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(54) **PROCESS FOR PRODUCING OIL TEMPERED WIRE**

VERFAHREN ZUR HERSTELLUNG VON ANGELASSENEM DRAHT

PROCEDE DE PRODUCTION D'UN FIL TREMPE A L'HUILE

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Description

TECHNICAL FIELD

5 **[0001]** A method for producing an oil temper treated wire for use in a coil spring or a valve spring, used in an internal combustion engine, a torsion spring used in a clutch mechanism for an automobile and the like.

BACKGROUND

10 **[0002]** There has been known such method for producing an oil temper wire according to the EP-A-1 013 780. This document relates to a technique for producing a spring steel material, which is called a rod, whereas the invention relates to a technique for producing an oil tempered wire. The subject of the document belongs to steel makers and the inventive method belongs to wire makers, which produce many kinds of spring products from the spring steel rod, provided by the steel makers.

15 **[0003]** There has been known a further method for producing an oil temper wire for a coil spring, the method comprising: using a wire material having a nonmetallic inclusion controlled and carrying out an isothermal transformation heat treatment, applying a lubrication film after acid washing, carrying out scalping or shaving, then carrying out an isothermal transformation heat treatment, applying a lubrication film after acid washing, carrying out wire-drawing processing, and finally applying an oil temper treatment. In this case, the isothermal transformation heat treatment with a wire material is often omitted since workability of a wire material is enhanced.

20 **[0004]** The conventional method for producing an oil temper wire which carries out the isothermal transformation heat treatment after the scalping has been carried out includes: (a) Since the wire material is heated to a degree in excess of a transformation temperature, decarburization likely occurs; (b) since the isothermal transformation heat treatment requires a traveling treatment with a strand, a dominant cause of producing a damage caused by the traveling treatment and handling results; (c) in the isothermal transformation heat treatment, a removal of an oxidized scale film produced during the heat treatment and the lubrication film treatment after acid washing in order to wire-drawing processing are necessary; and (d) an adhering state of the oxidized scale in the oil temper treatment after wire-drawing is uneven due to unevenness of the lubrication film after acid washing resulting in an evil of forming process of a coil spring (coiling).

25 **[0005]** In the EP-A-0 656 427 a method is described in which a finished, i.e. a completely drawn wire, is explicitly treated by a number of subsequent steps of a method, defined in that document. The method step described in this document is different from the subject matter of the invention. Method steps for carrying out annealing in an atmosphere of a mixture of nitrogen and oxygen of e.g. temperatures in the range of 500 to 650°C are not realized.

30 **[0006]** Finally a further document according to the JP-A-630 728 32 discloses a method for producing oil temper wire in such a way that there will be formed an oxide film on the surface of heated wire in an atmosphere of steam or in an atmosphere of inert gas, such as nitrogen or argon, including steam. Namely the method which is disclosed in this document is directed to forming an oxide film on the surface of the wire.

DISCLOSURE OF THE INVENTION

40 **[0007]** In view of the aforementioned problem, it is an object of the invention to provide a method for producing an oil temper wire, which improve quality, achieve reduction in cost and simplify the steps after the scalping.

[0008] It is a further object of the invention to provide a method for producing an oil temper wire which is free from decarburization of a wire material and free from a damage or unevenness of scale on a surface layer after an oil temper treatment has been carried out in order to facilitate the forming of a coil spring.

45 **[0009]** For solving the problems noted above the method for producing an oil temperature according to the present invention comprises: firstly applying an isothermal transformation heat treatment to the wire material having a non-metallic inclusion controlled, secondly applying a lubrication film after acid washing, thirdly carrying out the scalping followed by softening by annealing a work hardened layer produced on a surface layer at the time of scalping, fourthly carrying out the wire drawing and finally carrying out the oil temper treatment.

OPERATION OF THE INVENTION

50 **[0010]** The present inventor has found that in a method for producing an oil temper wire using a coil spring, to carry out annealing after scalping or shaving of a wire material having a nonmetallic inclusion controlled is effective for a thereafter wire drawing process. That is, the method for producing an oil temper wire for use in a coil spring resides in that a work hardened layer produced on a surface layer of a wire material during scalping of a wire material is softened by annealing to thereby remove an drawback, and after wire drawing an oil temper treatment is carried out.

