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PROPRIETE INDUSTRIELLE

RAPPORT DE RECHERCHE PRELIMINAIRE

établi sur la base des dernières revendications déposées avant le commencement de la recherche

2787735

N° d'enregistrement national

FA 566530
FR 9816477

DOCUMENTS CONSIDERES COMME PERTINENTS		Revendications concernées de la demande examinée
Catégorie	Citation du document avec indication, en cas de besoin, des parties pertinentes	
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A	* page 1, colonne 1, alinéa 1 - colonne 2, alinéa 1 * * page 1, colonne 2, alinéa 7 - page 2, colonne 1, alinéa 10 * * page 2, colonne 2, alinéa 9 - page 3, colonne 2, alinéa 4 * * page 3, colonne 2, alinéa 10 * * revendications A.1-A.4,B; figure *	1,3-7
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DOMAINES TECHNIQUES RECHERCHES (Int.Cl.6)
C23C B21D

1

Date d'achèvement de la recherche	Examinateur
8 septembre 1999	Ceulemans, J

CATEGORIE DES DOCUMENTS CITES

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ArcelorMittal Ex. 2001
Posco Co. LTD. v. ArcelorMittal
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DOCUMENTS CONSIDERES COMME PERTINENTS

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DOMAINES TECHNIQUES RECHERCHES (Int.Cl.6)

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Electronic Acknowledgement Receipt

EFS ID:	36193929
Application Number:	16413799
International Application Number:	
Confirmation Number:	7637
Title of Invention:	Coated Steel Strips, Coated Stamped Products and Methods
First Named Inventor/Applicant Name:	Pascal DRILLET
Customer Number:	23280
Filer:	William C. Gehris/Simon Steiner
Filer Authorized By:	William C. Gehris
Attorney Docket Number:	11020631.1028con5
Receipt Date:	04-JUN-2019
Filing Date:	16-MAY-2019
Time Stamp:	17:32:04
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Foreign Reference	EP3290199A1.pdf	2490921 ab1a6a92b372ba57d09b2d49d36bb98adc23f643	no	22

Warnings:

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3	Foreign Reference	WO2006097593A1.pdf	1224134 4bb137ffc6fb432bcbe02074490f0d6001eb7bf2	no	20
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4	Foreign Reference	DE102004007071A1.pdf	431568 185410ff839a349f2e5708b7f92cefa6e69e6b9e	no	8
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19	Foreign Reference	JP2006529002A.pdf	684054 135da50f00f8a6317b2a15a0822503c39594f3fd	no	18
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32	Non Patent Literature	3D12ForschungsvereinigungStahlanwendungeneVFFPARTI.pdf	24797449 beab41e0d8aaa601f4640a450fdaeca370d94ac4	no	75
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42	Non Patent Literature	12D40MerkleinMCharacterisationoftheFlowPropertiesoftheQuenchenableUltraHighStrengthSteel22MnB5.pdf	1043460 31fea61b50cf37ca1994a34954165762fd86 077d	no	4
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47	Non Patent Literature	17D33SuehiroMasayoshietalPropertiesofAluminiumcoatedSteelsforHotforming.pdf	1468256 29252daa99b749cd6ca361c07cd2ad95029d96dc	no	6
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50	Non Patent Literature	20D52GehringhoffNeuesteTrendsundEntwicklungeninderWarmumformungausTagungsband.pdf	3773446 542a9484914cc67b02398b6bc206f0c49195edd7	no	11
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51	Non Patent Literature	21D54GrotheDubbelTaschenbuchfuerdenMaschinenbau.pdf	2634846 f64228ad36072b177966e0b9cf701dbd0c17885c	no	18
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52	Non Patent Literature	22D55PalandTechnischesTaschenbuch7veraenderterNachdruck.pdf	1177587 fe5d3f1c05c12c0999e9153cf865d6467e4fd20a	no	8
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53	Non Patent Literature	23D9HeinPetalNeuereEntwicklungeninderBlechumformungunbekannt09Mai2006.pdf	10900407 1b177f82114e519c7de0b64e68c5789c93818cb6	no	51
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54	Non Patent Literature	24D31CornetteetalHighStrengthSteelsforAutomotiveSafetyParts.pdf	2016742 08052b82b0a81a871cd03eee38ffe293690b0e40	no	13
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55	Non Patent Literature	25D53TechnLieferspecification.pdf	3494826 524ab227b25ea586d935716d4c7c878f52a145f5	no	22
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57	Non Patent Literature	27D13ProcesverbaaAginBoederonsampletakingoftheVolkswagenPassatSMALL.pdf	13448708 3da041c20c582095be96aff9c7d598c0a812e193	no	45
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59	Non Patent Literature	29D17PrelOpinionofBoardonEP2242863B1.pdf	304680 f472c429074f6fe58776fbf9b7ebb37d9d2bffcf	no	10
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60	Non Patent Literature	30D18bDecisionoftheDistrictCourtTheHagueonEP2242863B1translated.pdf	8757112 807a5cf8fea9870a3bf496266351f0e272d7c641	no	56
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PTO/SB/08a (03-15)
Approved for use through 07/31/2016. OMB 0651-0031
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	16413799
Filing Date	2016-05-16
First Named Inventor	Drillet
Art Unit	
Examiner Name	
Attorney Docket Number	20631.1028CON5

U.S.PATENTS Remove

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
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	2	7559998	B2	2009-07-14	Nishibata et al.	
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	Application Number	16413799
	Filing Date	2016-05-16
	First Named Inventor	Drillet
	Art Unit	
	Examiner Name	
	Attorney Docket Number	20631.1028CON5

	9	7503116		2009-03-17	Machrowicz et al.	
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Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
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ArcelorMittal Ex. 2001
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	First Named Inventor	Drillet
	Art Unit	
	Examiner Name	
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	4	20110056594	A1	2011-03-10	Macherey et al.	
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Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
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Posco Co. LTD. v. ArcelorMittal
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	Examiner Name	
	Attorney Docket Number	20631.1028CON5

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	Attorney Docket Number	20631.1028CON5

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Application Number:	16413799
International Application Number:	
Confirmation Number:	7637
Title of Invention:	Coated Steel Strips, Coated Stamped Products and Methods
First Named Inventor/Applicant Name:	Pascal DRILLET
Customer Number:	23280
Filer:	William C. Gehris/Simon Steiner
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	Application Number	16413799
	Filing Date	2019-05-16
	First Named Inventor	Drillet
	Art Unit	
	Examiner Name	
	Attorney Docket Number	20631.1028CON5

	1	"Hot-Dip Aluminised Sheet Metal fal AS," Production information re. fire-aluminized sheet metal, August 2007, published by ThyssenKrupp Steel, see English translation	
	2	Naderi et al., "Hot stamping of ultra high strength steels", November 2, 2007	
	3	Self-study programme 339 - Volkswagen Passat, March 2005	
	4	Wikipedia Article on VW Passat, downloaded at https://fr.wikipedia.org/wiki/Volkswagen_Passat, last accessed on August 11, 2016 see machine translation	
	5	Declaration by Th. A. Kop: "On the physicis of heating a blank for hot forming," August 15, 2016	
	6	Declaration by Dr Grigorieva dated 17/10/2016 and curriculum vitae	
	7	Declaration by Dr Grigorieva dated 28/09/2016	
	8	Decision of the District Court of The Hague denying the request for stay and translation dated May 18, 2016, case number C/09/509050-HA ZA 16-435	
	9	Bourouga: "Report on the heating of coated steel blanks for hot stamping by Pr Bourouga," July 31, 2018	
	10	Exerpt of "Harmonized Tariff Schedule of the United States (2003) – Supplement 1", chapter 99, 2003	
	11	Arun M. Gokhale:"Quantitative Characterization and Representation of Global Microstructural Geometry," ASM Handboo, Volume 9: Metallography and Microstructures, G.F. Vander Voort, editor, p428-447	

