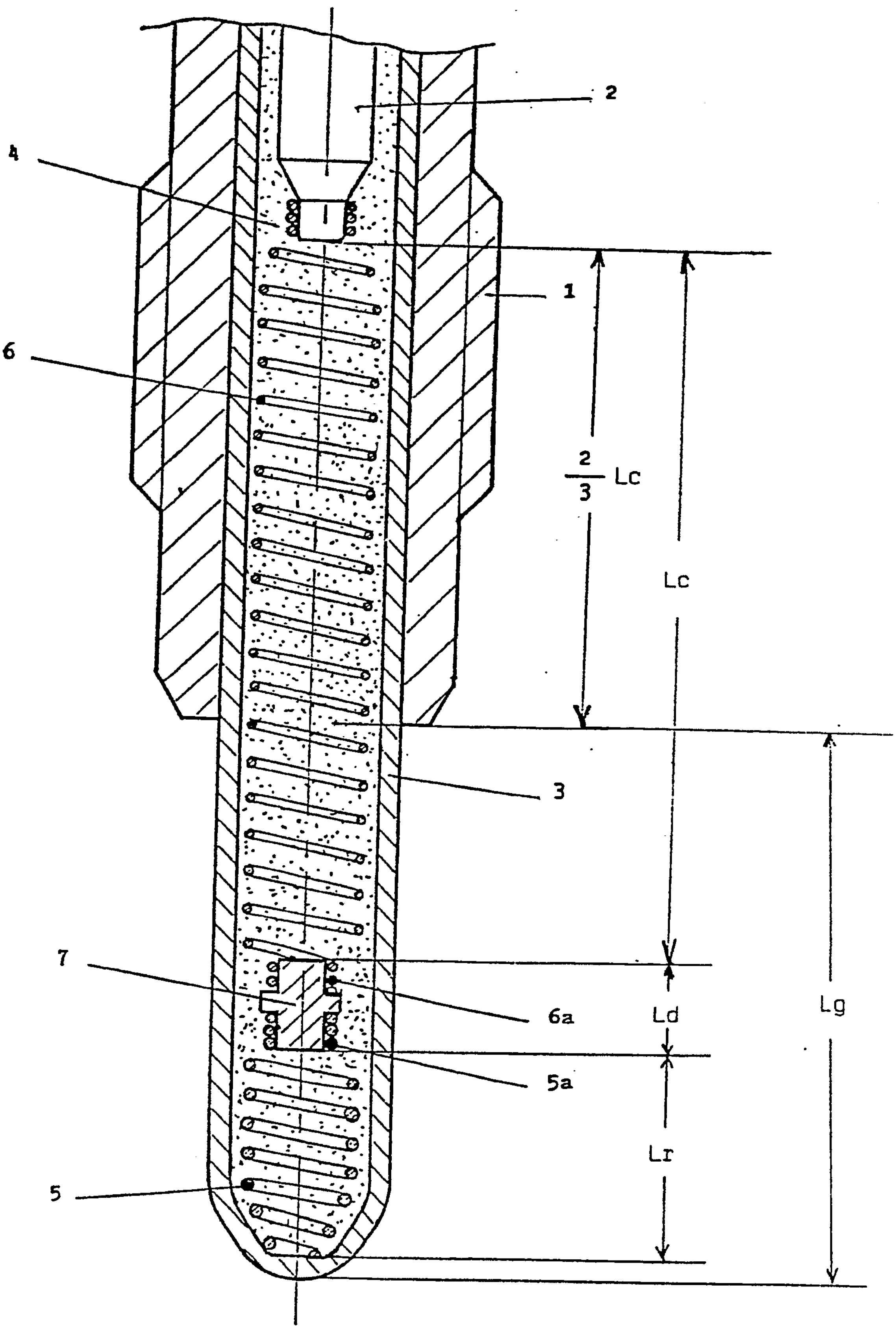

FIG. 1

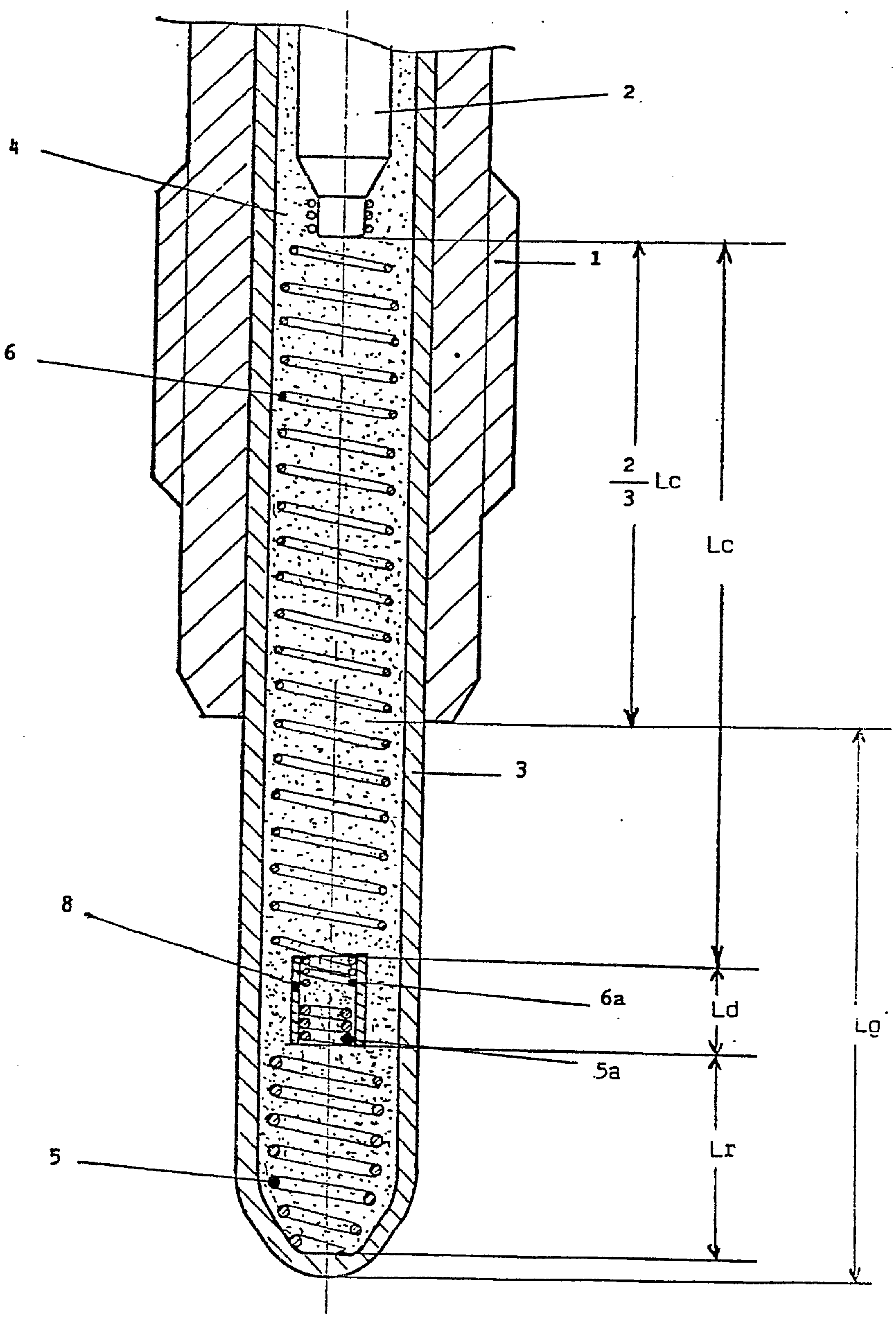

FIG. 2

