(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 240 650 A1**

(12) **EUROPEAN PATENT APPLICATION**

(21) Application number: **87100292.9**

(51) Int.Cl.³: **F 23 Q 7/00**

(22) Date of filing: **12.01.87**

(30) Priority: **16.01.86 IT 1909986**
29.09.86 IT 849286

(43) Date of publication of application:
14.10.87 Bulletin 87/42

(84) Designated Contracting States:
BE DE ES FR GB SE

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

(57) The glow plug is of the type including a tubular sheath (3) secured to the body (1) and containing two electrical spirals connected in series, one (5) for heating and other one (6) for controlling the supply current, wherein said control spiral is inserted into the sheath zone surrounded by the body (1) for a portion higher than one half of its length (Lc).

The invention embodies connection of two spirals by an electrically conductive spacer element (17) having a low thermal conductivity.

Advantages: there is reduced the tolerance range of the heating curves of the glow plugs with the aim of improving, in steady state, the maximum temperature control, whereby the engine preheating times are reduced and this is particularly important when the ambient temperature goes below zero centigrade degrees.

Application: Glow plug for diesel engines of motor vehicles (Fig. 1).

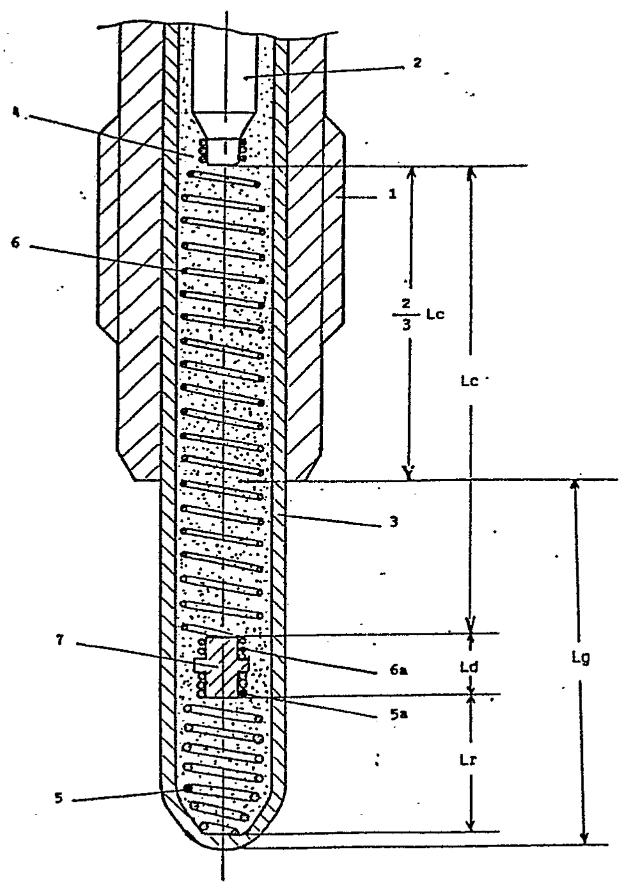

FIG. 1

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"GLOW PLUG HAVING TWO SPIRALS FOR DIESEL ENGINES OF MOTOR VEHICLES"

Description

The present invention relates to glow plugs having two spirals for diesel engines of motor vehicles.

More particularly, the invention relates to glow plugs including an hollow metal body, a current feeder and a tubular metal sheath which is secured to said body and is closed at the tip, in which sheath a portion of the current feeder and two series connected electrical spirals, one for heating and the other one for controlling the supply current, are inserted and embedded in an insulating powder, wherein from 50 to 70% of the lenght of the cotrol spiral is inserted into the sheath zone surrounded by said body.

As it is known, on starting the engine, the heating spiral performs the function of bringing the sheath to glow for sufficiently heating the combustion chamber or precombustion chamber, into which the sheath projects in order to facilitate the starting of the engine at low temperatures.

On the other hand, the control spiral performs the function of limiting the intensity of current that flows into the two spirals when the temperature increases in order to avoid the sheath overheating and therefore the burnout of one or both spirals.