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	12	Chawla et al:"Microstructure and mechanical behavior of porous sintered steels," Materials Science and Engineering A 390 (2005) 98–112,	
	13	Volkswagen Aktiengesellschaft, "Fahrzeugdaten" including opinion of Ingineurbuero fuer KfZ-Technik GmbH Nr. 18BS-00988JP, observations of notary and partial translation, August 2018 see partial English translation	
	14	D4A-"Evaluation of the porosity of the coating in a reference range of Fig. 1 of D4 [WO2008/053273]" see English translation	
	15	Wilsius et al.:"Status and future trends of hot stamping USIBOR 1500P," Tagungsband zum ersten Erlanger Workshop Warmblechumformung 2006	
	16	D4B-"Evaluation of the porosity of the coating in a reference range of Fig. 1 of D4 [WO2008/053273]" see English translation	
	17	Merklein et al.:"Investigation of the thermo-mechanical properties of hot stamping steels," Journal of Materials Processing Technology, Vol. 177, issues 1-3, July 2006, pages 452-455	
	18	Claim Chart comparing claims of EP2242863B1	
	19	Hein, "Press-hardening of Usibor 1500 P : simulation-based component and process analysis", 18 pages, 9./10. May 2006, and translation thereof, 13 pages	
	20	NEN - EN 10326 standard, July 2004, 25 pages	
	21	Zhao:"Analysis and Application of Axle Housing Hot Stamping Process", Forging Machinery, published in March, 2002, including English translation, 8 pages	
	22	Zhiyao Tan:"Basic Study on Hot Stamping of Ultrahigh-strength Steel", Dissertation for Degree of Master of Tongji University, July 2006, including partial translation, 41 pages	

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IPR2024-01376

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	Attorney Docket Number	20631.1028CON5

	23	A technical specification by Ford (1992).
	24	Aruna Bahadur et al., "Structural Studies of Hot Dip Aluminized Coatings on Mild Steel," Materials Transactions, JIM, Vol. 32, No. 11 (1991), pp. 1053-1061.
	25	X. Bano, et al., "Heat Treated Boron Steels in the Automobile Industry," 39"' MWSP Conf. Proc., ISS, Vol. XXXV, 1998.

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Name/Print	Jennifer L. O'Connell	Registration Number	57392

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EFS ID:	36194177
Application Number:	16413799
International Application Number:	
Confirmation Number:	7637
Title of Invention:	Coated Steel Strips, Coated Stamped Products and Methods
First Named Inventor/Applicant Name:	Pascal DRILLET
Customer Number:	23280
Filer:	William C. Gehris/Simon Steiner
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Attorney Docket Number:	11020631.1028con5
Receipt Date:	04-JUN-2019
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	3	1013785	FR	B1	2006-10-25	Laurent	See English translation	
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	1	Mahesh C. Somani, et al., "Dimensional Changes and Microstructural Evolution in a B-bearing Steel in the Simulated Forming and Quenching Process," ISIJ International, 2001, Volume 41, Issue 4, Pages 361-367 ("Somani")	
	2	Declaration of Mel Desart, dated April 16, 2019, relating to attached "High Strength Steels for Automotive Safety Parts," SAE Technical Paper 2001-01-0078. 2001, by Cornette, D., Hourman, T., Hudin, O., Laurent, J., and Reynaert, A."	
	3	Declaration Dr. Michael Miles, dated June 28, 2019 as filed in IPR2019-01275, US Patent No. 9,708,683	
	4	Declaration of Mel Desart, dated May 30, 2019, relating to attached "High Strength Steels for Automotive Safety Parts," SAE 2001 Transactions Journal of Materials & Manufacturing-V110-5, by Corneae, D., Hourman, T., Hudin, 0., Laurent, J., and Reynaert, A."	
	5	Declaration of Dr. Michael L. Knott dated April 22, 2019 realting to attached Somani (Mahesh C. Somani, et al., 'Dimensional Changes and Microstructural Evolution in a B-bearing Steel in the Simulated Forming and Quenching Process," ISIJ International, 2001, Volume 41, Issue 4, Pages 361-367 ("Somani")) from University of Michigan's Art, Architecture, and Engineering Library's Technical Services Department	
	6	Publication History from SAE Mobilus, dated May 30, 2019 for Cornette et al., "High Strength Steels for Automotive Safety Parts" SAE Technical Paper Series 2001-01-0078, March 24 001, ISSN: 0148-7191	
	7	Fekete, J., Stibich, A., and Shi, M., "A Comparison of the Response of HSLA and Dual Phase Sheet Steel in Dynamic Crush," SAE Technical Paper 2001-01-3101, 2001	

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	8	Robert R. Mayer, "Theoretical Effects of Hydroforming on Crashworthiness of Straight Sections," ASME International Mechanical Engineering Congress and Exposition, Applied Mechanics (2004):591-603
	9	Publication History from ISIJ International for "Mahesh C. Somani, et al., "Dimensional Changes and Microstructural Evolution in a B-bearing Steel in the Simulated Forming and Quenching Process," ISIJ International, 2001, Volume 41, Issue 4, Pages 361-367 ("Somani")"
	10	Webster's New Twentieth Century Dictionary (2nd ed. 1964), published by The World Publishing Company
	11	Random House Webster's Unabridged Dictionary (2nd ed. 1998), Random House New York
	12	ASM Materials Engineering Dictionary, ASM INternational, The Materials Information Society, 1992
	13	Dictionary of Materials and Manufacturing, Nichols Publishing: New York, 1990
	14	McGraw-Hill Dictionary of Scientific and Technical Terms, Sixth Edition, 2003
	15	Certified Translation of "alliation" and "alliage"
	16	Ahindra Ghosh, "Secondary Steelmaking, Principles and Applications" (2001), CRC Press
	17	Åkerström, P. et al., "Material parameter estimation for boron steel from simultaneous cooling and compression experiments," Modelling and Simulation in Materials Science and Engineering. 2005, Vol.13, No.8, p.1291
	18	ASTM Dictionaly of Engineering Science & Technology, ASTM International 2005

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	19	Chambers Dictionary of Science and Technology, Tenth edition, 1999	
	20	Webster's Third New International Dictionary of the English Language Unabridged, 2003	
	21	Engels, H. et al., "Controlling and Monitoring of the Hot-Stamping Process of Boron-Alloyed Heat-Treated Steels." – p. 135-50 ("Engels"), published in Liewald, M. (Ed.). "New developments in sheet metal forming": Frankfurt a.M.: MATINFO, Werkstoff-Informationsges (2006)	
	22	Declaration of Marcel Thoms of University of Stuttgart dated June 7, 2019 relating to attached "Engels, H. et al., 'Controlling and Monitoring of the Hot-Stamping Process of Boron-Alloyed Heat-Treated Steels." – p. 135-50 ("Engels"), published in Liewald, M. (Ed.). "New developments in sheet metal forming": Frankfurt a.M.: MATINFO, Werkstoff-Informationsges (2006)"	
	23	Certified translation of "Stahl"	
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CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

See attached certification statement.