[0011] Considering a wire drawing workability and a solid solution state of cementite caused by austenite heating at

the time of an oil temper treatment after wire drawing process, an annealing temperature of a wire material is set to a temperature region from 500 to 650°C. For the atmosphere at the time of annealing, nitrogen or a mixture of nitrogen and oxygen is used and the quantity of oxygen is preferably controlled. A control is made such that an oxidized scale film produced by annealing of a wire material is extremely thin and even. Thus it is possible to avoid the conventional lubrication film treatment after acid washing for wire drawing process.

[0012] A film of an oxidized scale caused by annealing prior to a wire drawing process of a wire material may be subjected to descaling by means of a shot blast or the like. The thickness of the oxidized scale after the oil temper process becomes even and lubricating property at the time of forming process (coiling) of a coil spring can be maintained.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] FIG. 1 is a photograph showing a surface crack of one wire material according to the method for producing an oil temper wire according to the present invention; FIG. 2 is a photograph showing a solid solution state of one more material according to the method for producing an oil temper wire; FIG. 3 is a schematic view representative of an evaluation standard in a coil winding state of a wire material according to the method for producing an oil temper wire; and FIG. 4 is a photograph showing a decarburization state of a comparative wire material.

BEST MODE FOR CARRYING OUT THE INVENTION

[0014] The method for producing an oil temper wire according to the present invention is characterized by softening by annealing a work hardened layer produced on the surface of a wire during scalping or shaving of a wire material to thereby remove any drawbacks thereby remove an evil, and after wire drawing is carried out carrying out an oil temper treatment.

[Embodiment 1]

[0015] There were prepared wire materials A to G and H, as oil temper wires, in which an alloy steel inclusion is controlled, comprising carbon 0.57% (hereinafter, % means weight % unless otherwise particularly described clearly), silicone 1.45%, manganese 0.69%, phosphor 0.014%, sulfur 0.004%, chromium 0.67% and iron (the reminder) and a comparative material H, these materials were subjected to an isothermal transformation treatment, applying a lubrication film after acid washing, and scalping or shaving of the surface. The scalping amount of a wire material is 0.3 mm in diameter (thickness 0.15 mm). Then, annealing of a wire material by batch was carried out in an atmosphere of mixed nitrogen and oxygen. An annealing temperature of a wire material was varied from 480 to 700°C to confirm workability of drawing of the wire materials A to G and the comparative material H at respective annealing temperatures. The state of the oxidized scale film after annealing of the wire material was extremely thin and even. Further, the decarburization of the wire materials A to G in annealing was not recognized, but the decarburization in the comparative material H was recognized, as shown in FIG. 4.

[0016] Next, the oil temper treatment was carried out with respect to a wire material, which is good in drawing wire process. The solid solution state (refer to FIG. 2) of cementite at the time of oil temper treatment was confirmed. In the oil temper treatment, since heating time is short, when the cementite is formed into sphere, the solid solution of cementite is insufficient by heating and adequate strength is not obtained.

[0017] A relationship between the annealing temperature and the drawing wire workability after the wire materials A to G in which an inclusion was controlled and the comparative material H were subjected to the isothermal transformation treatment, application of a lubrication film after acid washing, and scalping or shaving of the surface is as follows:

Wire material A: At an annealing temperature of 450°C, a breakage occurred during the drawing wire process, which was not practical.

Wire material B: At an annealing temperature of 480°C, the drawing wire process in excess of 80% of reduction of area was accomplished, but crack-like crevices at right angle to a fine wire axis occurred on the surface of the wire material, as shown in FIG. 1.

Wire materials C to F: At an annealing temperature of 500 to 650°C, a crack-like crevice at right angle to a fine wire axis was not recognized, and the cementite was not found to be formed into sphere. By austenite heating after drawing wire process, the cementite was sufficiently subjected to solid solution to obtain adequate strength. No unevenness was recognized on the external appearance of the oxidized scale film after the oil temper treatment.

Wire material G: In the annealing at a temperature of 700°C, formation of cementite into sphere progresses, and the solid solution of spherical-cementite is insufficient due to the austenite heating after the drawing wire process, failing to obtain the adequate strength.

