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(54) **Glow plug for diesel engine**

Glühkerze für Dieselmotoren

Bougie à incandescence pour moteur diesel

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(73) Proprietor: **DENSO CORPORATION**
Kariya-City Aichi-Pref. 448 (JP)

(72) Inventors:

- **Makino, Sigeharu**
Toyoake-shi, Aichi-ken (JP)
- **Koyama, Taiji**
Toyohashi-shi, Aichi-ken (JP)

- **Tsuji, Nobuyuki**
Hoi-gun, Aichi-ken (JP)

(74) Representative:
Leson, Thomas Johannes Alois, Dipl.-Ing. et al
Patentanwälte
Tiedtke-Bühling-Kinne & Partner,
Bavariaring 4
80336 München (DE)

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Description

FIELD OF THE INVENTION

[0001] The present invention relates generally to a glow plug which is designed to preheat an auxiliary chamber of a diesel engine for assuring quick starting, and more particularly to an extended life of a heating coil arrangement for such a glow plug.

BACKGROUND ART

[0002] A glow plug is well known in the art as a pre-heating element serving to heat a diesel engine above a self-starting temperature during a starting mode of engine operation. Shortening a heating time period of the glow plug makes it possible to start the diesel engine quickly.

[0003] Japanese Patent First Publication No. 2-110212 discloses a glow plug including a filament type resistance wire element disposed in a heat-resistant insulating material with which a plug tube is filled. The resistance wire element is formed with a plurality of resistant filaments, each having different chemical compositions, welded in series with each other. The plurality of resistant filaments include first, second, and third coils. The first coil is made of a Fe-Cr-Al alloy. The second coil is made of a 75Wt%Co-25Wt%Fe alloy. The third coil is made of a 92Wt%Co-8Wt%Fe alloy.

[0004] The above prior art glow plug, however, has suffered from a drawback in that a sudden change in temperature under severe operational conditions such as quick heating causes the resistance wire element to expand and contract, resulting in wire breakage.

[0005] This wire breakage is found to be caused by the second coil. The 75Wt%Co-25Wt%Fe (74At%Co-26At%Fe) alloy used in the second coil, as shown in Fig. 6, has an α/γ transformation point in the vicinity of 800°C. Therefore, due to heating of the second coil during the engine starting operation and combustion in the engine, the temperature of the second coil will pass repeatedly through the α/γ transformation point, resulting in a change in volume to create a strain on the second coil. This causes the second coil to be broken.

[0006] In order to avoid the above drawback, the inventors of this application have proposed an arrangement wherein the first coil consists of a Fe-Cr-Al alloy and the second coil is made of a 92Wt%Co-BWt%Fe alloy in view of the fact that they have a rate of change in resistance which is smaller than that of the 75Wt%Co-25Wt%Fe alloy, but greater than that of Fe or Ni commonly used in the art, and do not have the α/γ transformation point. Experiments were conducted with respect to a glow plug formed with the first coil and the second coil thus constructed. The experiments show that the glow plug provides quicker heating but remains indicating a short life (see the second comparative example C2 in Fig. 4).

[0007] Additionally, upon checking the life-tested glow plugs, as constructed above, it was found that a wire-breakage existed in a welded connection between the first and second coils for the following reasons. Since the content of Fe in the Fe-Cr-Al alloy of the first coil is 70Wt% and the content of Fe in the second coil is 8Wt%, a Fe-Co weight ratio of the welded connection shows 78: 92 (i.e., atomic percentage ratio of 47: 53), the welded connection, as is clear from Fig. 6, has the α/γ transformation point. Therefore, the volume of the welded connection is subject to change due to coil heating and combustion heating of the engine, resulting in a strain on the welded connection, causing wire-breakage to occur prematurely.

[0008] The DE-A-40 10 479 describes an electric resistance element for its use in a glow plug for an internal combustion engine, which glow plug comprises a housing, a heater tube extending from an end of the housing, and an insulating member arranged in the heater tube, the resistance element comprising a first resistance element having a given electric resistance and a second resistance element connected in series with the first resistance element, the second resistance element having a resistance temperature coefficient positively higher than that of the first resistance element and providing a function of regulating a current to the first resistance element, wherein the second resistance is made of a Co-Fe alloy whose compositions fall in a range where a change in phase from a body-centered cubic lattice arrangement to a face-centered cubic lattice arrangement does not occur and a change in phase from a close-packed hexagonal lattice arrangement to the face-centered cubic lattice arrangement does not occur even when the second resistance element is subjected to a temperature change from a given room temperature to 1000 °C, and wherein the first resistance element is welded at its end to an end of the second resistance element to form a connection therebetween which includes part of material forming the first resistance element and part of the Co-Fe alloy forming the second resistance element.

SUMMARY OF THE INVENTION

[0009] It is therefore a principal object of the present invention to avoid the disadvantages of the prior art.

[0010] It is another object of the present invention to provide an extended service life of a glow plug for pre-heating a diesel engine.

[0011] These objects are solved by the present invention by providing an electric resistance element as specified in claim 1, and by providing a glow plug as specified in claim 5.

[0012] According to one aspect of the present invention, there is provided an electric resistance element which comprises a first resistance element having a given electric resistance and a second resistance element, connected in series with the first resistance element,

having a resistance temperature coefficient positively higher than that of the first resistance element and providing a function of modifying a current to the first resistance element. The second resistance element is made of a Co-Fe alloy whose compositions fall in a range where a change in phase from a body-centered cubic lattice arrangement to a face-centered cubic lattice arrangement does not occur and a change in phase from a close-packed hexagonal lattice arrangement to the face-centered cubic lattice arrangement does not occur even when the second resistance element is subjected to a temperature change from a given room temperature to 1000°C. The first resistance element is welded at its end to an end of the second resistance element to form a connection therebetween which consists of part of material forming the first resistance element and part of the Co-Fe alloy forming the second resistance element, the material forming the first resistance element being so selected as to prevent compositions of the Co-Fe alloy in the connection from changing in phase from the body-centered cubic lattice arrangement to the face-centered cubic lattice arrangement and from the close-packed hexagonal lattice arrangement to the face-centered cubic lattice arrangement. Thus, the composition of the Co-Fe alloy in the connection is defined by a Fe content of 5 to 22 At.% by selecting the material forming said first resistance element such that a change in phase of the composition of the Co-Fe alloy in the connection from the body-centered cubic lattice arrangement to the face-centered cubic lattice arrangement and from the close-packed hexagonal lattice arrangement to the face-centered cubic lattice arrangement does not occur at temperatures from a given room temperature to 1000°C.