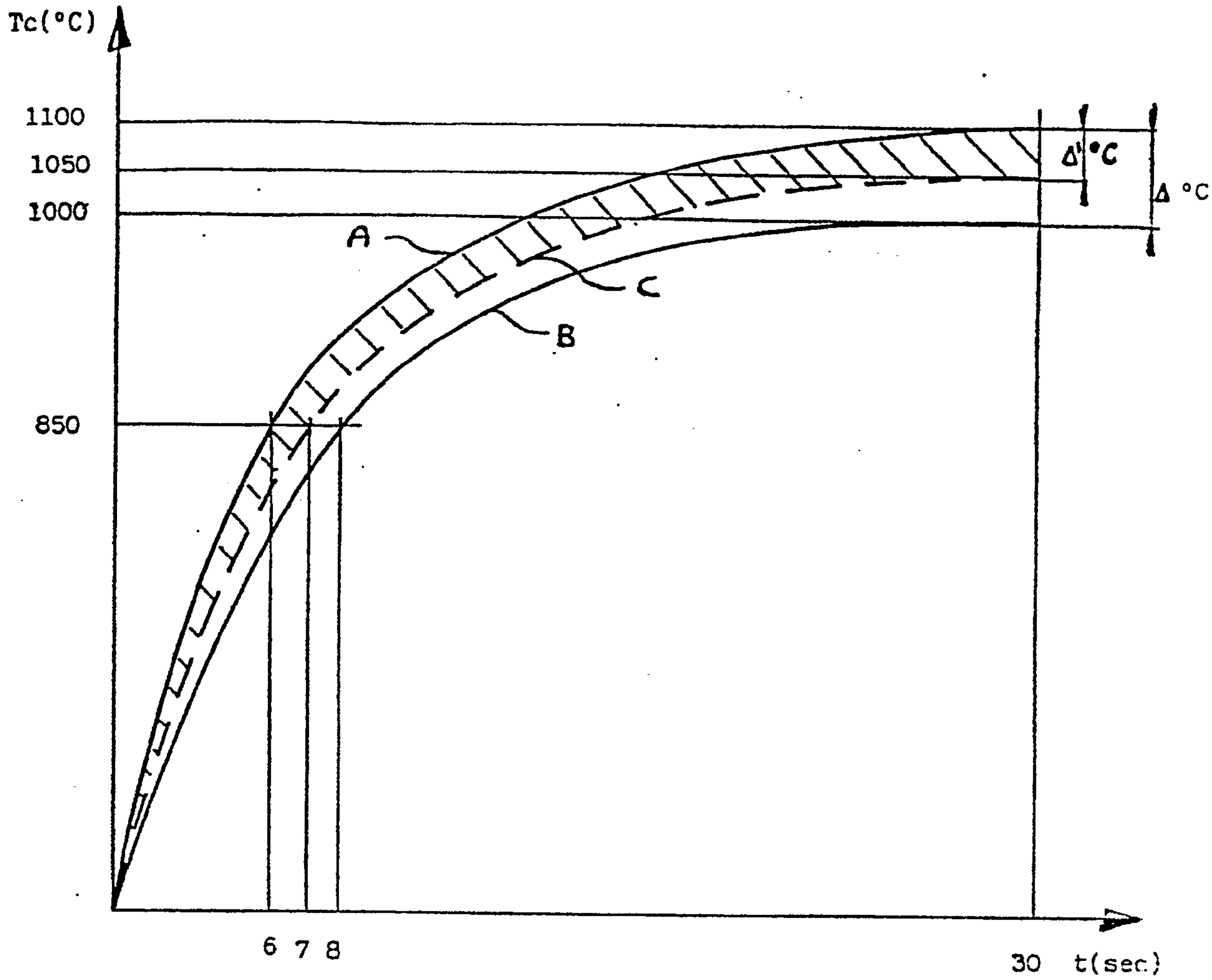
Tc(°C)
1100
1050
1000
850
A
C
B
Δ'°C
Δ °C
6
7
8
30
t(sec)

FIG. 3

