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(71) Applicant *(for all designated States except US)*: **AVESTA SHEFFIELD AKTIEBOLAG (publ)** [SE/SE]; Box 16377, S-103 27 Stockholm (SE).

(72) Inventor; and

(75) Inventor/Applicant *(for US only)*: **ROBINSON, Philip, S.** [GB/GB]; 31 Bannerdale Road, Sheffield S7 2DJ (GB).

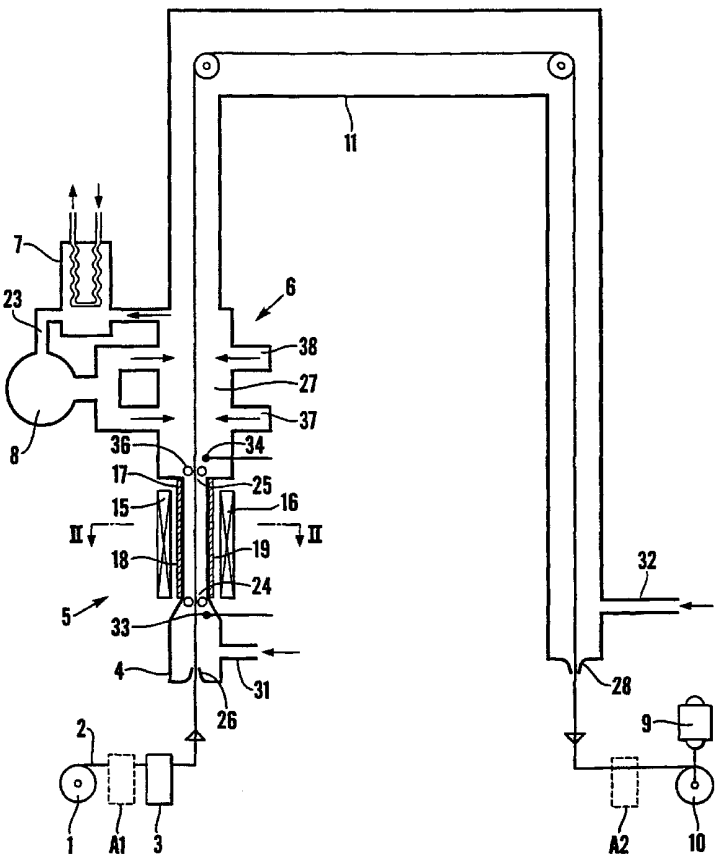
(74) Agents: **HYNELL, Magnus** et al.; Hynell Patenttjänst AB, Patron Carls väg 2, S-683 40 Hagfors/Uddeholm (SE).

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[Continued on next page]

(54) Title: A METHOD OF HEATING METAL STRIP AND APPARATUS THEREFOR



(57) Abstract: The invention concerns heating metal strips or other coilable strand metal object to an elevated temperature, wherein the metal object is passed in a heating section (5) through a furnace chamber (17) that is made at least partly of an insulating and electrically non-conductive material while being heated through transverse flux induction heating (TFIH) by means of transverse flux induction heating elements (15, 16) located outside of said chamber which contains a protective non-oxidising gas or gas mixture. The invention is characterised in that the metal object is a stainless steel object that has been cold rolled to a very high degree of surface reflectively, that the cold rolled stainless steel object is passed through said furnace chamber and is heated in said chamber to a processing temperature between 700 and 1200 °C, that the cold rolled stainless steel object is maintained at said temperature between 700 and 1200 °C for long enough for the steel to recrystallize completely, and that the heat treated metal object then is rapidly cooled directly from the processing temperature, in an airtight cooling section (6, 27) through which the non-oxidising gas is passed, to below a temperature of 600 °C.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 00/00389

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: C21D 8/02, F27B 9/04, C21D 9/60, H05B 6/02
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: F27B, C21D, H05B, B21B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPI

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	GB 2155740 A (DAVY MCKEE (POOLE) LIMITED (UNITED KINGDOM)), 25 Sept 1985 (25.09.85)	1-6,8
A	page 1, line 77 - line 79; page 1, line 125 - page 2, line 3, figures 1-2	9-16
X		21-22
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Y	WPI/Derwent's abstract, No 1995-077403, week 199511 ABSTRACT OF JP, 7001003 (KAWASAKI STEEL CORP	1-6,8
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A	DE 2430561 A1 (KLÖCKNER-WERKE AG), 15 January 1976 (15.01.76), claims 1-2	1-8
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[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" erlier document but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
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"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
22 Sept 2000	25 -09- 2000
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Mårten Hulthén/MP Telephone No. +46 8 782 25 00