Comparative material H: Unevenness was recognized on the external appearance of the oxidized scale film after

the oil temper treatment. Evaluation circumstances of the aforementioned wire materials A to G and comparative material H are summarized in Table 1. The adequate annealing temperature is 500 to 650°C of the wire materials C to F.

TABLE 1 Evaluation Results

Wire Mat'ls	system	heat treatment		decarb'tion	thick'ns scale	drawing workability
		temp.	ato'phre °C			
10	A	annealing	450 nitrogen	O	0 to 1	X
	B	annealing	480 nitrogen	O	0 to 2	Δ
	C	annealing	500 nitrogen	O	1 to 3	O
	D	annealing	550 nitrogen	O	1 to 3	O
	E	annealing	600 nitrogen	O	1 to 3	O
15	F	annealing	650 nitrogen	O	2 to 5	O
	G	annealing	700 nitrogen	O	3 to 8	O
	H	annealing	500 reduction	Δ	2 to 15	O
Wire Mat'ls	solid solution state	oil temper		eddy current		synthetic evaluation
		scale	unevenness	crack detection	crack number	
20	A	-	-	-	-	X
	B	-	-	-	-	X
	C	O	O	0	0	O
	D	O	O	0	0	O
25	E	O	O	0	0	O
	F	O	O	0	0	O
	G	Δ	-	-	-	X
	H	O	X	7	7	X

[0018] After the oil temper treatment, the inspection of cracks by eddy current crack detection was conducted over the full length on the off line. In the wire materials C to F subjected to the batch type annealing treatment, there is no number of cracks per coil (diameter: 6 mm, and length: 1500 m), whereas in the comparative material (which was subjected to the isothermal transformation heat treatment after scalping), seven cracks per coil were found.

[0019] In FIG. 3, A shows no scale-unevenness is present over the full length of the coil. B shows several times of scale-unevenness are found in a few places within the coil. C shows scores of rolls of scale-unevenness are found in one place within the coil. D shows scale-unevenness in which B-C are combined.

TABLE 2 Evaluation items

Evaluation items	evaluation standard
Decarburization	partial decarburization is not present
Workability	(a) degressive rate is not less than 80% (b) defect such as scratch is not present on the surface after peocessing
solid solution state	cementite is solid solution dispersed evenly
scale unevenness	A and B in scale-unevenness judgment standard are accepted

[Embodiment 2]

[0020] A wire material, in which an alloy steel inclusion is controlled comprising carbon 0.65%, silicone 1.53%, manganese 0.69%, phosphor 0.007%, sulfur 0.008%, chromium 0.68%, and iron (the reminder), which are different in component from Embodiment 1 was subjected to an isothermal transformation treatment, applying a lubrication film after acid washing, and scalping of a surface in diameter of 0.3 mm (thickness is 0.15 mm). The scalping amount of a wire material is 0.3 mm in diameter (thickness 0.15 mm).

[0021] Then, annealing of a wire material by batch was carried out. The annealing temperature was 500°C. The annealing treatment was carried out with respect to the wire material, after which the wire was drawn to an adequate diameter, and then the oil temper treatment was carried out. At this time, abnormality caused by the wire drawing process, the short in strength in the oil temper treatment, and abnormality such as unevenness of scale were not occurred.

[Embodiment 3]

[0022] As an oil temper wire used as a high fatigue strength material, a wire material, in which an alloy steel inclusion is controlled comprising carbon 0.64%, silicone 1.43%, manganese 0.71%, phosphor 0.006%, sulfur 0.005%, chromium 1.48%, molybdenum 0.47%, vanadium 0.19% and iron (the reminder) was applied with a lubrication film after acid washing, and scalping of a surface in diameter of 0.3 mm (thickness is 0.15 mm) was carried out. Then, the annealing treatment was carried out at 600°C with respect to the wire material by the batch. Then, the wire drawing process was carried out with respect to the wire material, after which the oil temper treatment was carried out.

[0023] Also in the aforementioned high fatigue strength material, the abnormality caused by the drawing wire process, the short in strength in the oil temper treatment, and the abnormality such as unevenness of scale were not observed.

