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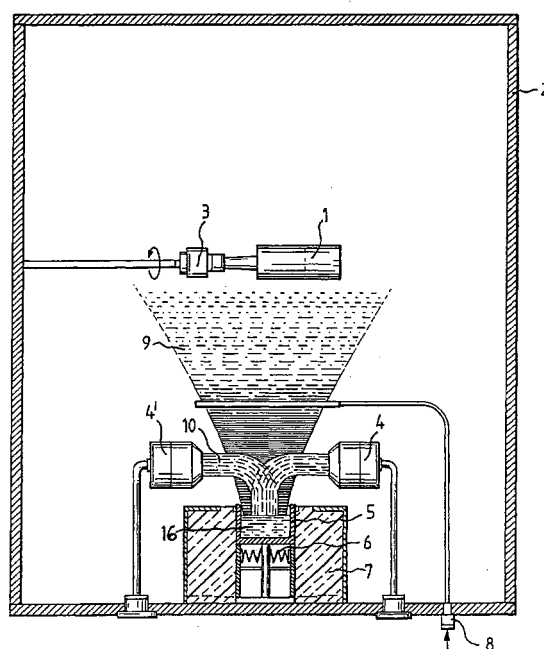
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(54) **Method of manufacturing a high Mn non-magnetic steel sheet for cryogenic temperature use**

(57) A method of manufacturing a high Mn non-magnetic steel sheet having low permeability at a cryogenic temperature suitable for use in large scale particle accelerators, the method comprises rolling a steel material containing, on the wt% basis, from 0.05 to 0.18% of C, from 26.0 to 30.0% of Mn, from 5.0 to 10.0% of Cr, 0.05 to 0.15% of N and, optionally, from 0.50 to 5.0% of Ni, in which a rolling start temperature is from 1050 to 1200°C and a rolling end temperature is from 700 to 1000°C. Further, a cold rolled sheet is annealed at an annealing temperature for cold rolled sheet of from 1050 to 1200°C and cooled after annealing, the annealed sheet being preferably applied with temper rolling under control for the strength by varying a draft ratio.

**FIG.1**





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| 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.7)            |
| X                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | WO 97 03215 A (ULLAKKO KARI MARTTI ;GAVRILJUK VALENTIN (UA); YAKOVENKO PETER (UA)) 30 January 1997 (1997-01-30)                                                       | 1,2                                                 | C21D8/02<br>C22C38/38                                   |
| A                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | * claims 1-14 *                                                                                                                                                       | 3-5                                                 |                                                         |
| X                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | PATENT ABSTRACTS OF JAPAN<br>vol. 018, no. 377 (C-1225),<br>15 July 1994 (1994-07-15)<br>-& JP 06 100941 A (KAWASAKI STEEL CORP),<br>12 April 1994 (1994-04-12)       | 1,2                                                 |                                                         |
| A                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | * abstract *                                                                                                                                                          | 3-5                                                 |                                                         |
| X                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | PATENT ABSTRACTS OF JAPAN<br>vol. 010, no. 067 (C-333),<br>15 March 1986 (1986-03-15)<br>-& JP 60 204864 A (SANYOU TOKUSHIYU SEIKOU KK), 16 October 1985 (1985-10-16) | 1,2                                                 |                                                         |
| A                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | * abstract *                                                                                                                                                          | 3-5                                                 |                                                         |
| A                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | US 4 875 933 A (WAN CHI-MEEN)<br>24 October 1989 (1989-10-24)<br>* claims 1-12 *<br>* column 2, line 24 - column 5, line 60 *                                         | 1-5                                                 | TECHNICAL FIELDS<br>SEARCHED (Int.Cl.7)<br>C21D<br>C22C |
| A                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | US 5 431 753 A (CHANG RAE W ET AL)<br>11 July 1995 (1995-07-11)<br>* claims 1-3 *<br>* examples 1-7 *                                                                 | 1-5                                                 |                                                         |
| A                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | EP 0 174 418 A (WESTINGHOUSE ELECTRIC CORP) 19 March 1986 (1986-03-19)<br>* claims 1-7 *<br>* table I *                                                               | 1-5                                                 |                                                         |
| The present search report has been drawn up for all claims                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                       |                                                     |                                                         |
| Place of search<br>THE HAGUE                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                       | Date of completion of the search<br>8 December 2003 | Examiner<br>Vlassi, E                                   |
| <p>CATEGORY OF CITED DOCUMENTS</p> <p>X : particularly relevant if taken alone<br/>Y : particularly relevant if combined with another document of the same category<br/>A : technological background<br/>O : non-written disclosure<br/>P : intermediate document</p> <p>T : theory or principle underlying the invention<br/>E : earlier patent document, but published on, or after the filing date<br/>D : document cited in the application<br/>L : document cited for other reasons<br/>&amp; : member of the same patent family, corresponding document</p> |                                                                                                                                                                       |                                                     |                                                         |

