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(54) **GRAY CAST IRON ALLOY AND CAST INTERNAL COMBUSTION ENGINE COMPONENT**

GRAUE GUSSEISENLEGIERUNG UND BRENNKRAFTMASCHINENGUSSBAUTEIL

ALLIAGE DE FONTE GRISE ET COMPOSANT DE MOTEUR A COMBUSTION INTERNE MOULE

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EP 1 506 323 B1

Description**BACKGROUND OF THE INVENTION**

1. Field of the invention

[0001] The present invention concerns a grey cast iron alloy. More specifically, the present invention concerns a pearlitic grey cast iron comprising further alloying elements for improved fatigue strength.

[0002] The invention further concerns an internal combustion engine component, cast from grey cast iron alloy according to the invention.

2. Description of the prior art

[0003] Grey cast iron is a most attractive material for e.g. internal combustion engine blocks for vehicles due to a relatively low cost and yet good to excellent performance. Compositions within quite a wide range are previously known, such compositions normally being a compromise between properties, such as tensile strength, wear properties etc., of the material as used and production properties, such as cost, machinability etc.

[0004] Thus, for cast internal combustion engine blocks a base material 0120 has a composition according to Table 1 below and a common standard alloy has a composition also according to Table 1, the Scania standard alloy providing a grey cast iron with a pearlitic structure and a sound (pore free) material due to a comparatively high carbon content.

[0005] However, although fully acceptable at present, an improved fatigue strength is today desirable as a complement to the present properties and would extend the possible use of such a prior art grey cast iron.

[0006] It is an object of the present invention to provide a grey cast iron with a comparatively sound structure and offering good machinability properties and having, in addition, a substantially improved fatigue strength compared to that of a standard alloy.

[0007] It is a further object of the present invention to provide a grey cast iron internal combustion engine component, such as an engine block, having a substantially improved fatigue strength compared to that of a standard alloy.

SUMMARY OF THE INVENTION

[0008] The object of the present invention is obtained by a grey cast iron according to the accompanying claim 1. Preferred embodiments are specified in the dependent claims.

[0009] Further, the object of the present invention is obtained by a grey cast iron internal combustion engine component according to the accompanying claim 4. Preferred embodiments are specified in the dependent claim.

BRIEF DESCRIPTION OF THE DRAWING

[0010] Fig. 1 shows Wöhler fatigue curves for a base alloy, a standard alloy and an alloy according to the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0011] In the following description all percentages given for elements in the alloys specified are given as percentage by weight.

[0012] The alloy according to the present invention is a grey cast iron having a pearlitic structure, the carbon content being 3.2 - 3.49 %. The comparatively high carbon content promotes a sound structure. Additions of 0.2 - 0.4 % chromium, having pearlite/carbide stabilizing properties, provides a fine pearlitic structure.

[0013] Additions of 0.1 - 0.4 % molybdenum, 0.03 - 0.3 % vanadium, 0.007 - 0.015 % titanium and < 0.15 % niobium act, in addition to their carbide forming properties, as nuclei providing a fine pearlitic and flake graphite structure as cast (both as primary and secondary precipitated carbides). Molybdenum also stabilises pearlite at elevated temperatures.

[0014] Silicon is present in an amount of 1.8 - 2.2 % promoting grey iron formation.

[0015] 0.3 - 0.8 % manganese is present as a pearlite stabilizing agent.

[0016] Copper, here in an amount of 0.3 - 1.0 %, promotes pearlite formation and stabilizes the pearlite and also promotes the fine structure formation.

[0017] The content of sulphur and phosphorus should be held below 0.15 %.

[0018] Nitrogen, 0.005 - 0.017 %, compacts flake graphite and promotes pearlite formation. Aluminium, < 0.01 %, act as graphite formation agent.

[0019] The grey cast iron alloy further comprises iron and normal impurities to balance. The amounts of titanium, nitrogen and aluminium are in the normal impurity range but may be preferred.

Examples:

[0020] 1500 kg batches were prepared, each batch being cast to four 300 kg engine blocks, casting starting at 1420°C and the temperature dropping about 10°C during the casting procedure.

[0021] Ten different combinations, batches, of molybdenum, vanadium, titanium and niobium, using a base alloy, were produced.