INDUSTRIAL APPLICABILITY

[0024] As described above, the method for producing an oil temper wire used for a valve spring of the internal combustion engine, a coil spring of a clutch mechanism and the like according to the present invention is useful in the point that no scratch and unevenness of scale occur on the surface layer after the drawing wire process and oil temper treatment, and forming of a coil spring is facilitated.

Claims

1. A method for producing an oil temper treated wire, comprising the following steps:

carrying out wire drawing and
carrying out scalping,

characterised in that,

firstly: applying an isothermal transformation heat treatment to the wire material having a non-metallic inclusion controlled,

secondly: applying a lubrication film after acid washing,

thirdly: carrying out the scalping, after which softening a work hardened layer produced on a surface layer at the time of scalping by annealing,

fourthly: carrying out the wire drawing and finally: carrying out the oil temper treatment.

2. The method for producing oil temper wire according to claim 1, wherein an annealing temperature is set to 500 to 600°C.

3. The method for producing an oil temper wire according to claim 1, wherein in said annealing step, the in-furnace atmosphere is nitrogen in order to suppress an oxidized scale film.

4. The method for producing an oil temper wire according to claim 1, wherein in said annealing step, the in-furnace atmosphere is a mixture of nitrogen and oxygen in order to suppress an oxidized scale film and a quantity of oxygen is controlled.

5. The method for producing an oil temper wire according to claim 1, wherein said wire material is Si-Cr steel.

Patentansprüche

1. Verfahren zur Herstellung eines mit Öl härtebehandelten Drahtes, umfassend die folgenden Schritte:

Ausführen des Ziehens des Drahtes und
Ausführen des Entferns der Oberflächenhaut,

dadurch gekennzeichnet,

daß zunächst eine isothermische Transformationswärmebehandlung des Drahtmaterials durchgeführt wird, das eine nichtmetallische gelenkte Einlagerung aufweist,

daß danach ein Schmierstoffilm nach dem Säurewaschen aufgebracht wird,

daß anschließend das Entfernen der Oberflächenschicht nach dem Enthärten einer gehärteten Schicht ausgeführt wird, die auf einer Oberflächenschicht im Augenblick ihres Entfernens durch Glühen erzeugt wird,
daß danach das Ziehen des Drahtes ausgeführt wird und
daß schließlich die Ölhärtebehandlung ausgeführt wird.

2. Verfahren zur Erzeugung eines mit Öl härtebehandelten Drahtes nach Anspruch 1, bei dem die Glühtemperatur bei 500 bis 600°C liegt.
3. Verfahren zur Erzeugung eines mit Öl härtebehandelten Drahtes nach Anspruch 1, bei dem der Glühschritt in der Ofenatmosphäre Stickstoff ist, um einen oxidierten Hautfilm zu unterdrücken.
4. Verfahren zur Erzeugung eines mit Öl härtebehandelten Drahtes nach Anspruch 1, bei dem der Glühschritt in der Ofenatmosphäre aus einem Gemisch aus Stickstoff und Sauerstoff besteht, um einen oxidierten Hautfilm zu unterdrücken, wobei eine bestimmte Menge von Stickstoff gesteuert wird.
5. Verfahren zur Erzeugung eines mit Öl härtebehandelten Drahtes nach Anspruch 1, bei dem das Drahtmaterial Si-Cr-Stahl ist.