The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Jennifer L. O'Connell/	Date (YYYY-MM-DD)	2019-07-08
Name/Print	Jennifer L. O'Connell	Registration Number	57392

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

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IPR2024-01376

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application of:	ARCELORMITTAL
Inventor(s):	Drillet et al.
Application No.:	16/412,799
Filed:	May 16, 2019
Examiner:	TBD
Attorney Docket No.:	20631.1028CON5
Confirmation No.:	7637
Title:	Coated Steel Strips, Coated Stamped Products and Methods

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

July 8, 2019

SUPPLEMENTAL INFORMATION DISCLOSURE STATEMENT UNDER 37 C.F.R. § 1.56

Sir:

In accordance with the provisions of 37 C.F.R. § 1.97, Applicants hereby make of record the documents listed on the accompanying Form PTO/SB/08a for consideration by the Examiner in connection with the examination of the above-identified patent application. While the references are being submitted herewith, some or all of the references may not constitute prior art under the U.S. patent laws.

Applicants also respectfully advise the Examiner that some or all of the references were cited on June 28, 2019 in a Petition for *Inter Partes Review* (IPR2019-01275) of U.S. Patent No. 9,708,683, which issued from U.S. Application No. 13/621,015, filed September 15, 2012 and is a parent of the present application.

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Applicants also respectfully advise the Examiner of the Opposition Proceedings in European counterpart patent application 06 842 403.5, filed on October 30, 2006, which issued on November 29, 2017 as EP2086755 B1

This Information Disclosure Statement is filed before the mailing date of the First Office Action, thus no fee is believed to be due.

In the event any fee is due or an overpayment is made in connection with this submission, the Commissioner is hereby authorized to charge said deficiency or credit said overpayment to our Deposit Account No. 50-0552.

Respectfully submitted,
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Page 727 of 1430

(19) Europäisches Patentamt
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(11) EP 1 013 785 B1

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C23C 2/26 (2006.01)

(21) Application number: **99403227.4**

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(54) Process for manufacturing a part from a hot-rolled sheet

(84) Designated Contracting States:
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(30) Priority: **12/24/1998 FR 9816477**

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(56) References cited:
CH-A- 382 512 DE-B- 1 252 034
FR-A- 1 297 906 US-A- 4 655 852

- **GIEREK A. E.A.: "Tauchalitieren – Eigenschaften und Einsatzgebiete" V.D.I. ZEITSCHRIFT, vol. 118, no. 8, April 1976 (1976-04), pages 19-22, XP002114744**
- **DATABASE WPI Week 9046 Derwent Publications Ltd., London, GB; AN 347101 XP002114745 "Aluminized steel strip production process – involves cooling and hot rolling under compression to improve adhesion of covering to base" & SU 331 284 A (FRUNZE POLY), 9 January 1991 (1991-01-09)**

Note: Within nine months of the publication of the mention of the grant of the European patent in the European Patent Bulletin, any person may give notice to the European Patent Office of opposition to that patent, in accordance with the Implementing Regulations. Notice of opposition shall not be deemed to have been filed until the opposition fee has been paid. (Art. 99(1) European Patent Convention).

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Description

[0001] The invention concerns a process for manufacturing a part from a strip of hot-rolled sheet steel.

[0002] Steel sheets having to undergo forming at high temperature or heat treatment are not delivered coated because of resistance of the coating during the heat treatment. The coating is therefore undertaken on the finished part, which requires careful cleaning of surfaces and grooved parts. This cleaning requires the use of acids or bases, recycling and storage of which entail a significant financial expense and present risks for the operators and for the environment. Furthermore, the heat treatment must be undertaken in a controlled environment to avoid any decarburation and oxidation of the steel. Then, in the case of hot forming, the carbon deposit, owing to its abrasive power, damages the forming tools, which reduces the quality of the parts obtained from a dimensional and aesthetic point of view, or requires frequent and costly tool repairs. Lastly, to increase their resistance to corrosion, the parts thus obtained must undergo costly post-treatment, application of which is difficult, even impossible, particularly in the case of parts comprising grooves.

[0003] The aim of the invention is to propose rolled steel sheets of a thickness of 0.2 mm to around 20 mm, coated after hot-rolling, and having to undergo forming, either hot or cold, followed by heat treatment, with the temperature having to be increased without decarburation of the sheet steel, without oxidation of the surface of the said sheet, before, during and after the hot forming or the heat treatment.

[0004] The invention has the purpose of a process for manufacturing a part from a strip of hot-rolled sheet steel and which is characterized in that:

- the rolled sheet is coated with a metal or a metal alloy providing protection of the surface and the steel,
- the temperature of the coated sheet is increased for its forming,
- this creates an alloyed intermetallic compound, providing protection against corrosion, and against decarburation of the steel, it being possible for said intermetallic compound to provide a lubricating function,
- the forming is undertaken by stamping,
- the part formed is cooled so as to confer a high degree of mechanical hardness of the steel and a high degree of superficial hardness of the coating.

[0005] The other features of the invention are:

- the hot-rolled sheet is coated after hot-rolling and pickling,
- the metal or metal alloy coating is made of aluminum or aluminum alloy,
- the intermetallic alloy is a compound principally based on aluminum, iron and silicon,
- the metal or metal alloy coating is hot-dipped,
- the coated sheet is heated to a temperature above 700°C before forming,
- the coated sheet is hot-stamped,
- the stamped part is quench-cooled at a rate above the critical quench rate.

[0006] The invention also concerns a hot-rolled sheet comprising a metal or metal alloy coating deposited on the surface, for the hot manufacture of an intermetallic compound, the intermetallic compound providing protection against corrosion, a barrier against decarburation of the steel sheet, lubrication upon hot forming of the sheet, and on the finished part, after forming and cooling, a high degree of mechanical hardness of the steel and a high degree of superficial hardness of the surface of the said finished part.

[0007] Another feature of the invention is:

- the sheet comprises an aluminum or aluminum alloy surface deposit.

[0008] The invention also concerns the use of the sheet in the hot forming by stamping parts with a high degree of mechanical hardness and a high degree of surface hardness providing very good resistance to abrasion.

The following description will help better understand the invention.

[0009] The process according to the invention consists of coating a hot-rolled steel sheet, for heat treatment or hot forming, with a metal or metal alloy such as aluminum or an aluminum alloy composed for example of aluminum and silicon. The metal or metal alloy coating is chosen to provide protection against corrosion and to withstand a high temperature. Upon heat treatment, or an increase in temperature for forming, the coating forms an alloyed layer presenting a high resistance to corrosion, abrasion, wear and fatigue. The coating does not change the formability properties of the steel, and thus allows a great variety of hot and cold forming.

[0010] After hot-rolling the strip can be pickled and cold-rolled before being coated.

[0011] The rolled steel can be coated, for example, with the following two types of metal alloy:

Alloy no. 1: Si: 9% to 10%; Fe: 2% to 3.5%; Balance: Al and impurities.

Alloy no. 2: Fe: 2% to 4%; Balance: Al and impurities.

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For alloy no. 1 the thickness of the coating is between 5 μm and 100 μm, and preferably between 10 μm and 25 μm. For alloy no. 2 the thickness of the coating is between 15 μm and 100 μm, and preferably between 30 μm and 50 μm.

[0012] For the forming or heat treatment the sheet is heated to a high temperature, preferably between 750°C and 1200°C, in a furnace comprising an atmosphere no longer requiring control owing to the barrier to oxidation formed by the coating. Upon increasing the temperature, the aluminum-based coating transformed into an alloyed layer on the surface comprising various phases depending on the heat treatment and presenting a high degree of hardness that can exceed 600 HV 100g.

[0013] According to the process of the invention, sheets can be produced of a thickness between 0.2 mm and 20 mm, having good forming properties and good resistance to corrosion.

[0014] The sheets delivered coated present a high resistance to corrosion during temperature increases, forming, heat treatments, and upon use of the finished formed parts.