[0013] In the preferred mode, the second resistance element contains 78At% to 95At% of Co and a remaining content of Fe. The first resistance element is made of a Ni-Cr alloy.

[0014] The Fe-Cr-Al alloy of the first resistance element has a Fe content of 68Wt% to 72Wt%. The Co-Fe alloy of the second coil has a Fe content of 7Wt% to 9Wt%. The volume ratio of the second to first resistance elements in a connection therebetween lies in a range from 1 : 0.15 to 1:0.25.

[0015] According to another aspect of the present invention, there is provided a glow plug for an internal combustion engine which comprises a housing, a heater tube extending from an end of the housing, an insulating member arranged in the heater tube, and a resistance element. The resistance element includes at least two elements: a heating element and a regulating element connected in series with each other. The regulating element is electrically arranged upstream from the heating element. The regulating element assumes a positive resistance temperature coefficient higher than that of the heating element for regulating a current flowing to the heating element. The regulating element is made of a Co-Fe alloy whose compositions fall in a range where

a change in phase from a body-centered cubic lattice arrangement to a face-centered cubic lattice arrangement does not occur and a change in phase from a close-packed hexagonal lattice arrangement to the face-centered cubic lattice arrangement does not occur even when the second resistance element is subjected to a temperature change from a given room temperature to 1000°C. The heating element is welded at its end to an end of the regulating element to form a connection therebetween which includes material of which the first resistance element is made and the Co-Fe alloy forming the regulating element. The material forming the heating element is so selected as to prevent compositions of the Co-Fe alloy in the connection from changing in phase from the body-centered cubic lattice arrangement to the face-centered cubic lattice arrangement and from the close-packed hexagonal lattice arrangement to the face-centered cubic lattice arrangement. Thus, the composition of the Co-Fe alloy in the connection is defined by a Fe content of 5 to 22 At.% by selecting the material forming said first resistance element such that a change in phase of the composition of the Co-Fe alloy in the connection from the body-centered cubic lattice arrangement to the face-centered cubic lattice arrangement and from the close-packed hexagonal lattice arrangement to the face-centered cubic lattice arrangement does not occur at temperatures from a given room temperature to 1000°C.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] The present invention will be understood more fully from the detailed description given hereinbelow and from the accompanying drawings of the preferred embodiment of the invention.

[0017] In the drawings:

Fig. 1 is a cross-sectional view which shows a glow plug according to the present invention.

Fig. 2 illustrates a connection between first and second coils of a heating coil of a glow plug.

Fig. 3 illustrates energizing testing conditions for testing the life of a glow plug.

Fig. 4 is a table which shows the test results of glow plugs performed under the conditions, as shown in Fig. 3.

Fig. 5 is a graph which shows temperature rise characteristics of a glow plug.

Fig. 6 is a graph which shows the relation between a Co-Fe ratio of an alloy forming a second coil and a transformation temperature.

Fig. 7 is a graph which shows the relation between temperature and a resistance change rate of an alloy forming a heating coil.

DESCRIPTION OF THE PREFERRED EMBODIMENT

[0018] Referring now to the drawings, wherein like

numbers refer to like parts in several views, particularly to Fig. 1, there is shown a glow plug 9 according to the present invention which is commonly used in internal combustion engine such as a diesel engine to provide additional heat required for insuring quicker starting.

[0019] The glow plug 9 includes generally a housing 7, a heater tube 90 partially inserted into the housing 7, and a heating coil 1 disposed within an insulating member 2 provided in the heater tube 90. The heating coil 1 is formed of a resistant filament including a first coil 11 serving as a heating element and a second coil 12 functioning as a regulating element for regulating a current flowing to the first coil. The first and second coils are connected in series by an arc welding process to form a welded connection 120.

[0020] The first coil 11 is made of a Ni-Cr alloy which contains Ni of 80Wt% and Cr of 20Wt%. The second coil 12 is made of a Co-Fe alloy which contains Co of 92Wt% and Fe of 8Wt%. The Co-Fe alloy represents a rate of change in resistance (i.e., a resistance temperature coefficient) of about 13 in a range from the room temperature to 1000°C. This value, as can be seen in Fig. 8, is greater than those of Fe, Ni, and the first coil 11. It is desired that the Fe content of the second coil 12 fall in a range from 5At% to 22At%. When the Fe content is less than 5At%, it will cause the ϵ/γ transformation to occur, resulting in a change in volume. Alternatively, when the Fe content is more than 22At%, the α/γ transformation may occur. Additionally, it is preferable that the Co content of the second coil 12, as shown in Fig. 7, lie in a range from 78At% to 95At%. The welded connection 120 between the first and second coils 11 and 12 has a Co-Fe atomic percentage ratio of 91.6 : 8.4. The Fe content of the welded connection 120 which is less than or equal to 22Wt% is desirable. When more than 22Wt%, it will cause the welded connection 120 to assume the α/γ transformation at an operational temperature of the glow plug 9.

[0021] The heater tube 90 has a smaller diameter end portion which is bottomed. Outer and inner diameters of the heater tube 90 are so selected that the insulating member 2 around the first coil 11 is denser than that around the second coil 12.

[0022] The insulating member 2 is made of insulating powder such as MgO. The heater tube 90 is formed of a heat-resistant alloy (e.g., SUS310S).

[0023] The first coil 11 of the heating coil 1 is welded to the bottom of the heater tube 90, while the second coil 12 is welded to the end of a core shaft 6 which is disposed coaxially in the housing 7. The core shaft 6 is electrically connected at its end to a positive terminal of a battery (not shown).

[0024] The housing 7 is so constructed as to mount the glow plug 9 in an engine head. The heater tube 90 is brazed to the housing 7.

[0025] Arranged between the housing 7 and the core shaft 6 is an O-ring 8 made of fluororubber.

[0026] The operation and effect of the glow plug thus

constructed will be discussed below.

[0027] When the heating coil 1 is energized, it will glow to heat the glow plug 9, providing additional heating required for insuring quicker starting of the engine.

