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(21) Numéro de la demande internationale: PCT/FR97/01328 (22) Date de dépôt international: 17 juillet 1997 (17.07.97) (30) Données relatives, à la priorité: 96/09080 19 juillet 1996 (19.07.96) FR (71) Déposant (pour tous les Etats désignés sauf US): THYSSEN FRANCE S.A. [FR/FR]; 6, avenue Gutenberg, Boîte postale 52, F-78310 Maurepas Cedex (FR). (72) Inventeurs; et (75) Inventeurs/Déposants (US seulement): ADRIEN, Jacques [FR/FR]; 2, square Saint Florentin, F-78150 Le Chesnay (FR). REMI, Bertrand [FR/FR]; 41 bis, rue des Essarts, F-78490 Les Mesnuls (FR). (74) Mandataire: CABINET CLAUDE BOIVIN; 9, rue Edouard Charton, F-78000 Versailles (FR).	(81) Etats désignés: AU, BR, CA, KR, MX, PL, US, brevet européen (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE). Publiée <i>Avec rapport de recherche internationale.</i>	
(54) Title: HIGH-SPEED STEEL (54) Titre: ACIER A COUPE RAPIDE (57) Abstract <p>A steel produced by densified and agglomerated high-purity pre-alloyed powder metallurgy is disclosed. The steel comprises < 1 wt.% of manganese, < 1 wt.% of silicon, 4.50-6.45 wt.% of chromium, 4-6 wt.% of molybdenum, 6.10-6.50 wt.% of vanadium, 18.20-18.70 wt.% of tungsten, ≤0.020 of sulphur, ≤0.030 of phosphorus, ≤100 ppm of oxygen, 5-7 wt.% of cobalt, 0.050-0.080 wt.% of nitrogen, ≤0.020 of aluminium and 1.80-1.95 wt.% of carbon. The balance is iron plus the typical impurities arising during steel production. Said steel has a dispersion essentially consisting of carbides such as vanadium MC.</p> (57) Abrégé <p>La présente invention a pour objet un acier obtenu par la métallurgie d'une poudre pré-alliée de haute pureté, agglomérée, densifiée. Selon l'invention l'acier a la composition pondérale suivante: Manganèse < 1%, Silicium < 1%, Chrome 4,50-6,45 %, Molybdène 4-6 %, Vanadium 6,10-6,50 %, Tungstène 18,20-18,70 %, soufre ≤0,020 %, Phosphore ≤0,030 %, Oxygène ≤100 ppm, Cobalt 5-7 %, Azote 0,050-0,080 %, Aluminium 0,020 %, Carbone 1,80-1,95 %. Le complément étant du fer plus les impuretés caractéristiques de la pratique de la fabrication de l'acier, ledit acier ayant une dispersion essentiellement de carbures du type MC de Vanadium.</p>		

PATENT APPLICATION

'Steel for shaping tools'

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ABSTRACT TO THE DISCLOSURE

The present invention concerns a steel obtained via the metallurgy of a high purity pre-alloyed, agglomerated and densified powder.

10 According to the invention, the steel has the following weighted composition :

Manganese < 1%, silicon < 1%, chromium 4, 50-6, 45%, molybdenum 4-6%,
vanadium 6, 10-6, 50%, tungsten 18, 20-18, 70%, sulphur < 0.020%, phosphorus \leq
0.030%, oxygen \leq 100 ppm, cobalt 5-7%, nitrogen 0.050-0.080%, \leq aluminium 0.020%,
15 carbon 1.80-1.95%. As the complement is iron plus the impurities which are
characteristic of producing steel, said steel has for the most part a dispersion of
vanadium MC type carbides.

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Steel for shaping tools

5 As in the aviation, munitions and associated industries, materials are machined still having greater mechanical resistance, it is clear that it is essential to have an extremely hard fast cut steel which, via the metallurgy of the powders, possesses high toughness, thus offering extremely high level resistance of the positive cut edges.

The object of the present invention is to provide a fast cut steel produced initially
10 from the metallurgy of powders, this steel proving to be extremely hard with a scale « C » Rockwell hardness of between 68 and 70 Rc.