[0015] The presence of the coating during heat treatments or hot forming makes it possible to avoid, in addition to corrosion, decarburation of the base steel. This has an undeniable advantage in the case of hot forming in a stamping press. Indeed, the intermetallic alloy formed avoids the formation of carbon deposit and therefore the wear of tools by the carbon deposit, and due to this lengthens the average life of the said tools. It has been noted that the hot formed intermetallic alloy provides a lubricating function at high temperature. Furthermore, the protective effect against decarburation of the intermetallic alloy enables the use of the furnace at a high temperature exceeding 900°C and having an uncontrolled atmosphere, even for heating times of several hours.

[0016] On leaving the furnace, it is no longer necessary to pickle the part obtained, hence a saving owing to the removal of the pickling bath for the finished parts.

[0017] Owing to the characteristics of the coating after increasing the temperature, the parts obtained have increased resistance to fatigue, wear, abrasion and corrosion. Furthermore, the coating can be welded before and after raising the temperature.

[0018] The sheet steel, through the effect of the quench cooling, provides high mechanical characteristics of the part obtained after forming, the coating transformed into an intermetallic alloy when hot providing, owing to its qualities of lubricant and resistance to friction, an improvement of the forming in the area of the hot stamping.

[0019] In one embodiment, a hot-rolled sheet steel strip is used of the following weight composition:

carbon: 0.15% to 0.25%,
manganese: 0.8% to 1.5%,
silicon: 0.1% to 0.35%,
chromium: 0.01% to 0.2%,
titanium: less than 0.1%,
aluminum: less than 0.1%,
phosphorus: less than 0.05%,
sulfur: less than 0.03%,
boron: 0.0005% to 0.01%,

the sheet strip is coated with a coating of alloy no. 1 or no. 2,
the sheet is austenitized at 950°C before forming and quenching in the tool, with the coating providing a role of lubricant upon forming, in addition to its functions of protection against cold and hot corrosion and against decarburation. Upon quenching, the alloy coating does not hinder the extraction of the heat by the tool and can favor it. After forming and quenching, it is no longer necessary to pickle the part or to protect it, as the base coating provides protection throughout the process.

Claims

1. Process of producing a part from a strip of hot-rolled steel sheet, **characterized in that**:

   - the rolled sheet is coated with an aluminum alloy containing 9 to 10% silicon and 2 to 3.5% iron, the balance consisting of aluminum and impurities, as a layer having a thickness between 5 and 100 μm, or with an aluminum alloy containing 2 to 4% iron, the balance consisting of aluminum and impurities, as a layer having a thickness between 15 and 100 μm, the coating with the aluminum alloy being carried out by hot-dip coating, immediately after hot-rolling and pickling;
   - the coated sheet is heated to a temperature above 700°C before the forming operation until consequently producing an alloyed intermetallic compound based on aluminum, iron and silicon on the surface, protecting the steel from corrosion and from decarburation, it being possible for said intermetallic compound to provide a lubricating function;
   - the part is hot-stamped; and
   - the formed part is quench-cooled at a rate above the critical quench rate.

2. Hot-rolled steel sheet having a coating consisting of an alloyed intermetallic compound, based on aluminum, iron and silicon, on the surface,

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said coating being obtained by the heat treatment of said sheet precoated with an aluminum alloy containing 9 to 10% silicon and 2 to 3.5% iron, the balance consisting of aluminum and impurities, as a layer having a thickness between 5 and 100 μm, or with an aluminum alloy containing 2 to 4% iron, the balance consisting of aluminum and impurities, as a layer having a thickness between 15 and 100 μm, said coating thickness between 15 and 100 μm, said coating being deposited by hot-dip coating, immediately after the hot-rolling and pickling, and said heat treatment being carried out at a temperature above 700°C.

3. Part obtained by hot-stamping the sheet according to Claim 2, followed by a quench at a rate above the critical quench rate.

Claims

1. Process of producing a part from a strip of hot-rolled steel sheet, **characterized in that**:

   - the rolled sheet is coated with an aluminum alloy containing 9 to 10% silicon and 2 to 3.5% iron, the balance consisting of aluminum and impurities, as a layer having a thickness between 5 and 100 μm, or with an aluminum alloy containing 2 to 4% iron, the balance consisting of aluminum and impurities, as a layer having a thickness between 15 and 100 μm, the coating with the aluminum alloy being carried out by hot-dip coating, immediately after hot-rolling and pickling;
   - the coated sheet is heated to a temperature above 700°C before the forming operation until consequently producing an alloyed intermetallic compound based on aluminum, iron and silicon on the surface, protecting the steel from corrosion and from decarburation, it being possible for said intermetallic compound to provide a lubricating function;
   - the part is hot-stamped; and
   - the formed part is quench-cooled at a rate above the critical quench rate.

2. Hot-rolled steel sheet having a coating consisting of an alloyed intermetallic compound, based on aluminum, iron and silicon, on the surface, said coating being obtained by the heat treatment of said sheet precoated with an aluminum alloy containing 9 to 10% silicon and 2 to 3.5% iron, the balance consisting of aluminum and impurities, as a layer having a thickness between 5 and 100 μm, or with an aluminum alloy containing 2 to 4% iron, the balance consisting of aluminum and impurities, as a layer having a thickness between 15 and 100 μm, said coating thickness between 15 and 100 μm, said coating being deposited by hot-dip coating, immediately after the hot-rolling and pickling, and said heat treatment being carried out at a temperature above 700°C.

3. Part obtained by hot-stamping the sheet according to Claim 2, followed by a quench at a rate above the critical quench rate.

Claims

1. Process of producing a part from a strip of hot-rolled steel sheet, **characterized in that**:

   - the rolled sheet is coated with an aluminum alloy containing 9 to 10% silicon and 2 to 3.5% iron, the balance consisting of aluminum and impurities, as a layer having a thickness between 5 and 100 μm, or with an aluminum alloy containing 2 to 4% iron, the balance consisting of aluminum and impurities, as a layer having a thickness between 15 and 100 μm, the coating with the aluminum alloy being carried out by hot-dip coating, immediately after hot-rolling and pickling;
   - the coated sheet is heated to a temperature above 700°C before the forming operation until consequently producing an alloyed intermetallic compound based on aluminum, iron and silicon on the surface, protecting the steel from corrosion and from decarburation, it being possible for said intermetallic compound to provide a lubricating function;
   - the part is hot-stamped; and
   - the formed part is quench-cooled at a rate above the critical quench rate.

2. Hot-rolled steel sheet having a coating consisting of an alloyed intermetallic compound, based on aluminum, iron and silicon, on the surface, said coating being obtained by the heat treatment of said sheet precoated with an aluminum alloy containing 9 to 10% silicon and 2 to 3.5% iron, the balance consisting of aluminum and impurities, as a layer having a thickness between 5 and 100 μm, or with an aluminum alloy containing 2 to 4% iron, the balance consisting of aluminum and impurities, as a layer having a thickness between 15 and 100 μm, said coating thickness between 15 and 100 μm, said coating being deposited by hot-dip coating, immediately after the hot-rolling and pickling, and said heat

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treatment being carried out at a temperature above 700°C.

3. Part obtained by hot-stamping the sheet according to Claim 2, followed by a quench at a rate above the critical quench rate.

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CERTIFICATE OF ACCURACY

I, Eve Hecht, declare the following:

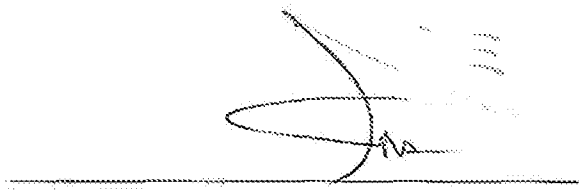
1. I am over 18 years of age and competent to make this declaration.