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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4830686 A (KOICHI HASHIGUCHI ET AL), 16 May 1989 (16.05.89), claim 1	1-8
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A	US 5472528 A (MICHEL BOYER), 5 December 1995 (05.12.95), figures 2-3	1-8
A	column 3, line 49 - line 60, abstract	21-22,23-27
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A	US 3711342 A (ORVILLE E. CULLEN ET AL), 16 January 1973 (16.01.73), claim 1	1-8
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A	EP 0822733 A1 (SELAS SA), 4 February 1998 (04.02.98), column 1, line 30 - line 36; column 4, line 6 - line 11; column 5, line 50 - line 54, figures 2-3	9-16
Y		23-27
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X	WO 9626296 A1 (DAVY MC-KEE (POOLE) LIMITED), 29 August 1996 (29.08.96), page 1 last paragraph - page 2, line 3; page 4 last paragraph; figures 1-3; abstract	17-20
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A	US 5403994 A (GEORGE HAVAS ET AL), 4 April 1995 (04.04.95), abstract	17-20
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INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 00/00389

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	US 1749700 A (MARCEL FOURMENT), 4 March 1930 (04.03.30), column 2, line 54 - line 60, figure 1 --	21-22
A	US 4106757 A (GEORGE JACKSON), 15 August 1978 (15.08.78), column 3, line 16 - line 35, figure 1 --	21-22
Y	JP 61257430 A (NISSHIN STEEL CO LTD) 1986-11-14 (abstract) World Patents Index (online). London U.K.: Derwent Publications, Ltd (retrieved on 2000-09-22). Retrieved from: EPO WPI Database DW 198652; Accession No. 1986-343241 & JP 61257430 A (NISSHIN STEEL CO LTD) 1987-04-10 (abstract) (online) (retrieved on 2000-09-22). Retrieved from: EPO PAJ Database. --	23-27
A	JP 10298668 A (SUMITOMO HEAVY IND LTD) 1998-11-10 (abstract) World Patents Index (online). London, U.K.: Derwent Publications, Ltd. (retrieved on 2000-09-22) Retrieved from: EPO WPI Database. DW 199904; Accession No. 1999-041098 & JP 10298668 A (SUMITOMO HEAVY IND LTD) 1999-02-26 (abstract) (online) (retrieved on 2000-09-22). Retrieved from: EPO PAJ Database. Figure 1 -- --------	23-27

INTERNATIONAL SEARCH REPORT

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Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).:

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

See extra sheet.

1. ☒ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☒ The additional search fees were accompanied by the applicant's protest.

☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

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This application contains the following inventions, which are not so linked as to form a single inventive concept under PCT Rule 13.1:

I. Claims 1-8 relate to a method of heating metal strips.
II. Claims 9-16 relate to an apparatus for heating a metal strip.
III. Claims 17-20 relate to a process line forming an integrated furnace for heating a metal strip.
IV. Claims 21-22 relate to another process line forming an integrated furnace for heating a metal strip.
V. Claims 23-27 relate to a process line for heating a metal strip.

The inventions listed as groups I , II, III , IV and V do not relate to a single inventive concept under PCT Rule 13.1, because, under PCT Rule 13.2, they lack the same or corresponding technical features for the following reasons:

The special technical features in the method of group I are heating, recrystallisation and rapid cooling of a stainless steel object, cold rolled to a high degree of surface reflectivity.

The special technical features of group II are that hydrogen is used as a protective gas in the heating chamber and that the heating chamber and the induction heating elements are inclosed in a gas tight enclosure which contains a non-explosive gas capable of acting as safety shroud.

The special technical features of group III are a sensor for registering the lateral position of the strip edges in relation to the induction elements and/or shading plates, a control unit and a motion means which serve to move the induction elements and/or the shading plates.

The special technical features of group IV are inlet gas conduits connected to the entrance section and to the exit section of the integrated furnace respectively for replenishing losses of the protective gas.

The special technical feature of group V is that the furnace chamber and the cooling chamber form part of a vertical section in which the strip is conveyed.

INTERNATIONAL SEARCH REPORT

Information on patent family members

01/08/00

International application No.
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INTERNATIONAL SEARCH REPORT

Information on patent family members

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