To obtain this result, the control spiral comprises a filament having a very high positive temperature coefficient of resistence with respect to that of the heating spiral, whereby, on starting the cold engine, the control spiral, that is at ambient temperature, has a low electric resistance for allowing the passage of a strong current into the heating spiral and thus a quick temperature increase of the sheath; alterwards, owing to the temperature increase of the said control spiral, this increase being caused substantially by the thermal influence of the heating spiral, an increase of its electical resistance occurs and therefore a reduction of the supply current, resulting in control of the maximum sheath temperature that is kept within suitable limits.

Known double spiral glow plugs show heating curves usually situated between two limit curves: the superior one, tending, in steady state, to a maximum temperature usually amounting to about 1100°C and, the other lower curve, tending, in steady state, usually to about 1000°C.

Therefore, the heating curves of known glow plugs lie in the range defined by the above mentioned limit curves with a temperature tolerance that, in steady state, amounts to about Δ °C = 100°C (1100-1000).

This is due to various parameters that influence the heating of the control spiral and these parameters change from one glow plug to any other glow plug owing to unavoidable manufacturing tolerances of spirals and/or assembly of the same ones into the sheath.

Therefore, when the heating curves are very near to the lower limit curve, it can happen that the starting of the engine can be irregular or prevented when the ambient temperatures are below 0°C and this occurs because the sheath reaches the necessary temperature for the ignition of the air/gas oil mixture only after a prehating time higher that the nominal foreseen time.

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

Another object of the present invention is to manufacture the double spiral by an automatized process for reducing the production costs of glow plugs.

The above mentioned objects are reached with a glow plug which, according to the invention, is characterized in that the two spirals are connected to each another by means of an electrically conductive spacer element having a low thermal conductivity, and in that the lenght of such spacer element is comprised betheen 8 and 18 mm, the ratio betheen the lenght of the control spiral and the lenght of the heating spiral being higher than 3 and the projection of the sheath from the body having a lenght comprised betheen 20 and 30 mm.

Owing to the above mentioned measures, the thermal influence of the heating spiral on the control spiral is reduced to a minimum value, as, on the one hand, the two spirals are thermally separated by means of said spacer element and, on the other hand, the control spiral is kept in thermal equilibrium with the external temperature thanks to the heat transmission that occurs through the plug body, so that the control spiral temperature is finally the temperature caused almost exclusively by the current flowing in the spirals.

This result is obtained because of the substantial elimination of some of the parameters that influence the heating control spiral in variable way owing to said manufacturing tolerances, the heating curves of glow plugs according to the invention are situated in a very reduced range that is kept near and under the conventional superior limit curve and, in steady state, the temperature tolerance is reduced by about 50% of the temperature tolerance of the heating curves of known glow plugs.

Further, as the connection of the two spirals is obtained by means of an intermediate element, the manufacturing of the double spiral can be carried out advantageously by simple automatic systems, so avoiding the costly Laser or plasma welding processes that were required until to-day for the direct connection of the two ends of spirals.

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 spirals to be connected be maintained perfectly side by side and that said ends terminate at the same level during the welding process.

Further advantages and characteristics of the glow plug according to the present invention will become apparent from the following description of the preferred but not limiting embodiment shown, by way of example, in the annexed drawings, in which:

Fig. 1 shows in longitudinal section the end tip of a two spirals glow plug, according to the invention;

Fig. 2 shows, again in longitudinal section, another embodiment of the glow plug according to the invention;

Fig. 3 shows the behaviour versus time (t) of heating temperature (Tc) of the sheath of conventional glow plugs (curves A,B) and of the sheath of glow plugs according to the invention (curves A, C); and

Fig. 4 shows the behaviour of temperature (Tc) required of the sheath of the glow plugs for getting mixture ignition, at start-up, when the external ambient temperature (Ta) changes.

Referring to the Fig. 1 and 2, the glow plug comprises an hollow metal body 1, a current feeder 2 and a tubular metal sheath 3, which, at one end, is secured to the interior of body 1 and, at the other end protrudes from the body and is closed at its tip. The sheath portion of lenght Lg protruding from the body 1 forms the glow tube that ends in the combustion chamber or precombustion chamber of a Diesel engine.