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| 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.7) |
| A                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | PATENT ABSTRACTS OF JAPAN<br>vol. 1997, no. 06,<br>30 June 1997 (1997-06-30)<br>-& JP 09 041087 A (KOBE STEEL LTD),<br>10 February 1997 (1997-02-10)<br>* abstract *                     | 1-5                                                        |                                              |
| A                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | ---<br>PATENT ABSTRACTS OF JAPAN<br>vol. 018, no. 296 (C-1209),<br>6 June 1994 (1994-06-06)<br>-& JP 06 057379 A (NIPPON STEEL CORP),<br>1 March 1994 (1994-03-01)<br>* abstract *       | 1-5                                                        |                                              |
| A                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | ---<br>PATENT ABSTRACTS OF JAPAN<br>vol. 018, no. 271 (C-1203),<br>24 May 1994 (1994-05-24)<br>-& JP 06 041685 A (KAWASAKI STEEL CORP),<br>15 February 1994 (1994-02-15)<br>* abstract * | 1-5                                                        |                                              |
| A                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | ---<br>PATENT ABSTRACTS OF JAPAN<br>vol. 1995, no. 06,<br>31 July 1995 (1995-07-31)<br>-& JP 07 062432 A (KOBE STEEL LTD;OTHERS:<br>01), 7 March 1995 (1995-03-07)<br>* abstract *       | 1-5                                                        |                                              |
| The present search report has been drawn up for all claims                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                          |                                                            | TECHNICAL FIELDS<br>SEARCHED (Int.Cl.7)      |
| Place of search<br><b>THE HAGUE</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                          | Date of completion of the search<br><b>8 December 2003</b> | Examiner<br><b>Vlassi, E</b>                 |
| <p>CATEGORY OF CITED DOCUMENTS</p> <p>X : particularly relevant if taken alone<br/>Y : particularly relevant if combined with another document of the same category<br/>A : technological background<br/>O : non-written disclosure<br/>P : intermediate document</p> <p>T : theory or principle underlying the invention<br/>E : earlier patent document, but published on, or after the filing date<br/>D : document cited in the application<br/>L : document cited for other reasons<br/>&amp; : member of the same patent family, corresponding document</p> |                                                                                                                                                                                          |                                                            |                                              |

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

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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  
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08-12-2003