[0028] The heating coil 1, as mentioned above, includes the first and second coils 11 and 12. The second coil 12, as shown in Fig. 7, has the resistance temperature coefficient positively higher than that of the first resistance element, and is made of the Co-Fe alloy whose compositions, as shown in Fig. 6, fall in a range where a change in phase from a body-centered cubic lattice arrangement to a face-centered cubic lattice arrangement does not occur and a change in phase from a close-packed hexagonal lattice arrangement to the face-centered cubic lattice arrangement does not occur even when the second coil 12 is subjected to a temperature change from a given room temperature to 1000°C. The connection 120 between the first and second coils 11 and 12 shows the Co-Fe atomic percentage ratio of 91.6 : 8.4 so that it lies, as is clear from Fig. 6, out of a range wherein changes in phase from the body-centered cubic lattice arrangement to the face-centered cubic lattice arrangement and from the close-packed hexagonal lattice arrangement to the face-centered cubic lattice arrangement occur. It will be appreciated that even when the temperature is changed rapidly, the connection 120 does not expand and contract so that it shows stable mechanical properties. Accordingly, the connection 120 is not broken even when the heating coil is heated rapidly many times so that the service life of the glow plug 9 is increased greatly.

[0029] The O-ring 8 arranged between the core shaft 6 and the housing 7 serves to prevent oil and/or water from leaking into the housing 7. This avoids the heating coil 1 from being oxidized undesirably.

[0030] The second coil 12 includes the Co-Fe alloy which assumes a relatively great rate of change in resistance of about 13 under the variation in temperature from the room temperature to 1000°C. In addition, the insulating member 2 is arranged to be denser around the first coil than that around the second coil 12. Therefore, the glow current controlling effect caused by a temperature rise of the second coil 12 is enhanced.

[0031] Further, the heater tube 90 includes the smaller diameter end portion in which the first coil is disposed and the large diameter middle portion in which the second coil is arranged so that the saturation temperature of the heating coil 1 is maintained safely and the temperature rising speed thereof is also improved greatly.

[0032] Fig. 2 shows an essential part of a second embodiment according to the invention. The heating coil 1 of this embodiment, similar to the first embodiment, includes first and second coils 11 and 12 which are welded to form a connection 120 by a laser beam welding process. The connection 120 is constructed by adjusting the output and the focal depth of a laser beam to have a 0.2 : 1 ratio of the volume B of a fused portion 121 of the first coil 11 to the volume A of a fused portion 122 of the

second coil 12.

[0033] Similar to the second embodiment, the first coil 11 is made of a 70Wt% Fe-25Wt% Cr-5Wt%Al alloy. The second coil 12 is also made of a 92Wt%Co-8Wt%Fe alloy. The connection 120 between the first and second coils 11 and 12 shows a Co-Fe atomic percentage ratio of 80 : 20.

[0034] Other arrangements and operation are the same as the first embodiment and explanation thereof in detail will be omitted here.

[0035] In the second embodiment, the B-A volume ratio of the connection 120, as stated above, falls in a range from 0.15 to 0.25 and thus the content of Fe in the connection 120 is low. Therefore, the α/γ transformation does not occur in the connection 120. The life of the glow plug is increased greatly without the connection 120 being broken.

[0036] Energizing cycle tests were performed with respect to the glow plugs constructed according to the above first and second embodiments (examples 1 and 2). The glow plugs were, as shown in Fig. 3, applied with current for seventy minutes to be heated up to about 1000°C after which it is maintained at approximately 900°C. Subsequently, cooling and heating processes were conducted in an electric furnace three times in three minutes, and then cooled down to the room temperature. These were assumed to be one cycle and repeated continuously.

[0037] In order to compare the results of the tests of the glow plugs of the invention, additional comparative experiments were performed with respect to prior art glow plugs (see comparative examples C1 and C2).

[0038] The glow plug of the comparative example C1 includes a first coil made of a 70Wt%Fe-25Wt%Cr-15Wt%Al alloy and a second coil made of Ni. Other arrangements are substantially the same as the first embodiment. The glow plug of the comparative example C2 includes a first coil made of a 70Wt%Fe-25Wt%Cr-15Wt%Al alloy and a second coil made of a 92Wt%Co-8Wt%Fe alloy. Other arrangements are substantially the same as the comparative example.

[0039] The energizing cycle tests, as explained above, were performed four times with respect to the above examples, respectively. Fig. 4 is a table showing the results of the tests. As will be appreciated from the table, the lifespans of the examples 1 and 2 all exceed over 20000 cycles. In examples 1 and 2, the wire-breakage has occurred at the central portion of the first coil which is subjected to the intensest heat. Therefore, the glow plugs according to the invention may be used until their inherent service lives have expired.

[0040] Additionally, the comparative example C1 shows substantially the same results as in the first and second embodiments, however, the use of Ni having a ratio of change in resistance of 6 in the second coil gives rise to a problem in regard to quick heating when a statutory temperature is the same as the examples according to the present invention. The comparative example

C2 exhibits an extremely shortened service life. There is a wire-breakage in a connection between the first and second coils.

[0041] Fig. 5 shows the relation between energizing time and temperature-rising speed in the glow plugs according to the first embodiment of the invention and the comparative example C1.

[0042] As will be clear from the graph, when the glow plug according to the first embodiment is heated up to 800°C within 4.5 minutes, the statutory temperature is maintained at 900°C which permits the glow plug to be energized constantly. This eliminates the need for reducing a voltage level applied to the glow plug after starting the engine, thereby eliminating the use of an after-glow resistor, a sub-relay, and their attachment harnesses. Thus, the manufacturing costs are reduced greatly.

[0043] The glow plug of the comparative example C1 shows a statutory temperature above 1000°C. It is thus, required to decrease the voltage applied to the glow plug after the engine starts.

Claims

1. An electric resistance element comprising:

a first resistance element (11) having a given electric resistance; and
a second resistance element (12) connected in series with said first resistance element (11), said second resistance element having a resistance temperature coefficient positively higher than that of said first resistance element and providing a function of regulating a current to said first resistance element (11),

wherein said second resistance element (12) is made of a Co-Fe alloy whose compositions fall in a range where a change in phase from a body-centered cubic lattice arrangement to a face-centered cubic lattice arrangement does not occur and a change in phase from a close-packed hexagonal lattice arrangement to the face-centered cubic lattice arrangement does not occur even when the second resistance element is subjected to a temperature change from a given room temperature to 1000°C, and

wherein said first resistance element (11) is welded at its end to an end of said second resistance element (12) to form a connection (120) therebetween which includes part of material forming said first resistance element and part of the Co-Fe alloy forming said second resistance element (12),
characterized in that

the composition of the Co-Fe alloy in the connection (120) is defined by a Fe content of 5 to 22 At.% by selecting the material forming said first resistance element (11) such that a change in phase of the

composition of the Co-Fe alloy in the connection (120) from the body-centered cubic lattice arrangement to the face-centered cubic lattice arrangement and from the close-packed hexagonal lattice arrangement to the face-centered cubic lattice arrangement does not occur at temperatures from a given room temperature to 1000 °C.