To the interior of the sheath 3, compacted in an insulating powder 4 such as MgO, are inserted, from the open end, the end of the current feeder 2 and two series connected electric spiral 5 and 6: the first spiral has the function of heating the sheath for bringing the latter to glow and so promote the start of the engine while the second spiral has the function of controlling the supply current that flows the spirals in order to prevent the sheath reaching inadmissible high temperatures. Control spiral 6 is inserted for about 2/3 of its lenght (2/3 Lc) into the sheath zone that is surrounded by the body 1. The opposite ends of the two spirals 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 spirals 5 and 6, that is the ones marked 5a and 6a, are connected to 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 lenght Ld of some millimeters, gives a spacing between the two spirals and thus a substantial thermal separation of the same and, on the other hand, owing to its low termal conductivity, reducts heat transmission, whereby, it minimizes the thermal influence of the heating spiral 5 on the control spiral 6.

On the other hand, since the control spiral 6 is inserted for about 60 - 70% of its lenght Lc into the zone of the sheath 3 that is surrounded by the body 1, it occurs that the body transmit to outside the heat coming from the heating spiral mainly through the sheath, so minimizing further the thermal influence of the heating spiral on the control spiral.

It is evident that the lenght of the control spiral that is placed in the interior of body should be selected in relation to optimization of the thermal equilibrium of the spiral with respect to external temperature.

Several tests have shown that the optimization of the control of the temperature maximum in steady glow plug state is got by a spiral 6 inserted for a portion higher than one half of its length Lc, preferably by 2/3 of L_c, in the sheath part placed in the interior of the body 1.

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

That is, it can be noticed that the graph showing the superior limit curve A related to all glow plug types, tends to 1100°C temperature, that is the maximum temperature the sheath must not exceed, in steady state, to avoid compromising the spirals life, while of 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, the first one tends to 1000°C temperature that is the minimum temperature the sheath in steady condition 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 tolerance of the conventional glow plugs of the same type.

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

In particular, tests made on a glow plug comprising:

- one control spiral 6 having lenght Lc of about 20 mm and inserted into the body by more than 2/3 of its length, that is by about 15 mm;
- one heating spiral 5 having a lenght Lr of about 6mm;
- one sheath 3 projecting from the body for about 25 mm, and
- one spacer element 8 having a lenght Ld of about 14 mm and a section of about 3 ÷ 4 mm²,

have shown that the sheath heating curve after twelve seconds (12") from start entered and remained stabilized within the tolerance range of temperature comprised between 1110°C and 1050°C even after 30".

In a more general way and under the same conditions is 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 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 mentione tolerance range.

It may thus be concluded that satisfactory results are obtained with a glow plug of the type specified in the preamble, having however: a spacer element 8 showing a lenght Ld comprised between 8 and 18 mm; a control spiral 6 of a lenght Lc; and a heating spiral 5 of a lenght Lr, the lenght ratio Lc/Lr being higher than 3 (i.e. $Lc/Lr > 3$), the sheath 3 protruding from the body 1 for a lenght Lg comprised between 20 and 30 mm.

Further is was noticed that the spacer element 8, which as above said, has a low thermal conductivity, by obstructing the heat transmission from the heating spiral towards the control spiral, causes, accordingly, a heat concentration at the sheath end.

More particularly, it was noticed that the hottest part of the sheath is located at a distance of from to 1 to 1,5 mm from the end of the sheath, differently from what occurs in known two spirals glow plugs in which the hottest part is located at a distance of about 3 mm from the end.

The heat concentration at the sheath end has the advantage of positionning the more incandescent part of the sheath close to the axis of the fuel (gas oil) jet and therefore of causing a quicker ignition of air/gas oil mixture.

The above 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 Fig. 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 temperatures with an heating according to the curve B.

For better understanding the graph of Fig. 3, the Fig. 4 shows the behaviour of the temperature Tc required of the sheath for causing 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 an heating temperature of about 800°C at an ambient temperature of +10°C, to a heating temperature of about 1100°C at an ambient temperature of -20°C. Therefore, the lower the ambient temperatures, the higher the preheating times, namely the times required for raising the sheath temperature to the necessary value for causing the mixture ignition.

The Fig. 1 shows a spacer element consisting of a shaped pin 7, while the Fig. 2 shows this element consisting of a tubular or drilled element 8. The connection of the ends 5a and 6a of spirals 5 and 6 with the spacer element 7 is made by means of normal electric resistance welding while the connection of these ends 5a and 6a with the element 8 is made by calking. However it is apparent that any other electric or mechanical anchoring system can be used according to practical exigences.

