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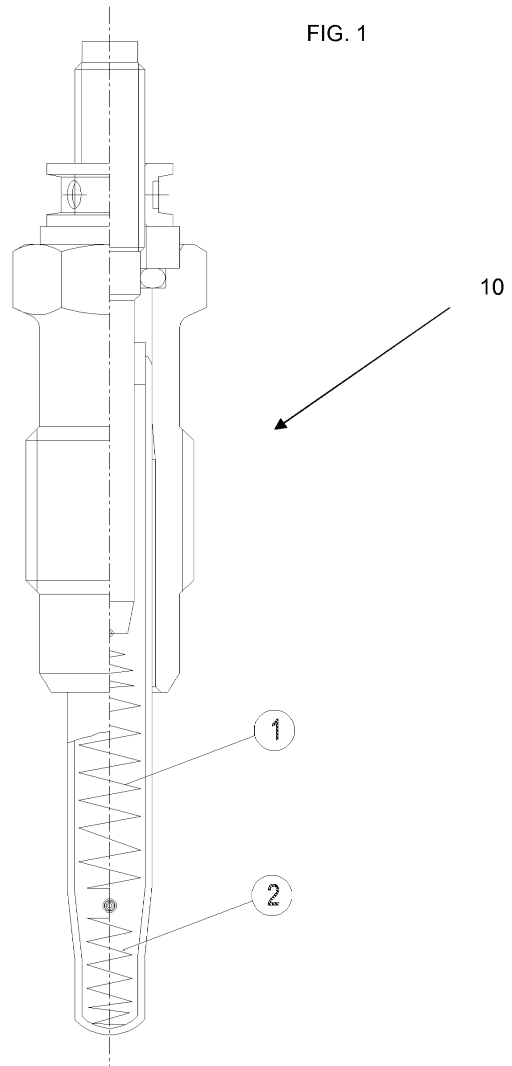
(54) Spark plug for internal combustion engines, exhaust gas systems and heaters

(57) A glow plug (10) for internal combustion engines or exhaust gas systems, of the type comprising a resistive filament formed by at least two series-connected spiral resistors (1, 2), of which, the spiral resistor (2) on the combustion chamber side acts as a heating element, and the spiral resistor (1) far from the combustion chambers acts, due to its high positive resistivity as a function of the temperature, as an adjusting element, and is made of a cobalt-iron alloy. Said spiral resistor (1), or adjusting element, of cobalt-iron alloy comprises a percentage of iron less than 5%.

FIG. 1



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Description

FIELD OF THE INVENTION

[0001] The present invention refers to a resistive wire or filament made of a cobalt-iron alloy, according to a percentage ratio defined in the following, and adapted to increase the technical effects obtainable in applications such as liquid heaters, exhaust gas systems, internal combustion engines.

PRIOR ART

[0002] The prior art relating the manufacturing of dual-filament electrical heaters uses two series resistors, of them, the back resistor is made of an cobalt-iron alloy, wherein the iron percentage is between 6% and 18%.

[0003] This cobalt-iron alloy has the characteristic of increasing its resistance as the temperature increases, therefore allowing a low resistance when the current flows with consequent low heating initial times with a cold back spiral, while, once the back spiral is warmed up, the heater substantially decreases its current absorption keeping the maximum temperature in an allowable range for the involved alloys.

[0004] An example of the prior art is described in the patent document US2004/0206742, which describes a glow plug for combustion chambers in endothermic engines comprising a first heating element, backwardly positioned, and a second element, in series to the first one, having a positive temperature coefficient and arranged at the tip, that is in the front portion of the glow plug itself, said second element consisting of iron and cobalt, iron having a percentage between 1 and 15 parts. In contrast to the cited priori art, the alloy of the regulating or stabilizing element of the present invention is backwardly located; because the operative temperature of the cobalt-iron alloy is lower than that of the other generally used alloys for high temperatures, this fact advantageously allows to position the latter, in the front portion where the operative temperature of the system must arrive to the maximum values, inside the combustion chamber.

