



Europäisches Patentamt  
European Patent Office  
Office européen des brevets



(11) **EP 0 947 597 A3**

(12) **EUROPEAN PATENT APPLICATION**

(88) Date of publication A3:  
**31.01.2001 Bulletin 2001/05**

(51) Int. Cl.<sup>7</sup>: **C22C 38/02, C21D 8/12**

(43) Date of publication A2:  
**06.10.1999 Bulletin 1999/40**

(21) Application number: **99105071.7**

(22) Date of filing: **23.03.1999**

(84) Designated Contracting States:  
**AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU  
MC NL PT SE**  
Designated Extension States:  
**AL LT LV MK RO SI**

(30) Priority: **30.03.1998 JP 8400798**  
**28.10.1998 JP 30750798**

(71) Applicant:  
**NIPPON STEEL CORPORATION**  
**Chiyoda-ku Tokyo-to (JP)**

(72) Inventors:  
• **Kumano, Tomoji,**  
**c/o NIPPON STEEL CORP. YAWATA WORKS**  
**Kitakyushu City, Fukuoka (JP)**  
• **Fujii, Norikazu,**  
**c/o NIPPON STEEL CORP YAWATA WORK**  
**Kitakyushu City, Fukuoka (JP)**

• **Kuroki, Katsuro,**  
**c/o NITTETSU PLANT DESIGNING CORP**  
**Kitakyushu City, Fukuoka (JP)**  
• **Yamasaki, Koji,**  
**c/o NIPPON STEEL CORP. YAWATA WORKS**  
**Kitakyushu City, Fukuoka (JP)**  
• **Ohata, Yoshifumi,**  
**NIPPON STEEL CORP. YAWATA WORK**  
**Kitakyushu City, Fukuoka (JP)**  
• **Mogi, Hisashi,**  
**c/o NIPPON STEEL CORP. YAWATA WORKS**  
**Kitakyushu City, Fukuoka (JP)**

(74) Representative:  
**VOSSIUS & PARTNER**  
**Siebertstrasse 4**  
**81675 München (DE)**

(54) **Method of producing a grain-oriented electrical steel sheet excellent in magnetic characteristics**

(57) A method for producing a grain-oriented electrical steel sheet excellent in magnetic characteristics is provided wherein differentiated use of primary and secondary inhibitors enables production without high temperature slab heating, few glass film defects and no lack of uniformity in secondary recrystallization.

A slab containing 0.025 ~ 0.10% of C, 2.5 ~ 4.0% of Si as well as acid-soluble Al, Mn, Cu, N, and Seq = (S + 0.406 Se) of 0.008 ~ 0.05% is reheated to a temperature of more than 1050°C and lower than 1350°C and hot-rolled into a hot-rolled strip. The hot-rolled strip is optionally annealed, subjected to at least one cold rolling with intermediate annealing, whereafter the sheet is decarburization annealed to have primary recrystallization grains after completion of the decarburization annealing of an average diameter of not less than 7 µm and less than 18 µm, nitrided up to the start of secondary recrystallization, coated with an annealing separator composed mainly of MgO, and subjected to final finish annealing.

**EP 0 947 597 A3**



European Patent  
Office

# EUROPEAN SEARCH REPORT

Application Number  
EP 99 10 5071

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	EP 0 378 131 A (NIPPON STEEL CORP) 18 July 1990 (1990-07-18) * page 3, line 44 - line 52; example 1 * * page 4, line 56 - line 57; claims 1-3 * ---	1-4,7	C22C38/02 C21D8/12
A	EP 0 219 611 B (NIPPON STEEL CORP) 29 April 1987 (1987-04-29) * claims 1-6 *	1-11	
A	US 4 623 407 A (SUGA YOZO ET AL) 18 November 1986 (1986-11-18) * claim 1 *	1-11	
D,A	& JP 59 056522 A 2 April 1984 (1984-04-02) ---		
A	EP 0 339 474 A (NIPPON STEEL CORP) 2 November 1989 (1989-11-02) * claim 1 *	1-11	
D,A	& JP 05 112827 A 7 May 1993 (1993-05-07) ---		
A	EP 0 743 370 A (ARMCO INC) 20 November 1996 (1996-11-20) * claims 1-3 *	1,4	
D,A	& JP 91 189964 A ---		TECHNICAL FIELDS SEARCHED (Int.Cl.6)
A	DE 43 11 151 C (THYSSEN STAHL AG) 28 July 1994 (1994-07-28) * claim 1 *	1-11	C21D C22C
D,A	& JP 06 322443 A 22 November 1994 (1994-11-22) ---		
D,A	PATENT ABSTRACTS OF JAPAN vol. 014, no. 456 (C-0765), 2 October 1990 (1990-10-02) & JP 02 182866 A (NIPPON STEEL CORP), 17 July 1990 (1990-07-17) * abstract * -----		
The present search report has been drawn up for all claims			
Place of search <b>BERLIN</b>		Date of completion of the search <b>11 December 2000</b>	Examiner <b>Kesten, W</b>
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons ----- & : member of the same patent family, corresponding document	

EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT  
ON EUROPEAN PATENT APPLICATION NO.**

EP 99 10 5071

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on  
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

11-12-2000

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 0378131 A	18-07-1990	JP 2182866 A	17-07-1990
		JP 8032929 B	29-03-1996
		JP 1958527 C	10-08-1995
		JP 2267223 A	01-11-1990
		JP 6084524 B	26-10-1994
		DE 69030771 D	03-07-1997
		DE 69030771 T	11-09-1997
		US 5759293 A	02-06-1998
		US 5215603 A	01-06-1993
EP 0219611 B	29-04-1987	JP 1548902 C	09-03-1990
		JP 62040315 A	21-02-1987
		JP 62045285 B	25-09-1987
		AT 52811 T	15-06-1990
		AU 5984486 A	19-02-1987
		CA 1272430 A	07-08-1990
		DE 3671248 D	21-06-1990
		EP 0219611 A	29-04-1987
		ES 2001517 A	01-06-1988
		KR 9007447 B	10-10-1990
		US 4929286 A	29-05-1990
US 4623407 A	18-11-1986	JP 1390181 C	23-07-1987
		JP 59056522 A	02-04-1984
		JP 61060896 B	23-12-1986
		CA 1210670 A	02-09-1986
		DE 3334519 A	29-03-1984
		FR 2533586 A	30-03-1984
		GB 2130241 A,B	31-05-1984
		IT 1167387 B	13-05-1987
		KR 8900882 B	12-04-1989
		SE 460482 B	16-10-1989
		SE 8305095 A	25-03-1984
EP 0339474 A	02-11-1989	JP 1990788 C	08-11-1995
		JP 5112827 A	07-05-1993
		JP 7017961 B	01-03-1995
		CA 1320108 A	13-07-1993
		DE 68908943 D	14-10-1993
		DE 68908943 T	05-01-1994
		KR 9301332 B	26-02-1993
		US 4979996 A	25-12-1990
		JP 2077525 A	16-03-1990
EP 0743370 A	20-11-1996	US 5643370 A	01-07-1997
		BR 9602240 A	13-01-1998

EPO FORM P0459

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

**ANNEX TO THE EUROPEAN SEARCH REPORT  
ON EUROPEAN PATENT APPLICATION NO.**

EP 99 10 5071

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.  
The members are as contained in the European Patent Office EDP file on  
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

11-12-2000

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 0743370 A		JP 9118964 A	06-05-1997
		US 5779819 A	14-07-1998
-----			
DE 4311151 C	28-07-1994	AT 169346 T	15-08-1998
		AU 673720 B	21-11-1996
		AU 5924394 A	27-10-1994
		BR 9401398 A	18-10-1994
		CA 2120438 A	06-10-1994
		CN 1098440 A,B	08-02-1995
		CZ 9400671 A	15-12-1994
		DE 59406591 D	10-09-1998
		EP 0619376 A	12-10-1994
		ES 2121590 T	01-12-1998
		HU 70224 A,B	28-09-1995
		JP 2728112 B	18-03-1998
		JP 6322443 A	22-11-1994
		KR 247598 B	01-04-2000
		PL 173284 B	27-02-1998
		RO 114637 B	30-06-1999
		RU 2126452 C	20-02-1999
		SK 38894 A	09-11-1994
		US 5711825 A	27-01-1998
		US 5759294 A	02-06-1998
-----			
JP 02182866 A	17-07-1990	JP 8032929 B	29-03-1996
		DE 69030771 D	03-07-1997
		DE 69030771 T	11-09-1997
		EP 0378131 A	18-07-1990
-----			