2. An electric resistance element as set forth in claim 1, wherein said second resistance element (12) contains 78 At.% to 95 At.% of Co and a remaining content of Fe.
3. An electric resistance element as set forth in claim 1 or 2, wherein said first resistance element (11) is made of a Ni-Cr alloy.
4. An electric resistance element as set forth in claim 1, wherein said first resistance element (11) is made of Fe-Cr-Al alloy having a Fe content of 68 wt.-% to 72 wt.-%, said second resistance element (12) being made of a Co-Fe alloy having a Fe content of 7 wt.-% to 9 wt.-%, a volume ratio of said second to first resistance elements in a connection therebetween lying in a range of from 1:0.15 to 1:0.25.
5. A glow plug for an internal combustion engine comprising:

a housing (7);
 a heater tube (90) extending from an end of said housing (7);
 an insulating member (2) arranged in said heater tube (90); and
 a resistance element (1), said resistance element (1) including at least two elements: a heating element (11) and a regulating element (12) connected in series with each other, said regulating element (12) being electrically arranged upstream from said heating element (11), said regulating element (12) assuming a positive resistance temperature coefficient higher than that of the heating element (11) for regulating a current flowing to said heating element (11),

wherein said regulating element (12) is made of a Co-Fe alloy whose compositions fall in a range where a change in phase from a body-centered cubic lattice arrangement to a face-centered cubic lattice arrangement does not occur and a change in phase from a close-packed hexagonal lattice arrangement to the face-centered cubic lattice arrangement does not occur even when the second resistance element is subjected to a temperature change from a given room temperature to 1000 °C, and

wherein said heating element (11) is welded at its end to an end of said regulating element (12)

to form a connection (120) therebetween which includes material of which said first resistance element is made and the Co-Fe alloy forming said regulating element (12),

characterized in that

the composition of the Co-Fe alloy in the connection (120) is defined by a Fe content of 5 to 22 At.% by selecting the material forming said heating element (11) such that a change in phase of the composition of the Co-Fe alloy in the connection (120) from the body-centered cubic lattice arrangement to the face-centered cubic lattice arrangement and from the close-packed hexagonal lattice arrangement to the face-centered cubic lattice arrangement does not occur at temperatures from a given room temperature to 1000 °C.

6. A glow plug as set forth in claim 5, wherein said regulating element (12) contains 78 At.% to 95 At.% of Co and a remaining content of Fe.
7. A glow plug as set forth in claim 5 or 6, wherein said heating element (11) is made of a Ni-Cr alloy.
8. A glow plug as set forth in claim 5, wherein said heating element (11) is made of a Fe-Cr-Al alloy having a Fe content of 68 wt.-% to 72 wt.-%, said regulating element (12) being made of a Co-Fe alloy having a Fe content of 7 wt.-% to 9 wt.-%, a volume ratio of said regulating element to said heating element in a connection therebetween falling in a range from 1:0.15 to 1:0.25.
9. A glow plug as set forth in claim 5, wherein said heater tube (90) has a smaller diameter end portion which is bottomed, outer and inner diameters of said heater tube (90) being so selected that said insulating member (2) around the heating element (11) is denser than that around the regulating element (12).

Patentansprüche

1. Elektrisches Widerstandselement, umfassend

ein erstes Widerstandselement (11) mit einem vorgegebenen elektrischen Widerstand; und ein in Reihe mit dem ersten Widerstandselement (11) geschaltetes zweites Widerstandselement (12), wobei das zweite Widerstandselement einen größeren positiven Widerstandstemperaturkoeffizienten als das erste Widerstandselement hat und eine Funktion zur Steuerung eines Stroms zum ersten Widerstandselement (11) bereitstellt,

wobei das zweite Widerstandselement (12) aus einer Co-Fe-Legierung gefertigt ist, deren Zusammensetzung in einen Bereich fällt, in welchem eine Phasenänderung von einer innenzentrierten kubischen Gitteranordnung zu einer flächenzentrierten kubischen Gitteranordnung nicht auftritt sowie eine Phasenänderung von einer dichtest gepackten hexagonalen Gitteranordnung zur flächenzentrierten kubischen Gitteranordnung selbst dann nicht auftritt, wenn das zweite Widerstandselement einer Temperaturänderung von einer vorgegebenen Raumtemperatur auf 1000°C unterworfen wird, und wobei das erste Widerstandselement (11) an seinem Ende an ein Ende des zweiten Widerstandselements (12) geschweißt ist, um eine Verknüpfung (120) zwischen beiden zu bilden, die Teile des das erste Widerstandselement bildenden Materials und Teile der das zweite Widerstandselement (12) bildenden Co-Fe-Legierung einschließt,

dadurch gekennzeichnet, daß

die Zusammensetzung der Co-Fe-Legierung in der Verknüpfung (120) definiert ist durch einen Fe-Gehalt von 5 bis 22 At.-%, indem das das erste Widerstandselement (11) bildende Material so ausgewählt ist, dass eine Phasenänderung der Zusammensetzung der Co-Fe-Legierung in der Verknüpfung (120) von der innenzentrierten kubischen Gitteranordnung zur flächenzentrierten kubischen Gitteranordnung sowie von der dichtest gepackten hexagonalen Gitteranordnung zur flächenzentrierten kubischen Gitteranordnung nicht auftritt bei Temperaturen von einer gegebenen Raumtemperatur bis 1000°C.

2. Elektrisches Widerstandselement nach Anspruch 1, wobei das zweite Widerstandselement (12) 78 At-% bis 95 At-% Co und die verbleibende Menge an Fe enthält.
3. Elektrisches Widerstandselement nach einem der Ansprüche 1 oder 2, wobei das erste Widerstandselement (11) aus einer Ni-Cr-Legierung gefertigt ist.
4. Elektrisches Widerstandselement nach Anspruch 1, wobei das erste Widerstandselement (11) aus einer Fe-Cr-Al-Legierung mit einem Fe-Gehalt von 68 Gew.-% bis 72 Gew.-% gefertigt ist, das aus einer Co-Fe-Legierung gemachte zweite Widerstandselement (12) einen Fe-Gehalt von 7 Gew.-% bis 9 Gew.-% hat, wobei ein Volumenverhältnis vom zweiten zum ersten Widerstandselement in einer Verknüpfung zwischen beiden in einem Bereich von 1:0,15 bis 1:0,25 liegt.