[0005] Nowadays, the market for heaters, particularly, glow plugs for diesel engines, requires products allowing to reach temperatures near the tip of 850°C with very short times and very fast starts of the vehicles, reducing at the same time the polluting emissions. To this end, the product must allow heating times at 850°C of few seconds, at the same time it must be able to keep its temperature below the maximum operative temperature typical of the involved materials, this to obtain extended ignitions of some minutes wherein the low initial ignition voltage (about 11V) is replaced by a high voltage generated by the alternator once has been started the engine (from 13V to 14V).

[0006] The known art has already reached its limit, for example, some manufacturers have reached shorter ignition times with a suitable life just using electronic systems which vary the glow plug supplying voltages.

DISCLOSURE AND ADVANTAGES OF THE INVENTION

[0007] The object of the present invention consists of providing an improved resistive filament for glow plugs for internal combustion engines, heaters and exhaust gas systems, formed in its back portion by a cobalt-iron alloy, capable of causing a greater increase of the resistivity as a function of the temperature, by simultaneously keeping almost constant the increase in the first 900°C, particularly between 850°C and 900°C, in that range where the stabilizing spiral of the resistor must drastically reduce the current flow. Another object consists of providing a filament having a cobalt percentage sufficient to obtain an abrupt increase of the resistance when the temperature approaches the maximum operative temperature of the filament itself.

[0008] The cobalt-iron alloy uses iron in a percentage lower than 6%, and particularly lower than 5%.

[0009] A dual-filament pre-heating glow plug which uses as stabilizing spiral a material with a more defined increase of the resistivity as a function of the temperature, particularly in the last 100°C, will have at the same time three important characteristics of the finished product:

- very high ignition rate
- low maximum temperature
- the maximum temperature is reached before the start of the post-heating step of the glow plug, wherein the operative voltage increases. The overvoltage of 13-14V will arrive when the glow plug is already at its maximum resistive value, capable of facing high voltages without suffering damages.

[0010] Said aims and advantages are all reached by the resistive wire for heating elements and glow plugs for combustion engines, object of the present invention, which is characterized for what it is provided in the attached claims.

BRIEF DESCRIPTION OF THE FIGURES

[0011] This and other characteristics will be better revealed from the following description of some embodiments shown in an illustrative non-limiting way in the attached drawings.

- Figure 1: a glow plug for internal combustion engines and/or heaters for exhaust combusted gas systems comprising a resistive winding with two spiral resistors according to the object of the invention;
- Figure 2: illustrates the graph of the trend of two different stabilizing alloys with a high ptc (positive temperature coefficient) effect series connected to the same heating element and forming a resistive filament, such as for example for glow plugs of Figure 1.

DESCRIPTION OF THE INVENTION

[0012] The invention has been envisioned by studying the most common alloys used for resistive filaments capable of increasing their resistance as a function of the temperature.

[0013] Among them, there are the cobalt based alloys; it has been envisioned of manufacturing a resistive filament having a very high percentage of cobalt, because cobalt is the material which has the best resistivity variation as the temperature increases.

[0014] After an extensive research, the idea of using a wire made of pure cobalt has been rejected due to its poor malleability and it has been chosen the addition of slight amounts of iron, in order to improve its characteristics for undergoing the drawing processing and, most importantly, the spiral-shaping processing (that is the wire is transformed to a resistive spiral). A preferred composition of an alloy obtaining what mentioned before is the following: Fe: 4.6%; Co: 95%; others: <1%.

[0015] The stabilizing resistance obtained with the new alloy, once it has been applied to a heater, shows an extremer behaviour than the commonly used alloy.

[0016] Referring particularly to Figure 1, 10 generally indicates a glow plug comprising, inside, a resistive winding with two series-connected spiral resistors indicated at 1 and 2.

[0017] Of the above mentioned two series-connected spiral resistors, a resistor consists of a material acting as a heating element, while the other resistor acts, due to its high temperature coefficient, as an adjusting element or stabilizing spiral.

[0018] In the example, the spiral resistor 2, located at the tip, that is on the combustion chamber side, consists of a material suitable to act as a heating element, while the spiral resistor 1, located far from the combustion chamber, acts, due to its high positive resistivity, as a function of the temperature, as an adjusting element, and consists of a cobalt-iron alloy.

[0019] More particularly, the spiral resistor 1 acting as a back adjusting element, is a spiral resistor formed by a cobalt-iron alloy that is less than 6%: COFe4 in the example considered in the following.