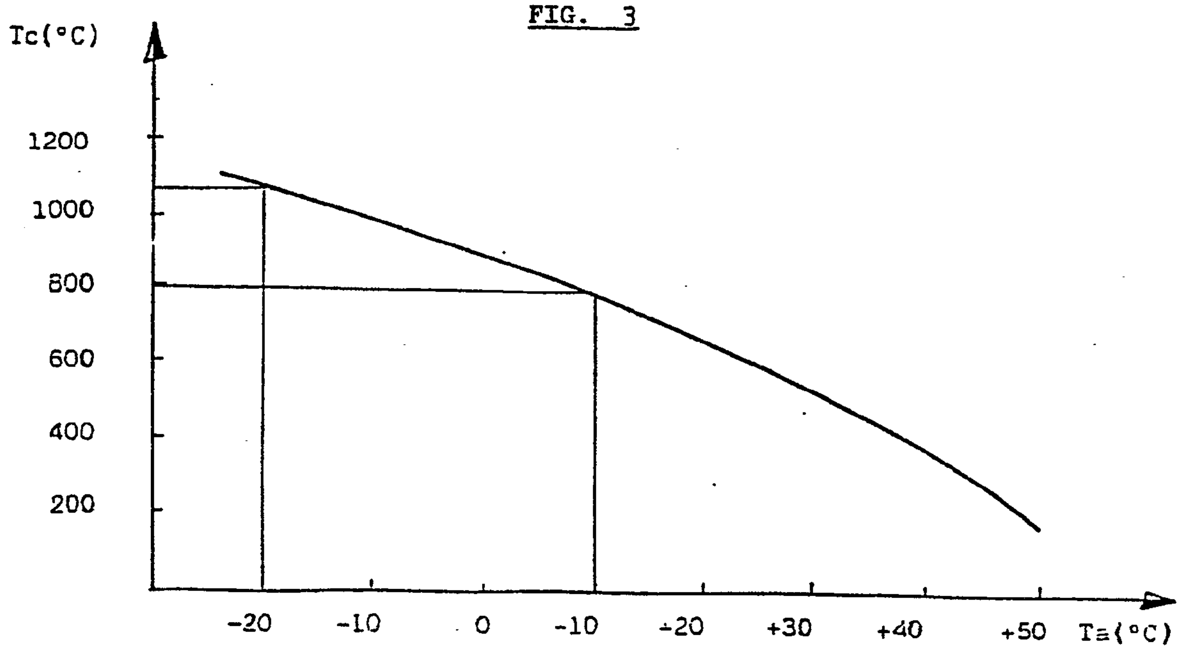
Tc(°C)
1200
1000
800
600
400
200
-20
-10
0
-10
+20
+30
+40
+50
Ta(°C)

FIG 4