Revendications

1. Un procédé de fabrication d'un fil traité par trempe à l'huile comprenant les étapes :

- d'étirage du fil
- d'écrouissage,

caractérisé en ce que

- premièrement: on procède au traitement thermique de transformation isotherme du matériau d'un fil comportant une inclusion non métallique contrôlée,
 - deuxièmement: on applique un film de lubrification après lavage à l'acide,
 - troisièmement: on procède à l'écrouissage, après quoi on ramollit une couche écrouie produite sur une couche de surface au moment de l'écrouissage par recuit,
 - quatrièmement: on procède à l'étirage du fil,
 - et enfin: on effectue le traitement de trempe à l'huile.
2. Le procédé de fabrication d'un fil traité par trempe à l'huile selon la revendication 1, dans lequel la température de recuit est fixée entre 500 et 600°C.
 3. Le procédé de fabrication d'un fil traité par trempe à l'huile selon la revendication 1, dans lequel, dans ladite étape de recuit, l'atmosphère du four est formée d'azote afin d'éviter la formation d'un film de calamine oxydée.
 4. Le procédé de fabrication d'un fil traité par trempe à l'huile selon la revendication 1, dans lequel, dans ladite étape de recuit, l'atmosphère du four est formée d'un mélange d'azote et d'oxygène afin d'éviter la formation d'un film de calamine oxydée et la quantité d'oxygène présente est contrôlée.
 5. Le procédé de fabrication d'un fil traité par trempe à l'huile selon la revendication 1, dans lequel ledit matériau métallique est en acier au Cr-Si.

FIG. 1

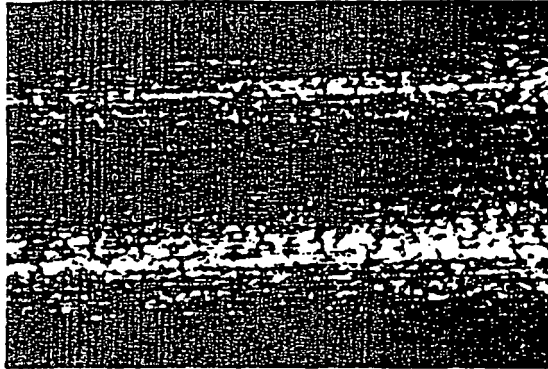


FIG. 2

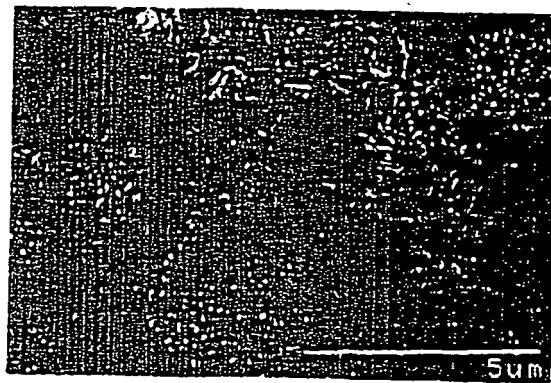


FIG. 3

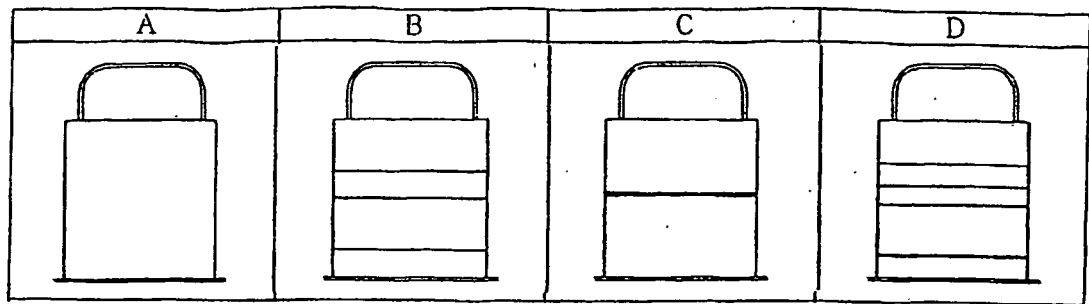
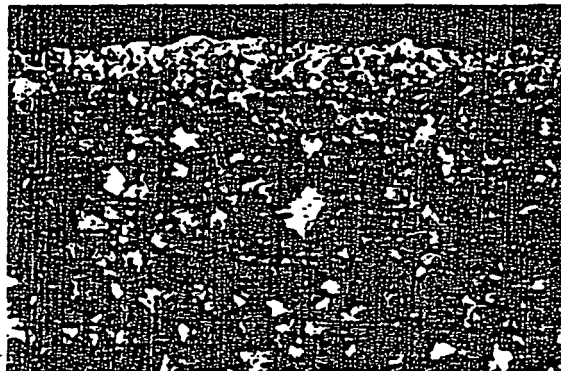


FIG. 4



REFERENCES CITED IN THE DESCRIPTION

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