5. Glühkerze für Verbrennungsmotoren, umfassend

ein Gehäuse (7);
eine sich vom einen Ende des Gehäuses (7)

ausdehnende Heizröhre (90);
ein in der Heizröhre (90) angeordnetes isolierendes Element (2); und
ein Widerstandselement (1),

wobei das Widerstandselement (1) mindestens zwei Elemente einschließt: Ein Heizelement (11) und ein Steuerelement (12), die miteinander in Reihe geschaltet sind, wobei das Steuerelement (12) elektrisch stromaufwärts vom Heizelement (11) angeordnet ist, das Steuerelement (12) einen positiven Widerstandtemperaturkoeffizienten annimmt, der höher als der des Heizelements (11) ist, um einen zum Heizelement (11) fließenden Strom zu steuern,

wobei das Steuerelement (12) aus einer Co-Fe-Legierung gemacht ist, deren Zusammensetzung in einen Bereich fällt, in welchem eine Phasenänderung von einer innenzentrierten kubischen Gitteranordnung zu einer flächenzentrierten kubischen Gitteranordnung nicht auftritt sowie eine Phasenänderung von einer dichtest gepackten hexagonalen Gitteranordnung zur flächenzentrierten kubischen Gitteranordnung selbst dann nicht auftritt, wenn das zweite Widerstandselement einer Temperaturänderung von einer vorgegebenen Raumtemperatur auf 1000°C unterworfen wird, und

wobei das Heizelement (11) an seinem Ende an ein Ende des Steuerelements (12) geschweißt ist, um eine Verknüpfung (120) zwischen beiden zu bilden, die Material, aus dem das erste Widerstandselement gemacht ist, und die das Steuerelement (12) bildende Co-Fe-Legierung einschließt,

dadurch gekennzeichnet, daß

die Zusammensetzung der Co-Fe-Legierung in der Verknüpfung (120) definiert ist durch einen Fe-Gehalt von 5 bis 22 At.-%, indem das das Heizelement (11) bildende Material so ausgewählt ist, dass eine Phasenänderung der Zusammensetzung der Co-Fe-Legierung in der Verknüpfung (120) von der innenzentrierten kubischen Gitteranordnung zur flächenzentrierten kubischen Gitteranordnung sowie von der dichtest gepackten hexagonalen Gitteranordnung zur flächenzentrierten kubischen Gitteranordnung nicht auftritt bei Temperaturen von einer gegebenen Raumtemperatur bis 1000°C.

6. Glühkerze nach Anspruch 5, wobei das Steuerelement (12) 78 At-% bis 95 At-% Co und die verbleibende Menge an Fe enthält.
7. Glühkerze nach einem der Ansprüche 5 oder 6, wobei das Heizelement (11) aus einer Ni-Cr-Legierung gefertigt ist.
8. Glühkerze nach Anspruch 5, wobei das Heizelement (11) aus einer Fe-Cr-Al-Legierung mit einem Fe-Gehalt von 68 Gew.-% bis 72 Gew.-% gefertigt

ist, das aus einer Co-Fe-Legierung gemachte Steuerelement (12) einen Fe-Gehalt von 7 Gew.-% bis 9 Gew.-% hat, wobei ein Volumenverhältnis vom Steuerelement zum Heizelement in einer Verknüpfung zwischen beiden in einem Bereich von 1:0,15 bis 1:0,25 liegt.

9. Glühkerze nach Anspruch 5, wobei die Heizröhre (90) einen Endabschnitt mit kleinerem Durchmesser als Boden hat, wobei die Außen- und Innendurchmesser der Heizröhre (90) so gewählt sind, daß das isolierende Element (2) um das Heizelement (11) dichter als um das Steuerelement (12) ist.

Revendications

1. Élément de résistance électrique comprenant :

un premier élément de résistance (11) possédant une résistance électrique donnée ; et
un second élément de résistance (12) connecté en série avec ledit premier élément de résistance (11), ledit second élément de résistance ayant un coefficient de température de résistance nettement supérieur à celui dudit premier élément de résistance et fournissant une fonction de régulation du courant pour ledit premier élément de résistance (11),

dans lequel ledit second élément de résistance (12) est formé d'un alliage Co-Fe, dont les compositions se situent dans une gamme dans laquelle un changement de phase depuis un agencement de réseau cubique centré à un agencement de réseau cubique à faces centrées ne se produit pas, et un changement de phase depuis un agencement de réseau hexagonal très condensé à l'agencement de réseau cubique à faces centrées ne se produit pas même lorsque le second élément de résistance est soumis à une variation de température depuis une température ambiante donnée jusqu'à 1000°C, et

dans lequel ledit premier élément de résistance (11) est soudé, par son extrémité, à une extrémité dudit second élément de résistance (12) pour former entre eux une connexion (120), qui inclut une partie du matériau formant ledit premier élément de résistance et une partie de l'alliage Co-Fe formant ledit second élément de résistance (12),

caractérisé en ce que la composition de l'alliage Co-Fe dans la connexion (120) est définie par une teneur en Fe de 5 à 22 % at. en choisissant le matériau formant ledit premier élément de résistance (11) de manière à empêcher qu'un changement de phase de la composition de l'alliage Co-Fe dans la connexion (120) depuis l'agencement de réseau cubique centré à l'agencement de réseau cubique

à faces centrées et depuis l'agencement de réseau hexagonal très condensé à l'agencement de réseau cubique à faces centrées ne se produise à des températures allant d'une température ambiante donnée jusqu'à 1000°C.

2. Élément de résistance électrique selon la revendication 1, dans lequel ledit second élément de résistance (12) contient 78 % atomiques à 95 % atomiques de Co, le reste étant formé de Fe.

3. Élément de résistance électrique selon la revendication 1 ou 2, dans lequel ledit premier élément de résistance (11) est formé d'un alliage de Ni-Cr.

4. Élément de résistance électrique selon la revendication 1, dans lequel ledit premier élément de résistance (11) est formé d'un alliage Fe-Cr-Al possédant une teneur en Fe comprise entre 68 % en poids et 72 % en poids, ledit second élément de résistance (12) étant formé d'un alliage Co-Fe ayant une teneur en Fe comprise entre 7 % en poids et 9 % en poids, un rapport volumique dudit second élément de résistance audit premier élément de résistance dans une connexion entre ces éléments étant situé dans une gamme de 1:0,15 à 1:0,25.