This steel, obtained from a pre-alloyed agglomerated powder, is characterised in that the alloy has the following composition :

15 Weighted value percentages :

	Preferred bracket	Wide bracket
Manganese	0.20-0.40	< 1%
Silicon	0.20-0.40	< 1%
Chromium	4.50-5	4.50-6, 45%
20 Molybdenum	4.50-5	4-6%
Vanadium	6.10 - 6.50	6.10 - 6.50
Tungsten	18.20 - 18.70	18.20 - 18.70
Sulphur	≤ 0.015%	≤ 0.020%
Phosphorus	≤ 0.020%	≤ 0.030%
25 Oxygen	≤ 100 ppm	≤ 100 ppm
Cobalt	5.40 - 6.20 %	5 - 7 %
Nitrogen	0.050 - 0.080 %	0.050 - 0.080 %
Aluminium	< 0.015 %	< 0.020 %
Carbon	1.83 - 1.90 %	1.80 - 1.95 %

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As the complement is iron plus the impurities characteristic of producing metal, said steel has a dispersion mainly composed of vanadium MC type carbides. The steel of the present invention possesses remarkable toughness, due mostly to a particular distribution of primary carbides associated with extremely good elevated temperature hardness. In addition to the hardness, elevated temperature hardness, resistance to wear and an exceptional toughness, the family of steels of the present invention can be particularly adapted to the shaping of tools : machinability, hardenability and wettability.

The carbon content limited to 1.95% is significant : beyond this value, the matrix would be rendered brittle. The low oxygen content, less than 100 ppm, prevents the oxygen from forming an oxide film on the surface which could create a large network of oxides in the steel following isostatic compaction. This oxygen content, combined with a nitrogen content of less than 800 ppm, guarantees 'super clean' products.

The stoichiometric relation for forming vanadium carbide (Cubic MC type with centered face) is 1% of vanadium for 0.020% of carbon. The carbon content of the steel is balanced with its contents of vanadium, chromium, molybdenum and tungsten to provide a sufficient amount of carbon and thus enable it to be heat-treated so as to obtain a hardness of 66Hrc.

According to the invention, the steel for shaping tools possesses a combination of different qualities : resistance to wear, elevated temperature hardness characterised by the Mathon cutting capacity test, a toughness not previously having been able to be obtained until now.

Toughness is determined via a measurement according to the Charpy test referred to in the standard ASTM-23-92 and 23-93. A 10x10x55mm reference test piece is treated at 1.160°C, stopped in oil or an isotherm stoppage at 560°C, followed by three annealings of one hour at 560°C. It then exhibits a toughness of more than 40 days/cm². The cutting capacity is characterised by the MATHON test (defined in the standard AFNOR A.03.654).



Claims

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1. Steel obtained via the metallurgy of powders and formed from a high-purity agglomerated densified pre-alloyed powder, characterised in that the steel has the following weighted composition :

10	Manganese	< 1%
	Silicon	< 1%
	Chromium	4.50 - 6.45%
	Molybdenum	4 - 6%
	Vanadium	6.10 - 6.50%
15	Tungsten	18.20 - 18.70%
	Sulphur	$\leq 0.020\%$
	Phosphorus	$\leq 0.030\%$
	Oxygen	≤ 100 ppm
	Cobalt	5 - 7%
20	Nitrogen	0.050 - 0.080%
	Aluminium	$\leq 0.020\%$
	Carbon	1.80 - 1.95%

As the complement is iron plus the impurities characteristic of producing steel,
25 said steel has a dispersion mainly composed of MC type vanadium carbides.

2. Steel according to claim 1, characterised in that the alloy has the following general composition :

	Manganese	0.20-0.40
30	Silicon	0.20-0.40



	Chromium	4.50-5 %
	Molybdenum	4.50-5 %
	Vanadium	6.10 - 6.50 %
	Tungsten	18.20 - 18.70 %
5	Sulphur	≤ 0.015%
	Phosphorus	≤ 0.020%
	Oxygen	≤ 100 ppm
	Cobalt	5.40 - 6.20 %
	Nitrogen	0.050 - 0.080 %
10	Aluminium	< 0.015 %
	Carbon	1.83 - 1.90 %