It is thus possible to automatize the connecting operations of parts and obtain double spirals using an automatized 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 spiral ends.

Of course, the principle of the invention is not limited to these construction details and embodiments, but can be susceptible of changes and improvements with respect to what described and shown without departing for this from the scope of the invention.

CLAIMS

1. Glow plug for diesel engines of motor vehicles of the type comprising an hollow metal body (1), a current feeder (2) and a tubular metal sheath (3) which is secured to the body and closed at the tip, in which sheath a portion of the current feeder and two series connected electrical spirals, one for heating (5) and the other (6) for controlling the supply current, are inserted and embedded in an insulating powder (4), said control - spiral being inserted for a portion higher than one half of its lenght (Lc), preferybly for about 2/3 of its lenght, into the sheath zone which is surrounded by the body (1), characterized in that the two spirals (5,6) are connected to each other by means of an electrically conductive spacer element (7,8) having a low thermal conductivity and a lenght (Ld) comprised betheen 8 and 18 mm with a ratio betheen the lenght (Lc) of the control spiral (6) and the lenght (Lr) of the heating spiral (5) higher than 3 ($Lc/Lr > 3$) and with a sheath (3) projecting from the body (1) for a lenght (Lg) comprised betheen 20 and 30 mm.

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

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

4. Glow plug according to the previous claims, characterized in that the connection of the ends (5a, 6a) of the spirals with the spacer element is performed by means of electric welding.

5. Glow plug according to claims 1, 2 and 3, characterized in that the connection of the ends (5a, 6a) of the spirals with the spacer element is performed by mechanical anchoring.

6. Glow plug as described and shown in the annexed drawings.

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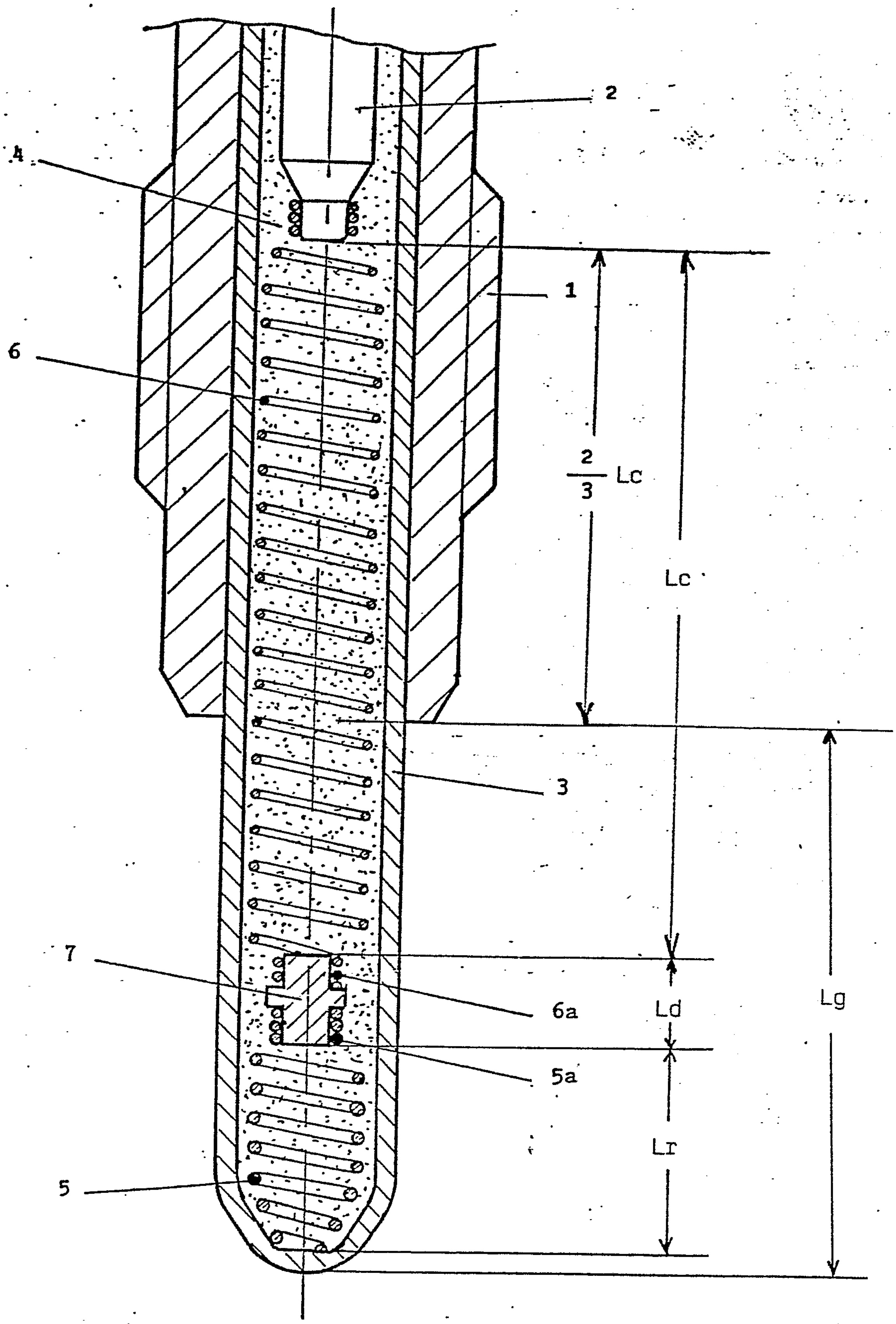