[0022] Further, the nitrogen and aluminium content was varied in 16 different batches with different nuclei forming agents (inoculants).

[0023] Fatigue test samples were taken from each casting and fatigue tests were performed.

[0024] Still further, batches combining the composition showing the best results from the previous tests were produced and fatigue tested.

[0025] Results are shown in Fig. 1, curve 3 corresponding to compositions within the composition ranges according to the invention, this composition also being shown in Table 1.

[0026] The grey cast irons according to the invention offer about 40 % higher fatigue strength than a grey cast iron base alloy and about 30 % higher fatigue strength than a standard engine block grey cast iron and still offering a grey cast iron which fulfils high performance with respect to machinability, soundness, etc.

[0027] As mentioned above, the grey cast iron alloy according to the invention is extremely useful for internal combustion cast engine components, such as engine block components, the alloy combining machinability, soundness and high fatigue strength. The alloy is also useful for other components such as cylinder heads, etc.

Table 1. Grey cast iron compositions, % by weight, according to prior art and the invention

Compound	Alloy					Example alloy 3 of Fig. 1
	Base 0120	Standard alloy	Invention in general	Preferred embodiment		
C	3.2 - 3.5	~3.4	3.2 - 3.49	3.3 - 3.4		3.37
Si	1.8 - 2.3	~2.0	1.8 - 2.2	1.8 - 2.2		1.8
S	0.06-0.15	< 0.14	< 0.15	< 0.1		0.1
P	<0.20	<0.10	< 0.15	< 0.05		0.05
Mn	0.6 - 0.8	0.6 - 0.8	0.3 - 0.8	0.4 - 0.6		0.68
Cr		0.2 - 0.35	0.2-0.4	0.2-0.4		0.34
Mo			0.1 - 0.4	0.2 - 0.3		0.26
V			0.03 - 0.3	0.05 - 0.1		0.1
Cu		0.4 - 0.8	0.3 - 1.0	0.5 - 1.0		0.6
Ni			< 0.1	< 0.1		
Ti			0.007-0.015	0.007 -0.013		0.013
Nb			< 0.15	< 0.10		0.04
N			0.005-0.017	0.005-0.015		0.010
Sn			< 0.1	< 0.1		
Al			< 0.01	< 0.01		

Claims

1. A pearlitic grey cast iron alloy comprising, by weight, 3.2 - 3.49 % carbon

1.8 - 2.2 % silicon

< 0.15 % sulphur

< 0.15 % phosphorus

0.3 - 0.8 % manganese

0.2 - 0.4 % chromium

0.1 - 0.4 % molybdenum

0.03 - 0.3 % vanadium

0.3 - 1.0 % copper

< 0.15 % niobium

0.007-0.015 % titanium

0.005-0.017 % nitrogen

Al < 0.01
Ni < 0.1
Sn < 0.1
the balance iron and impurities.

2. An alloy according to claim 1, comprising

3.3 - 3.4 % carbon
1.8 - 2.2 % silicon
< 0.1 % sulphur
< 0.05 % phosphorus
0.4 - 0.6 % manganese
0.2 - 0.4 % chromium
0.2 - 0.3 % molybdenum
0.05 - 0.1 % vanadium.

3. An alloy according to claim 1 or 2, **characterized in that** vanadium is present to an amount less than 0.1 %.

4. An internal combustion, cast engine component made of a pearlitic grey cast iron alloy, said alloy comprising 3.2 - 3.49 % carbon

1.8 - 2.2 % silicon
< 0.15 % sulphur
< 0.15 % phosphorus
0.3 - 0.8 % manganese
0.2 - 0.4 % chromium
0.1 - 0.4 % molybdenum
0.03 - 0.3 % vanadium
0.3 - 1.0 % copper
0.007 - 0.013 % titanium
< 0.15 % niobium
0.005 - 0.015 % nitrogen
< 0.01 % aluminium
Ni < 0.1
Sn < 0.1
the balance iron and impurities.

5. A component according to claim 4, **characterized in that** it is an engine block component or a cylinder head component.