5. Bougie d'allumage pour un moteur à combustion interne comprenant :

un boîtier (7) ;
un tube de chauffage (90) s'étendant à partir d'une extrémité dudit boîtier (7) ;
un élément isolant (2) disposé dans ledit tube de chauffage (90) ; et
un élément de résistance (1),
ledit élément de résistance (1) comprenant au moins deux éléments : un élément de chauffage (11) et un élément de régulation (12) connectés réciproquement en série, ledit élément de régulation (12) étant disposé électriquement en amont dudit élément de chauffage (11), ledit élément de régulation (12) possédant un coefficient de température de résistance positif supérieur à celui de l'élément de chauffage (11) pour réguler un courant circulant dans ledit élément de chauffage (11),

dans lequel ledit élément de régulation (12) est formé d'un alliage Co-Fe, dont les compositions se situent dans une gamme, dans laquelle un changement de phase depuis un agencement de réseau cubique centré à un agencement de réseau cubique à faces centrées ne se produit pas et un changement de phase depuis un agencement de réseau hexagonal très condensé à l'agencement de réseau cubique à faces centrées ne se produit pas même lorsque le second élément de résistance est soumis

à une variation de température depuis une température ambiante donnée jusqu'à 1000°C, et

dans lequel ledit élément de chauffage (11) est soudé, par son extrémité, à une extrémité dudit élément de régulation (12) pour former entre eux une connexion qui inclut un matériau dont est constitué ledit premier élément de résistance, et l'alliage Co-Fe formant ledit élément de régulation (12),

caractérisée en ce que la composition de l'alliage Co-Fe dans la connexion (120) est définie par une teneur en Fe de 5 à 22 % atomiques en choisissant le matériau formant ledit élément de chauffage (11) de manière à empêcher qu'un changement de phase de la composition de l'alliage Co-Fe dans la connexion (120) depuis l'agencement de réseau cubique centré à l'agencement de réseau cubique à faces centrées et depuis l'agencement de réseau hexagonal très condensé à l'agencement de réseau cubique à faces centrées ne se produise à des températures allant d'une température ambiante donnée jusqu'à 1000°C.

6. Bougie d'allumage selon la revendication 5, dans laquelle ledit élément de régulation (12) contient entre 78 % atomiques et 95 % atomiques de Co, le reste étant formé de Fe.
7. Bougie d'allumage selon la revendication 8 ou 9, dans laquelle ledit élément de chauffage (11) est formé d'un alliage Ni-Cr.
8. Bougie d'allumage selon la revendication 5, dans laquelle ledit élément de chauffage (11) est formé d'un alliage Fe-Cr-Al possédant une teneur en Fe comprise entre 68 % en poids et 72 % en poids, ledit second élément de résistance (12) étant formé d'un alliage Co-Fe ayant une teneur en Fe comprise entre 7 % en poids et 9 % en poids, un rapport volumique dudit élément de régulation audit élément de chauffage dans une connexion entre ces éléments étant situé dans une gamme de 1:0,15 à 1:0,25.
9. Bougie d'allumage selon la revendication 5, dans laquelle ledit tube de chauffage (90) possède une partie d'extrémité de diamètre inférieur, qui est pourvue d'un fond, les diamètres extérieur et intérieur dudit tube de chauffage (90) étant choisis de telle sorte que ledit élément isolant (2) autour de l'élément de chauffage (11) est plus dense qu'autour de l'élément de régulation (12).