2. I am a qualified French to English translator as certified by the American Translators Association.

3. I have translated the attached document dated 12/21/1999 in connection with European Patent Application number: 99403227.4.

4. I affirm that the translated text has been translated and edited to the best of my ability and knowledge to accurately reflect the content, meaning, and style of the original text. I hereby certify under penalty of perjury under the laws of the United States of America that the foregoing constitutes, pursuant to my knowledge and belief, a true and correct translation of the original document.

4. I declare that all statements made herein of my knowledge are true, and that all statements made on information and belief are believed to be true, and that these statements were made with the knowledge that willful false statements and the like are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code.



Dated and Signed on June 6, 2019

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Page 1430

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(45) Date de publication et mention de la délivrance du brevet:
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C23C 2/26 *(2006.01)*

(21) Numéro de dépôt: **99403227.4**

(22) Date de dépôt: **21.12.1999**

(54) Procédé de réalisation d'une pièce à partir d'une bande de tôle d'acier laminée à chaud

Herstellungsverfahren für Formteile aus warmgewalztem Stahlblech

Process for manufacturing of a part from a hot-rolled sheet

(84) Etats contractants désignés:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE

(30) Priorité: **24.12.1998 FR 9816477**

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(56) Documents cités:
CH-A- 382 512
DE-B- 1 252 034
FR-A- 1 297 906
US-A- 4 655 852

- **GIEREK A. E.A.: "Tauchalitieren - Eigenschaften und Einsatzgebiete" V.D.I. ZEITSCHRIFT, vol. 118, no. 8, avril 1976 (1976-04), pages 19-22, XP002114744**
- **DATABASE WPI Week 9046 Derwent Publications Ltd., London, GB; AN 347101 XP002114745 "Aluminised steel strip production process - involves cooling and hot rolling under compression to improve adhesion of covering to base" & SU 331 284 A (FRUNZE POLY), 9 janvier 1991 (1991-01-09)**

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Description

[0001] L'invention concerne un procédé de réalisation d'une pièce à partir d'une bande de tôle d'acier laminée à chaud.

[0002] Les tôles en acier devant subir un formage à haute température et ou un traitement thermique ne sont pas livrées revêtues pour des considérations de tenue du revêtement lors du traitement thermique. Le revêtement est donc effectué sur pièce finie ce qui nécessite un nettoyage soigné des surfaces et des parties creuses. Ce nettoyage requiert l'utilisation d'acides et ou de bases dont le recyclage et le stockage sont une charge financière importante et présentent des risques pour les opérateurs et pour l'environnement. De plus, le traitement thermique doit être effectué sous atmosphère contrôlée afin d'éviter toute décarburation et oxydation de l'acier. Ensuite, dans le cas du formage à chaud, la calamine, de par son pouvoir abrasif, endommage les outils de mise en forme, ce qui diminue la qualité des pièces obtenues du point de vue dimensionnel et esthétique, ou oblige à de fréquentes et coûteuses réparations d'outils. Enfin, pour augmenter leur résistance à la corrosion, les pièces ainsi obtenues doivent recevoir un post traitement coûteux dont l'application est difficile, voire impossible, en particulier dans le cas de pièces comportant des creux.

[0003] Le but de l'invention est de proposer des tôles d'acier laminées de 0,2 mm à environ 20 mm d'épaisseur, revêtues après laminage à chaud, et devant subir une mise en forme, soit à chaud, soit à froid suivie d'un traitement thermique, l'élévation de température devant être assurée sans décarburation de l'acier de la tôle, sans oxydation de la surface de ladite tôle, avant, pendant et après la mise en forme à chaud et ou le traitement thermique.

[0004] L'invention a pour objet un procédé de réalisation d'une pièce à partir d'une bande de tôle d'acier laminée à chaud et qui se caractérise en ce que:

- on revêt la tôle laminée d'un métal ou d'un alliage métallique assurant une protection de la surface et de l'acier,
- on soumet la tôle revêtue à une élévation en température pour sa mise en forme,
- on réalise, de ce fait un composé allié intermétallique, en surface, assurant une protection contre la corrosion, contre la décarburation de l'acier, le composé intermétallique pouvant assurer une fonction de lubrification,
- on effectue la mise en forme par emboutissage,
- on refroidit la pièce formée pour conférer des caractéristiques mécaniques de dureté élevées de l'acier et une dureté superficielle élevée du revêtement.

[0005] Les autres caractéristiques de l'invention sont:

- on revêt la tôle laminée à chaud après laminage à chaud et décapage,
- le métal ou l'alliage métallique de revêtement est de l'aluminium ou un alliage d'aluminium.
- l'alliage intermétallique est un composé à base principalement d'aluminium, de fer et de silicium,
- le revêtement de métal ou d'alliage métallique et effectué au trempé à chaud.
- la tôle revêtue est soumise à une élévation de température supérieure à 700°C avant la mise en forme,
- la tôle revêtue est emboutie à chaud.
- la pièce obtenue par emboutissage est refroidie pour subir une trempe, à une vitesse supérieure à la vitesse critique de trempe.

[0006] L'invention concerne également une tôle laminée à chaud comportant un revêtement de métal ou d'alliage métallique déposé en surface, pour la réalisation à chaud d'un composé intermétallique, le composé intermétallique assurant, une protection contre la corrosion, une barrière contre la décarburation de l'acier de la tôle, une lubrification lors de la mise en forme à chaud de la tôle, et sur la pièce finie, après mise en forme et refroidissement, des caractéristiques mécaniques de dureté de l'acier élevées ainsi qu'une dureté superficielle élevée de la surface de ladite pièce finie.

[0007] Une autre caractéristique de l'invention est:

- la tôle comporte un dépôt en surface d'aluminium ou d'un alliage d'aluminium.

[0008] L'invention concerne encore l'utilisation de la tôle dans la mise en forme à chaud par emboutissage de pièces de hautes caractéristiques mécaniques en dureté et de hautes caractéristiques de dureté en surface assurant une très bonne tenue à l'abrasion.

La description qui suit fera bien comprendre l'invention.

[0009] Le procédé selon l'invention consiste à revêtir un acier laminé à chaud, pour traitement thermique et ou formage à chaud, avec un métal ou un alliage métallique tels que de l'aluminium ou un alliage d'aluminium composé par exemple d'aluminium et de silicium. Le revêtement de métal ou d'alliage métallique est choisi de manière à avoir une protection contre la corrosion et de manière à résister à une haute température. Lors d'un traitement thermique, ou d'une élévation de température pour la mise en forme, le revêtement forme une couche alliée présentant une grande résistance à la corrosion, à l'abrasion, à l'usure et à la fatigue. Le revêtement ne modifie pas les propriétés de formabilité de l'acier et autorise ainsi une grande variété de mise en forme à froid et à chaud.

[0010] Après laminage à chaud la bande peut être décapée et laminée à froid avant d'être revêtue.

[0011] On peut revêtir la tôle laminée avec, par exemple, les deux types d'alliage métallique suivants:

Alliage N°1: Si: 9% à 10%; Fe: 2% à 3,5%; Solde: Al et des impuretés.
Alliage N°2: Fe: 2% à 4%; Solde: Al et des impuretés.

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Pour l'alliage N°1 l'épaisseur du revêtement est compris entre 5 μm et 100 μm, et de préférence entre 10 μm et 25 μm. Pour l'alliage N°2 l'épaisseur du revêtement est compris entre 15 μm et 100 μm, et de préférence entre 30 μm et 50 μm.