[0020] The spiral resistor 2 of the heating element, is a spiral resistor formed by another alloy different from the one of the resistor 1.

EXPERIMENTAL TESTS.

[0021] The following data were gathered in a laboratory from two glow plugs for combustion engines, one was made according to the prior art and the other was made according to the invention of the present patent.

[0022] Both the glow plugs comprised two series-connected spiral resistors, of which a resistor, which was the same for both, acted as a heating element formed by an alloy having a constant resistivity as a function of the temperature, while the second resistor, due to its high positive temperature coefficient, acted as an adjusting element or stabilizing spiral. Particularly, said adjusting element (or stabilizing spiral) was formed by a cobalt-iron alloy having an identical geometry: the prior art alloy was a CoFe8 alloy, while the alloy of the invention was a CoFe4.

[0023] The two test glow plugs were supplied by a direct current at a constant voltage of 10V and the reference temperature was detected by an optical pyrometer oriented in the hottest area of the back stabilizing spiral, while the resistance was obtained by the ratio between the supplying voltage and the absorbed current of the glow plug. From that it was obtained the resistivity based on the cross-section and the length of the wire of the spiral itself.

[0024] The following table shows some data obtained from the tests:

Temp °C	FeCo4	Prior art
20	1	1
555	2.000940734	1.604166667
600	2.101778656	1.730337079
650	2.19731405	1.811764706
700	2.319520174	1.929824561
750	2.430857143	2.037037037
800	2.556490385	2.115384615
850	2.675471698	2.241630277
900	2.832223702	2.436708861
935	2.95924875	2.75
950	3.038571429	
960	3.262269939	

[0025] The first column shows the temperature trend, the other two columns show the multiplication factor of the resistivity as a function of the temperature, referred to the present alloy and a known reference alloy.

$$Fm = p(t)/pi$$

Wherein *Fm* is the multiplication factor, p(t) is the resistivity of the alloy at a given temperature and pi is the resistivity of the alloy at a temperature of 20°C.

[0026] The graph shown in Figure 1 of the attached drawing is obtained from the table. The solid line illustrates the trend of a resistive filament comprising the new low-content iron alloy, for example the alloy CoFe4, while the dotted line shows the trend of a conventional alloy, for example, a cobalt-iron alloy having a percentage of iron of about 8%.

[0027] The ordinate represents the temperature in Celsius degrees, while the abscissa represents the above described multiplication factor *Fm*.

[0028] In the graph, it is possible to observe how the multiplication factor *Fm* increase of the new alloy is greater than one of a known alloy: the increase is 3.26 times with respect to 2.75 of the known alloy. The iron percentage is the minimum amount necessary for obtaining a multiplication factor (*Fm*) of the resistivity as a function of the temperature greater than 3.

[0029] Another characteristic clearly visible is the abrupt increase of the resistivity when the line approaches 960°C, in the last 40°C, which is more defined than the conventional alloy. The temperature increase obviously occurs after a current flow through the filament itself. An important data obtained by the test also at higher voltages, is that the maximum value of *Fm* does not have variations, but it is obtained at higher temperatures. Under the same geometry of the spiral, the *Fm* maximum value is therefore typical of the alloy object of the test.

[0030] Once a heater has been fabricated, for example a pre-heating glow plug for diesel engines, the already highlighted characteristics of the alloy have been revealed in the following product, which has:

- a very fast ignition time (about 3.1 seconds), which is one second less than the best stabilizing glow plugs actually marketed.
- Maximum restrained temperature (1092°C), similar to, if not less than the temperature of the best glow plugs actually marketed and definitely less than the critical temperatures quantified in temperatures more than 1200°C.
- The maximum temperature is reached in 8 seconds, which is less than initial time of the post-heating step at voltages greater than 13V, which generally starts after 10 seconds.
- A final temperature of the glow plug after an ignition extended to 90 seconds of only 970°C, which substantially remains at about 1000°C also if it is subjected to voltages between 13V and 14V.

[0031] The present alloy can be used as a resistive filament for glow plugs of internal combustion engines and/or heaters for generic use or for exhaust systems; the back portion of said filament comprises a FeCo alloy, wherein the iron is present in a percentage less than 6% and particularly less than 5%, preferably 4.6%.