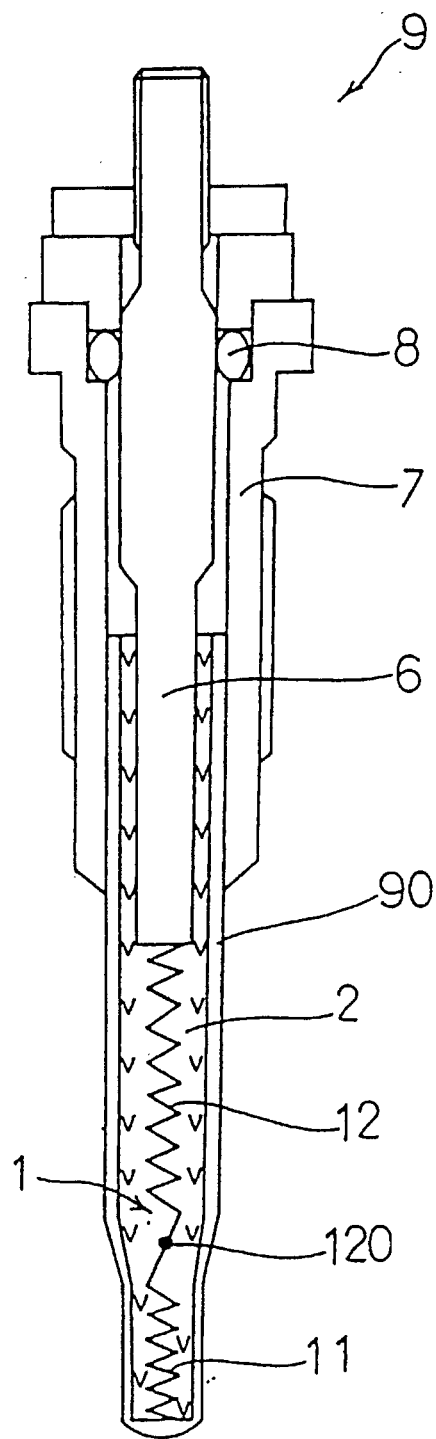


Fig. 1

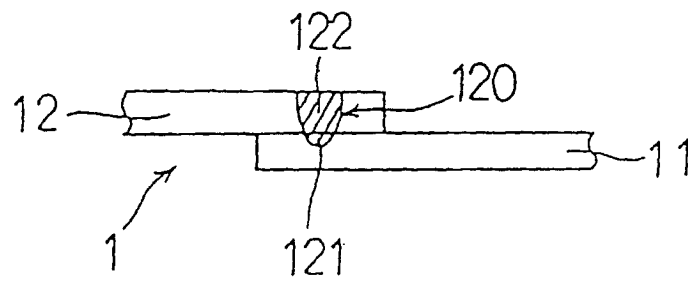


Fig. 2

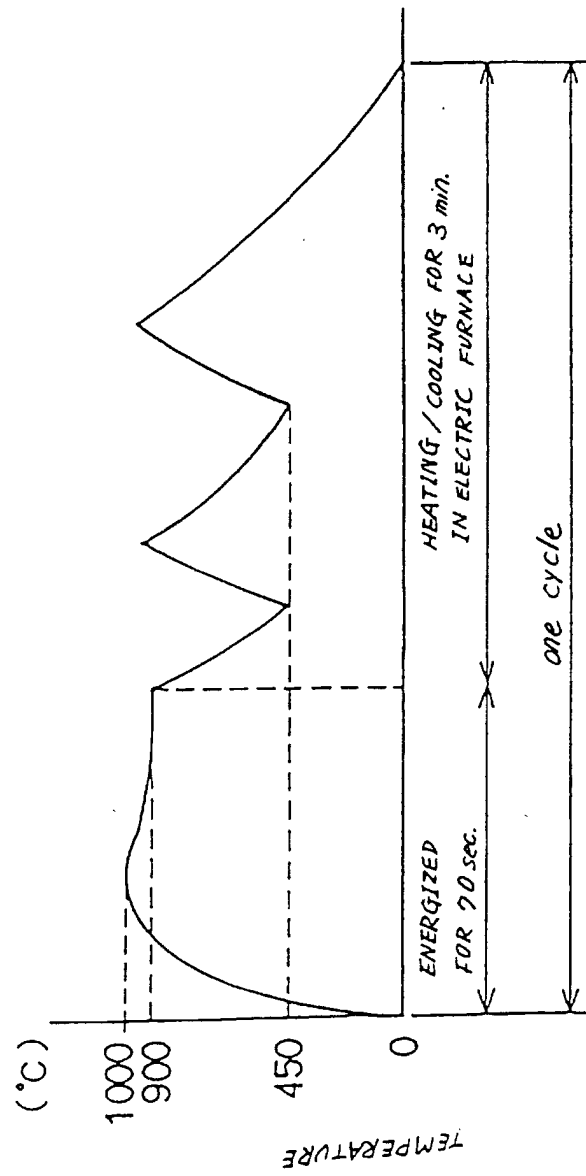


Fig. 3

	FIRST COIL MATERIAL	SECOND COIL MATERIAL	THIRD COIL MATERIAL	FUSED VOLUME RATIO (B:A)	SERVICE LIVE		WIRE - BREAKAGE
					10000	20000 cycle	
EXAMPLE 1	NiCr	Co 92 Fe 8	—	1 : 1		X X X X	FIRST COIL
EXAMPLE 2	FeCrAl	Co 92 Fe 8	Ni	1 : 1 (2nd-3rd coil ratio)		X X X X	FIRST COIL
EXAMPLE 3	FeCrAl	Co 92 Fe 8	—	0.2 : 1 1 : 0.2		X X X X	FIRST COIL
COMPARATIVE EXAMPLE C1	FeCrAl	Ni	—	1 : 1		X X X X	FIRST COIL
COMPARATIVE EXAMPLE C2	FeCrAl	Co 92 Fe 8	—	1 : 1	X X X X		CONNECTION BETWEEN FIRST AND SECOND COILS