[0012] Pour la mise en forme ou le traitement thermique, la tôle est soumise à une élévation de température comprise de préférence entre 750°C et 1200°C dans un four comportant une atmosphère ne nécessitant plus de contrôle du fait de la barrière à l'oxydation formée par le revêtement. Lors de l'élévation de la température, le revêtement à base d'aluminium se transforme en une couche alliée en surface comportant différentes phases dépendant du traitement en température et présentant une grande dureté pouvant dépasser 600 HV 100g.

[0013] Selon le procédé de l'invention, on peut produire des tôles dont l'épaisseur est comprise entre 0,2 mm et 20 mm, ayant de bonnes propriétés de mise en forme ainsi qu'une bonne résistance à la corrosion.

[0014] Les tôles livrées revêtues, présentent une résistance importante à la corrosion pendant les élévations de température, la mise en forme, les traitements thermiques, et lors de l'utilisation des pièces formées finies.

[0015] La présence du revêtement lors de traitements thermiques ou de formages à chaud permet d'éviter en plus de la corrosion, la décarburation de l'acier de base. Cela à un avantage indéniable dans le cas d'une mise en forme à chaud dans une presse d'emboutissage. En effet, l'alliage intermétallique formé évite, la formation de la calamine, l'usure des outils par la calamine, et permet de ce fait, un allongement de la vie moyenne desdits outils. Il a été remarqué que l'alliage intermétallique formé à chaud, a une fonction de lubrifiant à haute température. De plus, l'effet de protection contre la décarburation de l'alliage intermétallique permet l'usage de four haute température dépassant 900°C ayant une atmosphère non contrôlée, et cela, même pour des temps de chauffe de plusieurs heures.

[0016] En sortie de four, il n'est plus nécessaire de décaper la pièce obtenue, d'où une économie du fait de la suppression du bain de décapage des pièces finies.

[0017] De par les caractéristiques du revêtement après élévation de température, les pièces obtenues ont une résistance accrue à la fatigue, à l'usure, à l'abrasion et à la corrosion. De plus, le revêtement est soudable avant et après élévation de température.

[0018] L'acier de la tôle assure, par effet de trempe au refroidissement, des caractéristiques mécaniques élevées de la pièce obtenue après mise en forme, le revêtement transformé en un alliage intermétallique à chaud assurant pour sa part, du fait de ses qualités de lubrifiant et de résistance aux frottement, une amélioration de la mise en forme, dans le domaine de l'emboutissage à chaud.

[0019] Dans un exemple de réalisation, on utilise une bande de tôle laminée à chaud en acier de composition pondérale suivante:

carbone: 0,15% à 0,25%,
manganèse: 0,8% à 1,5%,
silicium: 0,1% à 0,35%,
chrome: 0,01% à 0,2%,
titane: moins de 0, 1 %,
aluminium: moins de 0,1 %,
phosphore: moins de 0,05%,
soufre: moins de 0,03%,
bore : 0,0005% à 0,01 %,

on revêt la bande de tôle d'un revêtement de type alliage N°1 ou 2,
on austénitise la tôle à 950°C avant formage et trempe dans l'outil, le revêtement assurant un rôle de lubrifiant lors de la mise en forme, en plus de ses fonctions de protection contre la corrosion à froid, à chaud et contre la décarburation. Lors de la trempe, le revêtement allié ne gène pas l'extraction de la chaleur par l'outil et peut la favoriser. Après formage et trempe, il n'est plus nécessaire de décaper la pièce ou de la protéger, le revêtement de base assurant la protection tout au long du procédé.

Revendications

1. Procédé de réalisation d'une pièce à partir d'une bande de tôle d'acier laminée et laminée à chaud, **caractérisée en ce que** :

   - on revêt la tôle laminée d'un alliage d'aluminium comprenant de 9 à 10% de silicium et de 2 à 3,5% de fer, le solde étant constitué d'aluminium et d'impuretés, en une couche d'épaisseur comprise entre 5 et 100μm, ou d'un alliage à aluminium comprenant de 2 à 4% de fer, le solde étant constitué d'aluminium et d'impuretés, en une couche d'épaisseur comprise entre 15 et 100 μm, le revêtement d'alliage d'aluminium étant effectué au trempé à chaud, immédiatement après laminage à chaud, et décapage,
   - on soumet la tôle revêtue à une élévation en température supérieure à 700°C avant la mise en forme jusqu'à réaliser, de ce fait un composé allié intermétallique à base d'aluminium, de fer et de silicium, en surface, assurant une protection contre la corrosion, contre la décarburation de l'acier, le composé intermétallique pouvant assurer une fonction de lubrification,
   - on emboutit la pièce à chaud,
   - on refroidit la pièce formée par trempe, à une vitesse supérieure à la vitesse critique de trempe.

2. Tôle d'acier laminée à chaud comportant un revêtement constitué d'un composé allié intermétallique à base d'aluminium, de fer et de silicium, en surface,

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ledit revêtement étant obtenu par traitement thermique de ladite tôle préalablement revêtue d'un alliage d'aluminium comprenant de 9 à 10% de silicium et de 2 à 3,5% de fer, le solde étant constitué d'aluminium et d'impuretés, en une couche d'épaisseur comprise entre 5 et 100µm, ou d'un alliage à aluminium comprenant de 2 à 4% de fer, le solde étant constitué d'aluminium et d'impuretés, en une couche d'épaisseur comprise entre 15 et 100 µm, ledit revêtement étant déposé ou trempé à chaud, immédiatement après laminage à chaud, et décapage et ledit traitement thermique étant effectué à une température supérieure à 700°C.

3. Pièce obtenue par emboutissage à chaud de la tôle selon la revendication 2, suivi d'une trempe, à une vitesse supérieure à la vitesse critique de trempe.

Claims

1. Process of producing a part from a strip of a hot-rolled steel sheet, **characterized in that**:

   - the rolled sheet is coated with an aluminium alloy containing 9 to 10% silicon and 2 to 3.5% iron, the balance consisting of aluminium and impurities, as a layer having a thickness between 5 and 100 µm, or with an aluminium alloy containing 2 to 4% iron, the balance consisting of aluminium and impurities, as a layer having a thickness between 15 and 100 µm, the coating with the aluminium alloy being carried out by hot-dip coating, immediately after hot rolling and pickling;
   - the coated sheet is heated to a temperature above 700°C before the forming operation until consequently producing an alloyed intermetallic compound based on aluminium, iron and silicon on the surface, protecting the steel from corrosion and from decarburation, it being possible for said intermetallic compound to provide a lubricating function;
   - the part is hot-stamped; and
   - the formed part is quench-cooled at a rate above the critical quench rate.

2. Hot-rolled steel sheet having a coating consisting of an alloyed intermetallic compound, based on aluminium, iron and silicon, on the surface, said coating being obtained by the heat treatment of said sheet precoated with an aluminium alloy containing 9 to 10% silicon and 2 to 3.5% iron, the balance consisting of aluminium and impurities, as a layer having a thickness between 5 and 100 µm, or with an aluminium alloy containing 2 to 4% iron, the balance consisting of aluminium and impurities, as a layer having a thickness between 15 and 100 µm, said coating being deposited by hot-dip coating, immediately after the hot rolling and pickling, and said heat treatment being carried out at a temperature above 700°C.

3. Part obtained by hot-stamping the sheet according to Claim 2, followed by a quench at a rate above the critical quench rate.