Claims

1. A glow plug (10) for internal combustion engines or exhaust gas systems, of the type comprising a resistive filament formed by at least two series-connected spiral resistors (1, 2), of which the spiral resistor (2) on the combustion chamber side acts as a heating element, and the spiral resistor (1) far from the combustion chamber acts, due to its high positive resistivity as a function of the temperature, as an adjusting element, and consists of a cobalt-iron alloy, **characterized by** the fact said spiral resistor (1) or adjusting element of cobalt-iron alloy comprises an iron percentage less than 5%.

2. Glow plug, according the claim 1, **characterized by** the fact the cobalt-iron alloys of said resistor (1) is CoFe4.

3. Glow plug, according to claim 1, **characterized by** the fact said resistor (1) consists of an alloy comprising Fe: 4.6%; Co: 05%, others: < 1%.

FIG. 1

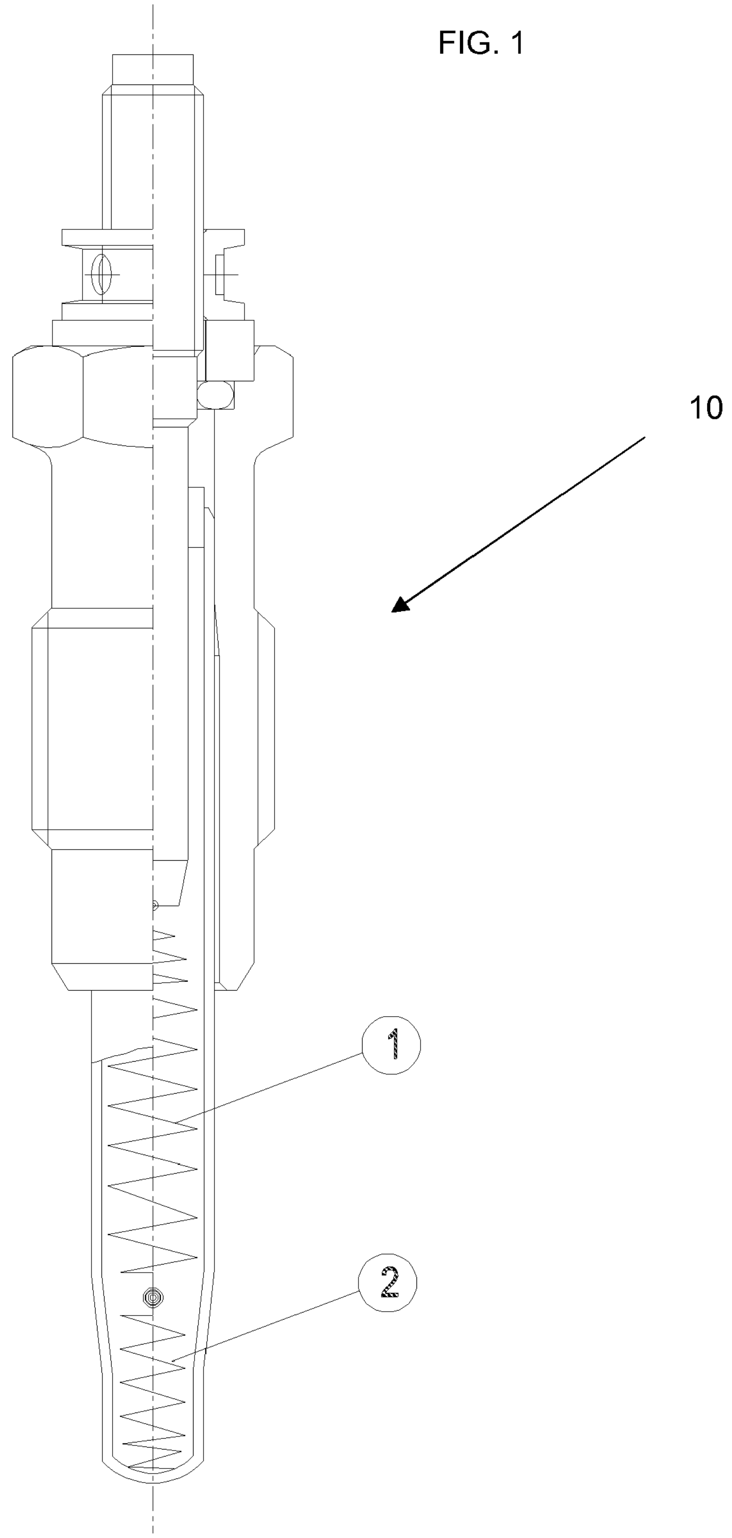
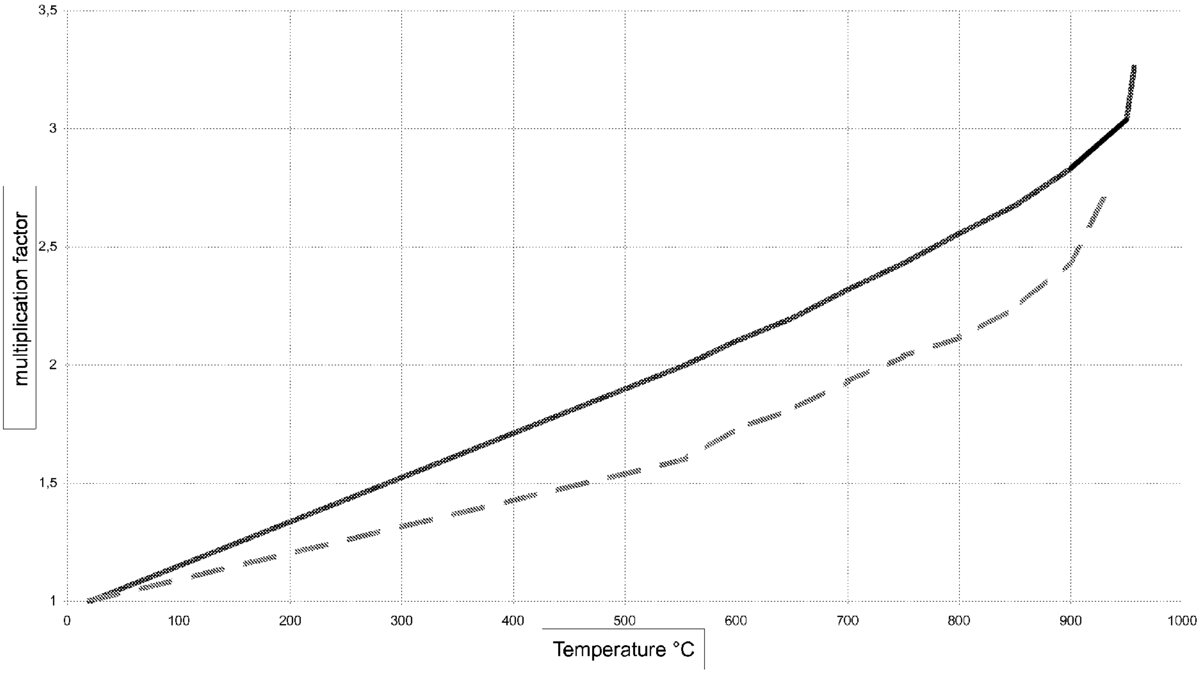


FIG. 2


3,5
3
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multiplication factor
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100
200
300
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700
800
900
1000
Temperature °C

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EUROPEAN SEARCH REPORT

Application Number
EP 10 16 9659

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	DE 10 2004 025854 A1 (VACUUMSCHMELZE GMBH & CO KG [DE]) 29 December 2005 (2005-12-29) * abstract * * claims 1-3 * * figure 1 * -----	1-3	INV. H05B3/12 F23Q7/00
A	US 2004/206742 A1 (DUBA DAVID E [US]) 21 October 2004 (2004-10-21) * abstract * * figures 2-4 * * paragraph [0025] * * claims 1-3 * -----	1-3	
A	EP 0 950 858 A2 (NGK SPARK PLUG CO [JP]) 20 October 1999 (1999-10-20) * abstract * * paragraphs [0033], [0050] * * figure 2a * -----	1-3	

TECHNICAL FIELDS SEARCHED (IPC)

H05B
F23Q

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	15 December 2010	de la Tassa Laforgue

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CATEGORY OF CITED DOCUMENTS

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15-12-2010

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

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- US 20040206742 A **[0004]**