Fig. 4

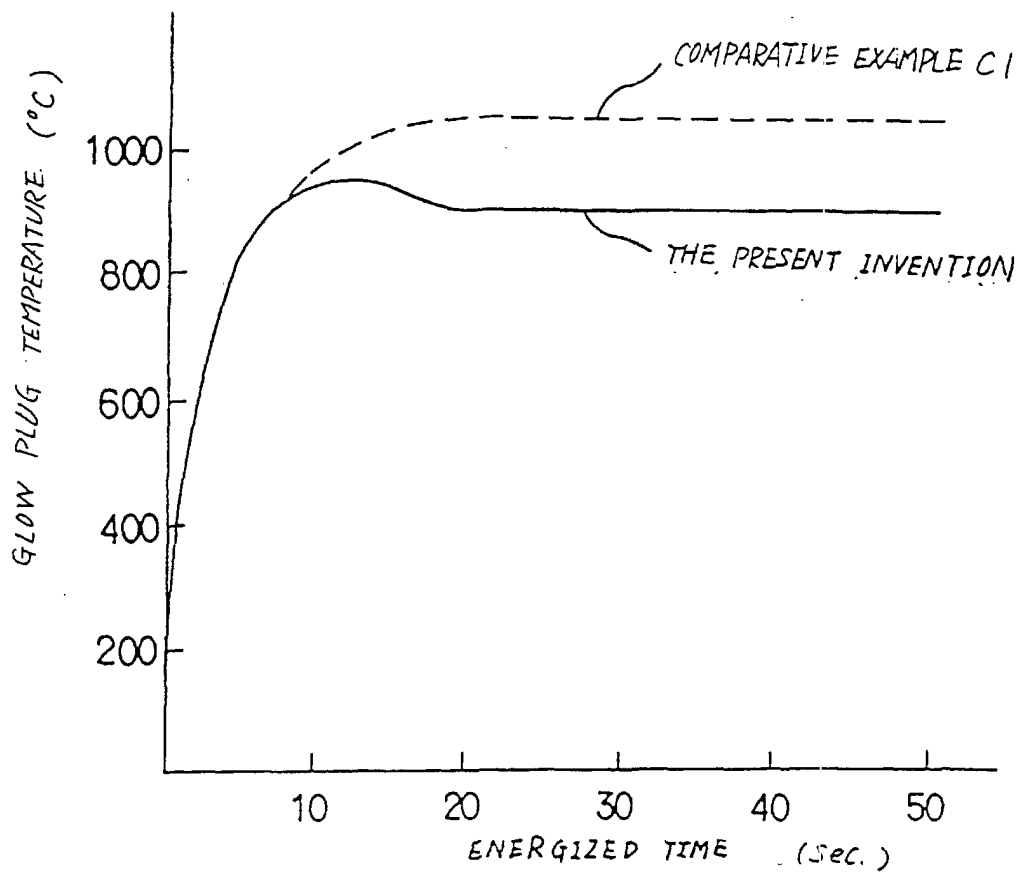


Fig. 5

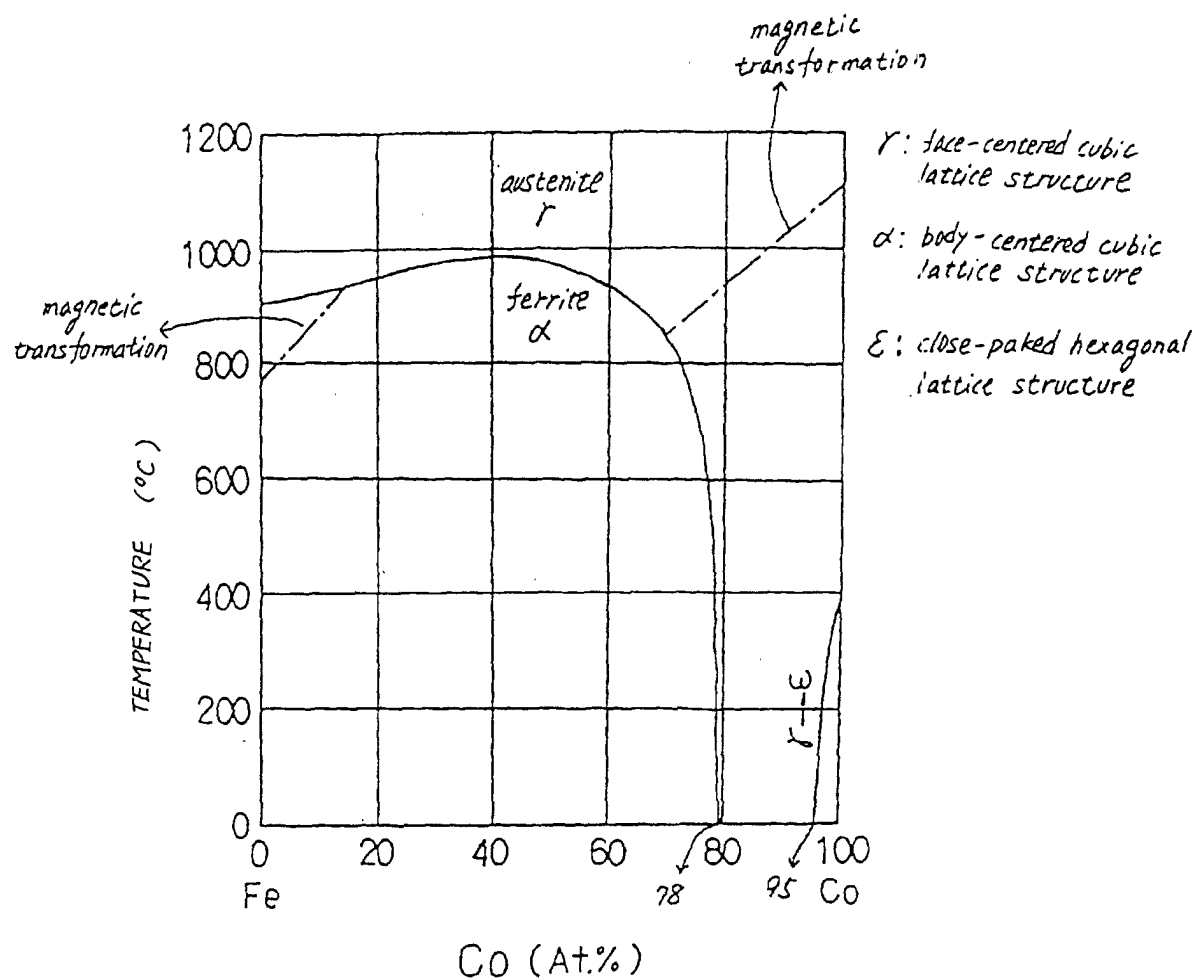


Fig. 6

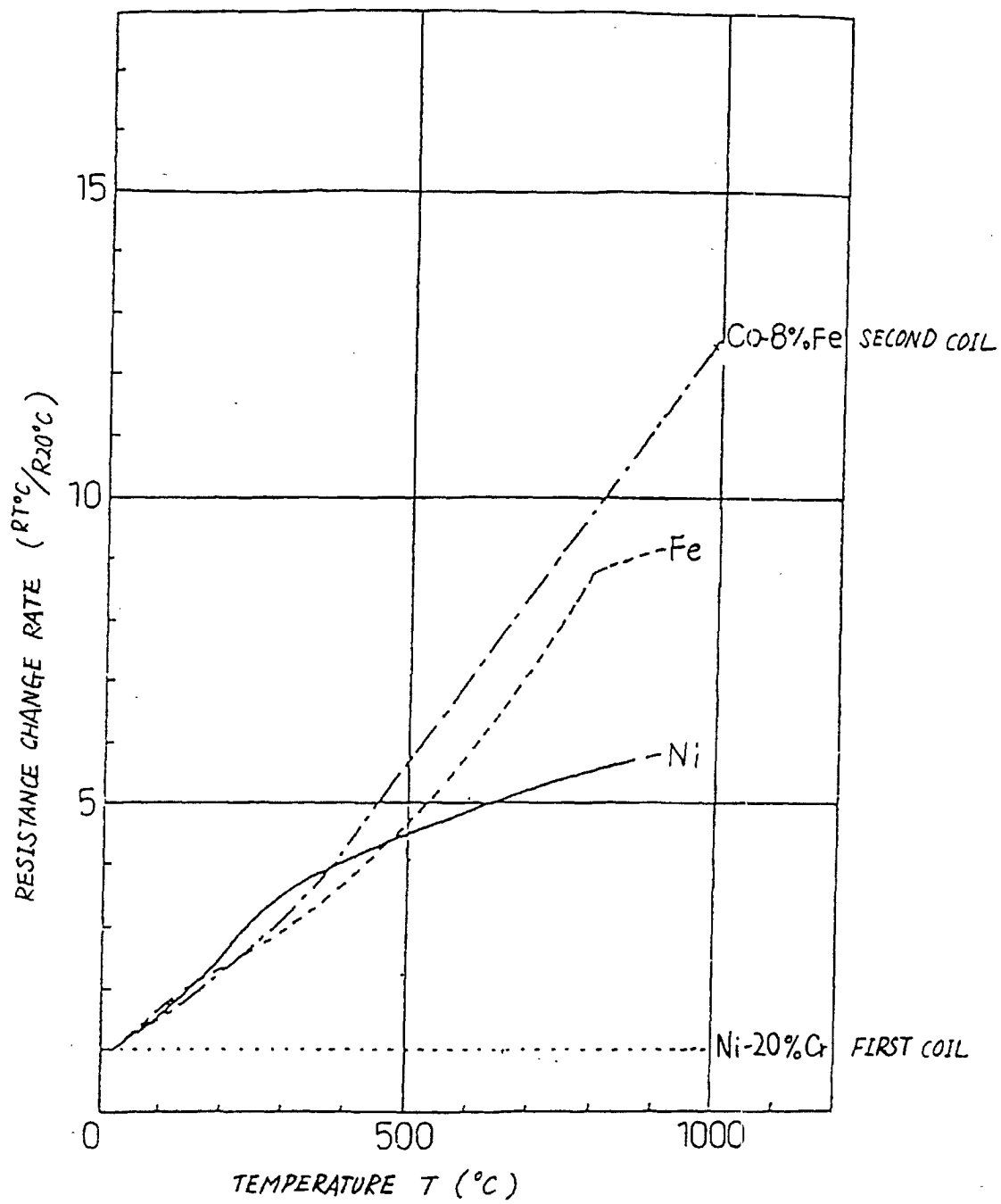


Fig. 7