Patentansprüche

1. Verfahren zum Herstellen eines Formteils ausgehend von einem warmgewalzten Stahlblechband, **dadurch gekennzeichnet, dass**:

   - man das gewalzte Blech mit einer Aluminiumlegierung, die 9 bis 10 % Silicium und 2 bis 3,5 % Eisen enthält, wobei der Rest aus Aluminium und Verunreinigungen besteht, in einer Schicht mit einer Stärke zwischen 5 und 100 µm beschichtet oder mit einer Aluminiumlegierung, die 2 bis 4 % Eisen enthält, wobei der Rest aus Aluminium und Verunreinigungen besteht, in einer Schicht mit einer Stärke zwischen 15 und 100 µm, wobei die Beschichtung mit einer Aluminiumlegierung durch Warmhärten unmittelbar nach dem Warmwalzen und Beizen erfolgt,
   - man das beschichtete Blech einer Temperaturerhöhung über 700 °C vor dem Formen unterwirft, bis man **dadurch** eine intermetallische legierte Verbindung auf der Basis von Aluminium, Eisen und Silicium auf der Oberfläche herstellt, die einen Schutz vor Korrosion, Entkohlen des Stahls sicherstellt, wobei die intermetallische Verbindung eine Schmierfunktion sicherstellen kann,
   - man das Formteil warm stanzt,
   - man das durch Härten gebildete Formteil mit einer Geschwindigkeit über der kritischen Härtgeschwindigkeit abkühlt.

2. Warmgewalztes Stahlblech, das eine Beschichtung aufweist, die aus einer legierten intermetallischen Verbindung auf der Basis von Aluminium, Eisen und Silicium auf der Oberfläche besteht, wobei die Beschichtung durch eine Wärmebehandlung des Blechs erzielt wird, das zuvor mit einer Aluminiumlegierung beschichtet wurde, die 9 bis 10 % Silicium und 2 bis 3,5 % Eisen enthält, wobei der Rest aus Aluminium und Verunreinigungen besteht, in einer Schicht mit einer Stärke zwischen 5 und 100 µm, oder mit einer Aluminiumlegierung, die 2 bis 4 % Eisen enthält, wobei der Rest aus Aluminium und Verunreinigungen besteht, in einer Schicht mit einer Stärke zwischen 15 und 100 µm, wobei die Beschichtung durch Warmhärten unmittelbar nach dem Warmwalzen und Beizen erfolgt, und die Wärmebe-

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handlung bei einer Temperatur über 700 °C erfolgt.

3. Formteil, das durch Warmstanzen des Blechs nach Anspruch 2 erzielt wird, gefolgt von einem Härten bei einer Geschwindigkeit, die größer ist als die kritische Härtgeschwindigkeit.

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TRANSLATION

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(54) **HOT-FORMING METHOD AND IN PARTICULAR OBTAINING ALL OR PART OF AN AUTOMOTIVE VEHICLE WHEEL.**

(57) Hot-forming method and in particular obtaining all or part of an automotive vehicle wheel, for example a wheel disk, characterized in that in a hot-stamping operation a precoated steel sheet hot-rolled for thermal treatment is used.

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TRANSLATION

2,833,504

Hot-Forming Method and in Particular Obtaining All or Part of an Automotive Vehicle Wheel

The present invention relates to obtaining a part by a hot-forming method and in particular obtaining all or part of an automotive vehicle wheel.

Currently, wheel disks are obtained by cold stamping of a sheet-metal blank or by flow-turning.

In the case of obtaining a wheel disk by stamping of a sheet-metal blank, it is necessary to perform several shaping operations, for which several stamping tools must be made. The number of stamping tools is of order 7, 8 or 9.

The following are the main disadvantages of the indicated present technique:

- Any change of shape requires machining or fabricating 7 to 9 different pairs of tools.
- Any manufacturing change leads to disassembling then assembling and adjusting 7 to 9 tools together with the adjustment of the associated presses.
- All these tools must be stored.
- Because of the fabrication cost of the tools, small runs cannot be made economically.
- It is not possible to make thick parts.

In the case of getting, for example, a wheel disk by flow-turning, productivity is reduced compared to stamping, which limits the manufacturing in large runs.

In the two cases indicated:

- Using stamping or lubricating oil is essential and requires degreasing before painting.
- These oils and the effluents must be stored and treated.

From the perspective of the properties sought:

- The increase of the mechanical properties leads to reduction of the formability, which limits the shape of the wheel disks and generates an increased elastic return, penalizing the dimensional guarantees.
- Increasing the mechanical properties requires the use of more and more powerful presses.
- The temporary protection against corrosion, before painting for example a stamped wheel disk, requires oiling the part and then degreasing it. It is also

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necessary to remove the stamping oil before painting, which comes with a cost and an ecological risk.

The goal of the invention is the execution of a part by hot stamping, in one single pass, adhering to the dimensional guarantees, while also having the possibility of getting complex shapes.

The object of the invention is obtaining a part by a hot-forming method and in particular obtaining all or part of an automotive vehicle wheel, for example a wheel disk, characterized in that in a hot-stamping operation a precoated steel sheet hot-rolled for thermal treatment is used.

The other characteristics of the invention are:

- The steel sheet is a precoated hot or cold-rolled steel sheet with the following general composition by weight:

  0.15% < carbon < 0.5%
  0.5% < manganese < 3%
  0.1% < silicon < 0.5%
  0% < chrome < 1%
  Titanium < 0.2%
  Aluminum < 0.1%
  Phosphorus < 0.1%
  Sulfur < 0.05%
  0.0005% < boron < 0.08%

The other characteristics of the invention are:

- The coating is aluminum-based,
- Preferably, the steel sheet is a precoated hot or cold-rolled steel sheet with the following composition by weight:

  0.15% < carbon < 0.5%
  0.8% < manganese < 1.5%
  0.1% < silicon < 0.35%
  0% < chrome < 1%
  Titanium < 0.1%
  Aluminum < 0.1%
  Phosphorus < 0.05%

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Sulfur < 0.03%

0.0005% < boron < 0.01%

- In the composition by weight of the sheet, the titanium concentration relative to the nitrogen concentration is greater than 3.42;
- The base composition by weight of the metal bath for coating comprises from 9% to 10% silicon, 2% to 3.5% iron, and the remainder of the bath is composed of aluminum and impurities;
- The base composition by weight of the metal bath for coating comprises from 2% to 4% iron;
- The base composition by weight of the metal bath for coating comprises from 0 to 50% zinc.

The following description will make the invention well understood.

The problem to be solved is to make a part by a hot-forming method and in particular getting all or part of an automotive vehicle wheel like for example a light vehicle or truck wheel disk or a wheel disk and a part of the wheel rim, in a single pass, meeting the dimensional guarantees, while also implementing complex shapes.

From French patent application 98/08793, a coated hot or cold steel sheet and comprising a very high strength after thermal treatment is known. From the French patent application 98/016477, a method for execution of a part from a strip of rolled steel sheet, and in particular hot-rolled, is known.

According to the invention, a particularly significant use of the sheet and of the method presented was demonstrated by getting a part by a hot-shaping method and, in particular, getting all or part of an automotive vehicle wheel, in a single hot-stamping pass, whereas the techniques used to date call for many complex tools and also many shaping operations.

Contrary to known industrial habits, the inventors obtained a wheel disk, in a single pass, by hot stamping a precoated hot-rolled steel sheet, which previously was done in 7 or 8 stamping operations, with the plane of the precut sheet having the following general composition by weight:

0.15% < carbon < 0.5%

0.5% < manganese < 3%

0.1% < silicon < 0.5%

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0.01% < chrome < 1%

Titanium < 0.2%

Aluminum < 0.1%

Phosphorus < 0.1%

Sulfur < 0.05%

0.0005% < boron < 0.08%

A notable improvement in fatigue resistance without posing welding problems and having increased corrosion resistance after painting can be obtained by using a precoated steel for thermal treatment.

Further, the method and the steel used allow a notable weight reduction and an increase of the fatigue life. Finally, the resulting wheel disk can be welded and then painted without changes to existing lines.