| Patent document<br>cited in search report |   | Publication<br>date | Patent family<br>member(s) | Publication<br>date |
|-------------------------------------------|---|---------------------|----------------------------|---------------------|
| WO 9703215                                | A | 30-01-1997          | FI 960866 A                | 12-01-1997          |
|                                           |   |                     | AU 6361396 A               | 10-02-1997          |
|                                           |   |                     | CA 2225679 A1              | 30-01-1997          |
|                                           |   |                     | EP 0846189 A1              | 10-06-1998          |
|                                           |   |                     | WO 9703215 A1              | 30-01-1997          |
|                                           |   |                     | JP 2000501778 T            | 15-02-2000          |
|                                           |   |                     | RU 2169786 C2              | 27-06-2001          |
| -----                                     |   |                     |                            |                     |
| JP 06100941                               | A | 12-04-1994          | NONE                       |                     |
| -----                                     |   |                     |                            |                     |
| JP 60204864                               | A | 16-10-1985          | NONE                       |                     |
| -----                                     |   |                     |                            |                     |
| US 4875933                                | A | 24-10-1989          | AT 114736 T                | 15-12-1994          |
|                                           |   |                     | AT 114737 T                | 15-12-1994          |
|                                           |   |                     | AU 610429 B2               | 16-05-1991          |
|                                           |   |                     | AU 3981589 A               | 05-02-1990          |
|                                           |   |                     | AU 619336 B2               | 23-01-1992          |
|                                           |   |                     | AU 4033789 A               | 05-02-1990          |
|                                           |   |                     | CA 1336364 C               | 25-07-1995          |
|                                           |   |                     | CA 1336550 C               | 08-08-1995          |
|                                           |   |                     | DE 68919672 D1             | 12-01-1995          |
|                                           |   |                     | DE 68919693 D1             | 12-01-1995          |
|                                           |   |                     | EP 0380630 A1              | 08-08-1990          |
|                                           |   |                     | EP 0411061 A1              | 06-02-1991          |
|                                           |   |                     | JP 3500305 T               | 24-01-1991          |
|                                           |   |                     | JP 3500306 T               | 24-01-1991          |
|                                           |   |                     | WO 9000629 A1              | 25-01-1990          |
|                                           |   |                     | WO 9000630 A1              | 25-01-1990          |
|                                           |   |                     | US 4975335 A               | 04-12-1990          |
|                                           |   |                     | US 4966636 A               | 30-10-1990          |
| -----                                     |   |                     |                            |                     |
| US 5431753                                | A | 11-07-1995          | KR 9408945 B1              | 28-09-1994          |
|                                           |   |                     | KR 9407374 B1              | 16-08-1994          |
|                                           |   |                     | BR 9205689 A               | 24-05-1994          |
|                                           |   |                     | CA 2100656 A1              | 01-07-1993          |
|                                           |   |                     | CN 1079513 A ,B            | 15-12-1993          |
|                                           |   |                     | DE 69226946 D1             | 15-10-1998          |
|                                           |   |                     | DE 69226946 T2             | 12-05-1999          |
|                                           |   |                     | EP 0573641 A1              | 15-12-1993          |
|                                           |   |                     | ES 2121985 T3              | 16-12-1998          |
|                                           |   |                     | JP 2807566 B2              | 08-10-1998          |
|                                           |   |                     | JP 6505535 T               | 23-06-1994          |
|                                           |   |                     | WO 9313233 A1              | 08-07-1993          |
|                                           |   |                     | MX 9207639 A1              | 01-07-1993          |
|                                           |   |                     | RU 2074900 C1              | 10-03-1997          |
|                                           |   |                     | SE 512626 C2               | 10-04-2000          |

EPO FORM P459

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 00 10 1428

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.

08-12-2003

| Patent document<br>cited in search report | Publication<br>date | Patent family<br>member(s) | Publication<br>date |
|-------------------------------------------|---------------------|----------------------------|---------------------|
| US 5431753 A                              |                     | SE 9302258 A               | 25-01-1994          |
| EP 0174418 A                              | 19-03-1986          | CA 1245474 A1              | 29-11-1988          |
|                                           |                     | DE 3577882 D1              | 28-06-1990          |
|                                           |                     | EP 0174418 A2              | 19-03-1986          |
|                                           |                     | JP 61009560 A              | 17-01-1986          |
|                                           |                     | US H326 H                  | 01-09-1987          |
| JP 09041087 A                             | 10-02-1997          | JP 2978427 B2              | 15-11-1999          |
| JP 06057379 A                             | 01-03-1994          | NONE                       |                     |
| JP 06041685 A                             | 15-02-1994          | NONE                       |                     |
| JP 07062432 A                             | 07-03-1995          | NONE                       |                     |