FIG. 1

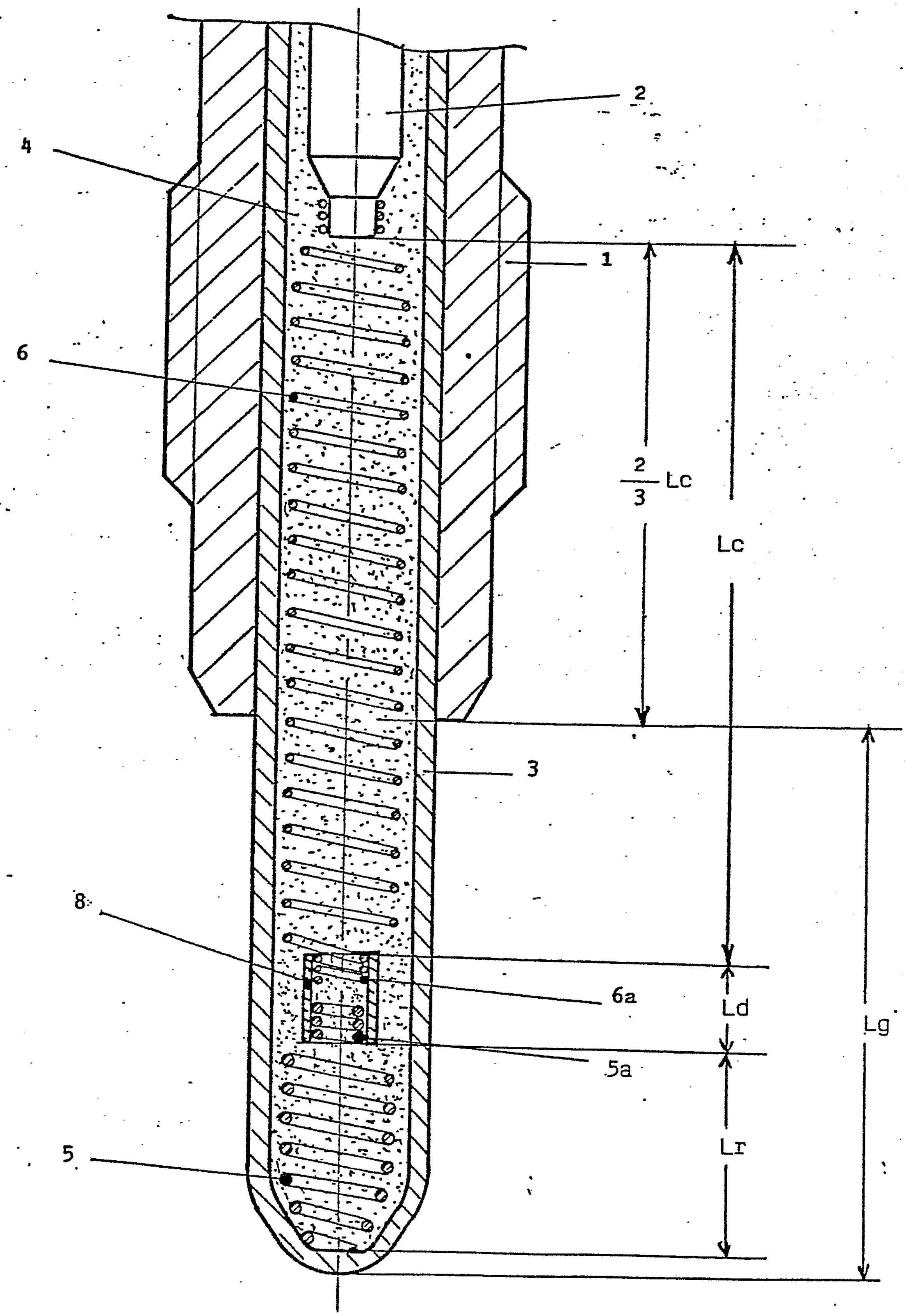

FIG. 2

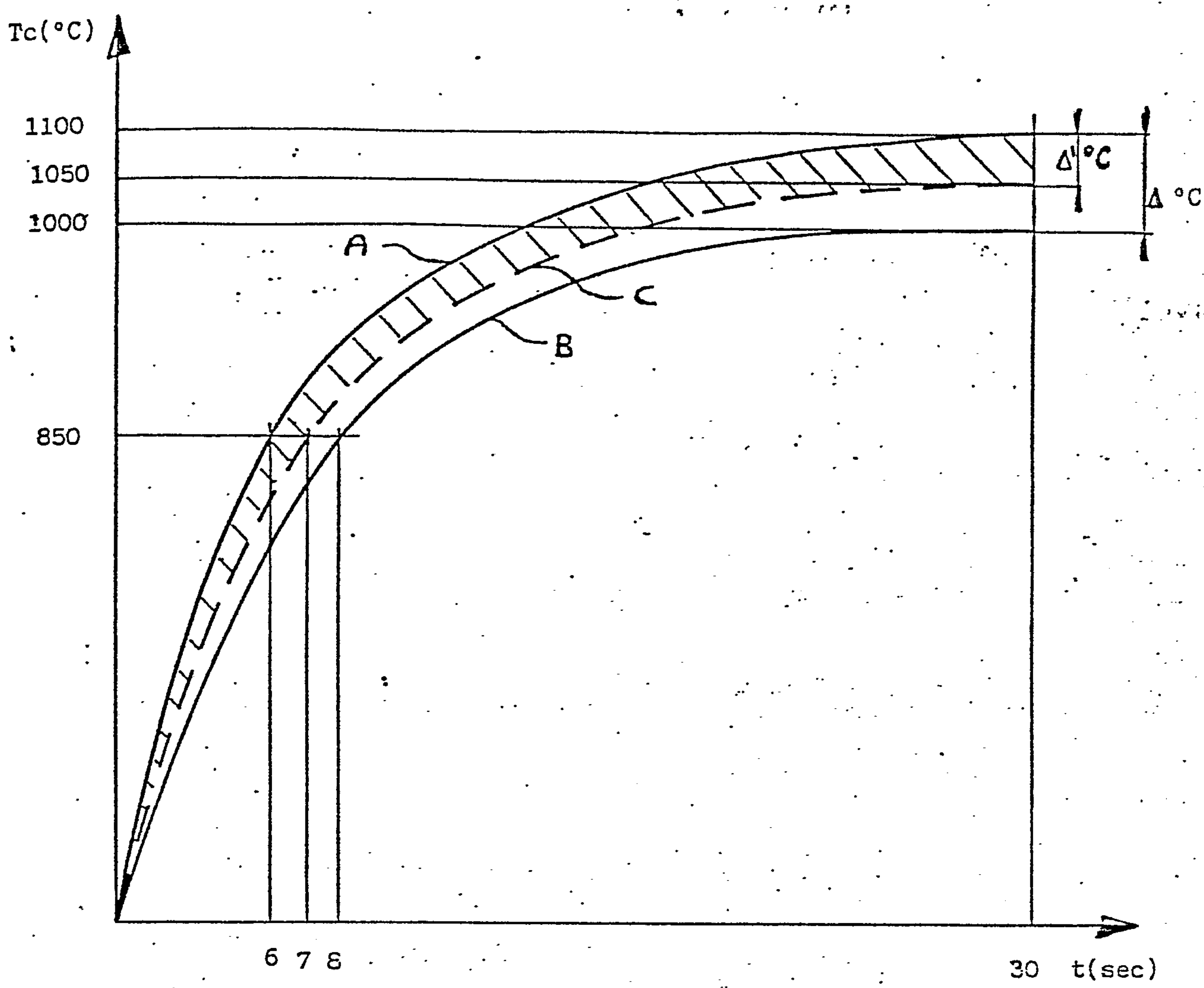
Tc(°C)
1100
1050
1000
850
A
B
C
Δ'°C
Δ °C
6 7 8
30 t(sec)