Patentansprüche

1. Perlitische Graugusseisenlegierung umfassend, nach Gewicht,

3,2 - 3,49 % Kohlenstoff
1,8 - 2,2 % Silizium
<0,15 % Schwefel
<0,15 % Phosphor
0,3 - 0,8 % Mangan
0,2 - 0,4 % Chrom
0,1 - 0,4 % Molybdän
0,03 - 0,3 % Vanadium
0,3 - 1,0 % Kupfer
<0,15 % Niob
0,007 - 0,015 % Titan
0,005-0,017 % Stickstoff
<0,01 % Aluminium

<0,1 % Nickel
<0,1 % Zinn
Rest Eisen und Verunreinigungen.

5 **2.** Legierung nach Anspruch 1, umfassend

3,3 - 3,4 % Kohlenstoff
1,8 - 2,2 % Silizium
10 <0,1 % Schwefel
 <0,05 % Phosphor
 0,4 - 0,6 % Mangan
 0,2 - 0,4 % Chrom
 0,2 - 0,3 % Molybdän
 0,05 - 0,1 % Vanadium.

15 **3.** Legierung nach Anspruch 1 oder 2, **dadurch gekennzeichnet, dass** Vanadium in einer Menge von weniger als 0,1 % enthalten ist.

20 **4.** Brennkraftmaschinen-Gussbauteil, das aus einer perlitischen Graugusseisenlegierung hergestellt ist, wobei die Legierung umfasst

3,2 - 3,49 % Kohlenstoff
1,8 - 2,2 % Silizium
25 <0,15 % Schwefel
 <0,15 % Phosphor
 0,3 - 0,8 % Mangan
 0,2 - 0,4 % Chrom
 0,1 - 0,4 % Molybdän
 0,03 - 0,3 % Vanadium
30 0,3 - 1,0 % Kupfer
 0,007 - 0,013 % Titan
 <0,15 % Niob
 0,005 - 0,015 % Stickstoff
 <0,01 % Aluminium
35 <0,1 % Nickel
 <0,1 % Zinn
 Rest Eisen und Verunreinigungen.

40 **5.** Bauteil nach Anspruch 4, **dadurch gekennzeichnet, dass** es ein Motorblockbauteil oder ein Zylinderkopfbauteil ist.

Revendications

45 **1.** Alliage de fonte grise perlitique comprenant, en poids : 3,2 à 3,49 % de carbone,

1,8 à 2,2 % de silicium,
< 0,15 % de soufre,
< 0,15 % de phosphore,
50 0,3 à 0,8 % de manganèse,
 0,2 à 0,4 % de chrome,
 0,1 à 0,4 % de molybdène,
 0,03 à 0,3 % de vanadium,
 0,3 à 1,0 % de cuivre,
 < 0,15 % de niobium,
55 0,007 à 0,015 % de titane,
 0,005 à 0,017 % d'azote,
 Al < 0,01
 Ni < 0,1

Sn<0,1

le restant étant constitué de fer et d'impuretés.

2. Alliage selon la revendication 1, comprenant :

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3,3 à 3,4 % de carbone,

1,8 à 2,2 % de silicium,

< 0,1 % de soufre,

< 0,05 % de phosphore,

10

0,4 à 0,6 % de manganèse,

0,2 à 0,4 % de chrome,

0,2 à 0,3 % de molybdène,

0,05 à 0,1 % de vanadium.

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3. Alliage selon la revendication 1 ou 2, **caractérisé en ce que** le vanadium est présent en une quantité inférieure à 0,1 %.

4. Composant en fonte d'un moteur à combustion interne constitué d'un alliage de fonte grise perlitique, ledit alliage comprenant : 3,2 à 3,49 % de carbone,

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1,8 à 2,2 % de silicium,

< 0,15 % de soufre,

< 0,15 % de phosphore,

0,3 à 0,8 % de manganèse,

25

0,2 à 0,4 % de chrome,

0,1 à 0,4 % de molybdène,

0,03 à 0,3 % de vanadium,

0,3 à 1,0 % de cuivre,

0,007 à 0,013 % de titane,

30

< 0,15 % de niobium,

0,005 à 0,015 % d'azote,

< 0,01 % d'aluminium

Ni < 0,1

Sn<0,1

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le restant étant constitué de fer et d'impuretés.

5. Composant selon la revendication 4, **caractérisé en ce qu'il** s'agit d'un bloc moteur ou d'une culasse.

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