FIG. 3

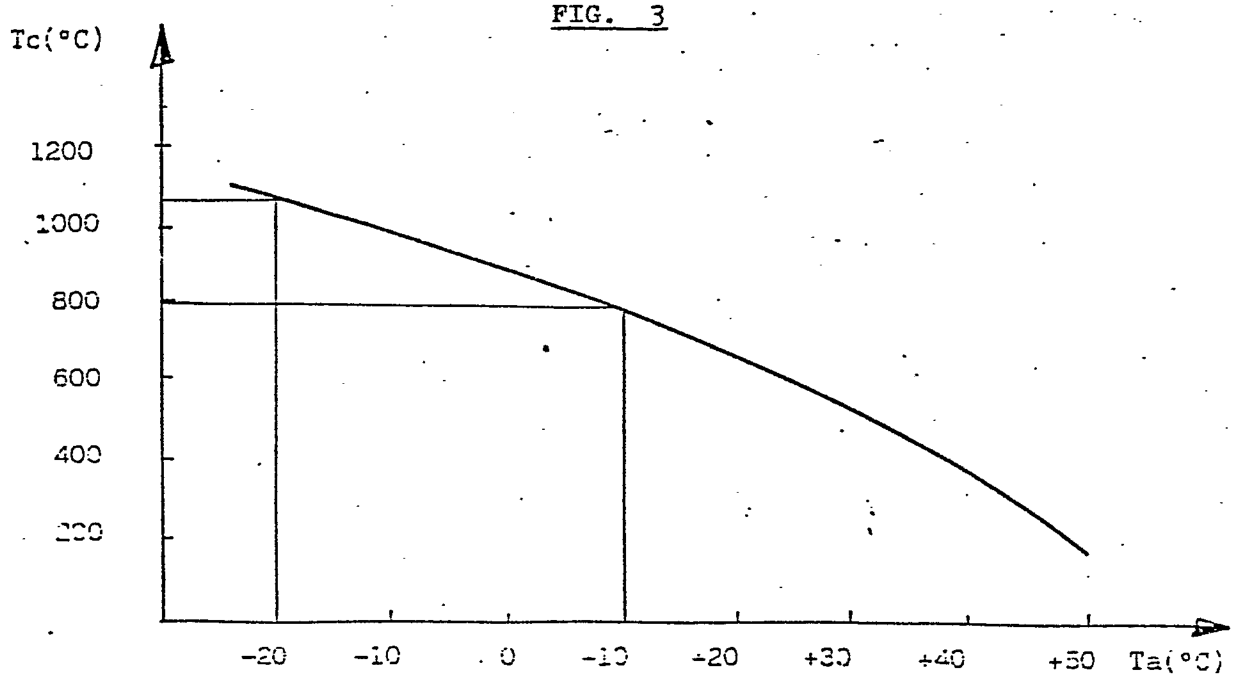
Tc(°C)
1200
1000
800
600
400
200
-20
-10
0
+10
+20
+30
+40
+50
Ta(°C)

FIG 4

European Patent Office

EUROPEAN SEARCH REPORT

0240650
Application number

EP 87 10 0292

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
X	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 ---	1,2,5	F 23 Q 7/00
A	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 ---	1,5	
A	EP-A-0 098 035 (GENERAL MOTORS) * Page 1, abstract; figures 1,2 * ---	1,3,5	
A	US-A-4 549 071 (KOJI HATANAKA) ---		TECHNICAL FIELDS SEARCHED (Int. Cl.4)
A	DE-A-3 421 950 (SPARK PLUG) -----		F 23 Q

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	21-04-1987	VANHEUSDEN J.

CATEGORY OF CITED DOCUMENTS

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