Preferably the steel for the sheet has the following composition by weight:

0.15% < carbon < 0.5%

0.8% < manganese < 1.5%

0.1% < silicon < 0.35%

0.01% < chrome < 1%

Titanium < 0.1%

Aluminum < 0.1%

Phosphorus < 0.05%

Sulfur < 0.03%

0.0005% < boron < 0.01%

The sheet provides a very high mechanical strength after thermal treatment and the aluminum-based coating provides a high corrosion and fatigue resistance.

In order to get the part, in a single pass, by hot stamping of the coated hot-rolled sheet, it is preferable that the ratio of the titanium concentration to the nitrogen concentration be greater than 3.42.

The base composition by weight of the aluminum-based coating of the coated hot-rolled sheet comprises from 9% to 10% silicon and from 2% to 3.5% iron.

The base composition by weight of the coating of the coated hot-rolled sheet can also comprise from 2% to 4% iron. The base composition by weight of the metal bath comprises from 0 to 50% zinc.

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In an implementation example, the steel according to the invention containing 0.231% carbon; 1.145% manganese; 0.020% phosphorus; 0.0038% sulfur; 0.239% silicon; 0.043% aluminum; 0.009% copper; 0.020% nickel; 0.179% chrome; 0.0042% nitrogen; 0.032% titanium; 0.0028% boron; and 0.0051% calcium, in sheet form, is coated with an aluminum-based layer about 25 μm thick before thermal treatment.

The sheet-metal blank is heated in a furnace at a temperature included between 750°C and 1000°C and more generally at a temperature included between 850°C and 950°C for a time that varies depending on the thickness. For a thickness of 2 mm, the sheet-metal blank stays in the furnace for six minutes. The rate of temperature increase is greater than 3°C/s. Because of the coating, it is not necessary to use an inert atmosphere furnace.

During reheating of the sheet-metal blank, the coating alloys with the substrate to form an intermetallic alloy. By interdiffusion, the alloying leads to an increase of the thickness of the layer which, for the treatment specified above, corresponds to a 50% increase.

The hot-sheet-metal blank is next transferred to the cooling tool or not, depending on the production rate, thickness of the sheet and the targeted cooling speed, in order to be shaped. There must not be blank clamping pressure in order to avoid tearing of the sheet due to the low high temperature strength thereof. The deformation speed must be sufficient for avoiding deforming the steel at a temperature below 400°C.

The resulting wheel disk is kept in the tool until reaching a temperature below 200°C and preferably below 100°C in order to meet the dimension guarantees. If the targeted structure for the substrate is a martensitic structure, the average cooling speed from the temperature on leaving the furnace to 400°C must be over 27°C/s. If the average cooling speed is below this value, bainite, ferrite or even pearlite can appear. It is therefore possible to get various structures and therefore various properties depending on the targeted cooling speed. Just the same, the best fatigue results are obtained with a totally martensitic steel structure.

Because of the hot forming, there is no damage to the metallurgical structure. This has a beneficial effect on the fatigue resistance because of the elimination of

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internal defects that could serve to initiate fatigue cracks. It is not necessary to add stamping lubricant because the precoating acts as a lubricant.

The resulting part can directly go through the painting cycle. If this is not the case, it is not necessary to apply a temporary corrosion protection because the alloyed layer slows the appearance of corrosion. During the thermal cycle, the coating, alloyed or not, protects the steel from oxidation and decarburization.

The alloy layer made on the part has a hardness gradient. Starting from the extreme layer and moving towards the sheet, the hardness varies from 750HV0.1 to 300HV0.1 at the coating layer-sheet interface, and then increases up to about 500HV0.1 in the sheet, when the structure of the steel is entirely martensitic. It is the layer at 300HV0.1 which, by stopping cracks, gives the part an increased fatigue resistance.

If the steel from the proposed solution is used but not precoated, a significant breakdown of the average fatigue limit is noted, as seen in Table 1 below, principally related to the decarburization of the steel. The proposed solution avoids this phenomenon, because of the presence of the precoating. The alternating reversed-bending fatigue tests show a notable improvement.

Table 1.

Steel	Rp0.2 (MPa) Through	Rm (MPa) Through	Number of validation cycles for the limitation of the fatigue limit (millions of cycles)	Average Fatigue Limit (MPa)
USIDUR 355 comparison example	432	514	1.106	279
USIFORM 800 comparison example	766	872	2.106	388
Result according to the invention, no precoating	980	1490	2. 106	249

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Result according to the invention	980	1480	2. 106	439

Compared to the USIDUR 355 sheet, commonly used industrially for implementing wheel disks, the improvement is 40% in life or reduced weight. Compared to the grade indicated, used for wheel disks, the fatigue limit has an improvement of over 12%.

The following are the advantages of obtaining a part by a hot-forming method and in particular obtaining all or part of an automotive vehicle wheel:

- A wheel disk implementation in a single forming pass;
- Because of the significant hot formability, a single tool is needed; it is therefore possible to make parts with complex shapes, in series, economically such as styled wheels;
- A very good dimensional guarantee because there is no elastic return as in the case of cold stamping or flow-turning;
- The high mechanical properties after tempering in the stamping tool allow significant weight reduction;
- The precoating provides an enhanced guarantee against corrosion and wear;
- An increased formability during heating of the sheet-metal blank allows hot forming of thicknesses that usually could only be formed by flow-turning;
- The deformation can take place during the hot austenitic phase, without damage, which guarantees a better fatigue resistance by elimination of internal defects generally created during hot deformation;
- Because of the precoating, there is no need to lubricate the sheet during the hot forming, thus eliminating the degreasing step before painting;
- Because of the coating, there is no need to apply temporary corrosion protection on the parts awaiting painting;
- Unlike zinc-based coatings, the thermally untreated precoating does not degrade the fatigue resistance and even increases it;
- The impact behavior is improved by the use of the selected steel type;
- The thermally treated precoating does not need specific welding material and precautions.

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TRANSLATION

Other parts can benefit from this production method. Specifically, the fatigue-sized suspension parts can be indicated such as: control arms, tie rods, etc.

CLAIMS

1. A hot-forming method and in particular obtaining all or part of an automotive vehicle wheel, for example a wheel disk, characterized in that in a hot-stamping operation a precoated steel sheet hot or cold rolled for thermal treatment is used.

2. The method according to claim 1, characterized in that the steel sheet is a precoated hot-rolled steel sheet with the following general composition by weight:

   0.15% < carbon < 0.5%
   0.5% < manganese < 3%
   0.1% < silicon < 0.5%
   0% < chrome < 1%
   Titanium < 0.2%
   Aluminum < 0.1%
   Phosphorus < 0.1%
   Sulfur < 0.05%
   0.0005% < boron < 0.08%

3. The method according to claim 1, characterized in that the coating is aluminum-based.

4. The method according to claim 1, characterized in that preferably, the steel sheet is a precoated hot or cold-rolled steel sheet with the following composition by weight:

   0.15% < carbon < 0.5%
   0.8% < manganese < 1.5%
   0.1% < silicon < 0.35%
   0.01% < chrome < 1%
   Titanium < 0.1%
   Aluminum < 0.1%

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Phosphorus < 0.05%

Sulfur < 0.03%

0.0005% < boron < 0.01%

5. The method according to claim 1, characterized in that in the composition by weight of the sheet, the titanium concentration relative to the nitrogen concentration is greater than 3.42.

6. The method according to claim 1, characterized in that the base composition by weight of the metal bath for coating comprises from 9% to 10% silicon, 2% to 3.5% iron, and the remainder of the bath is composed of aluminum and impurities.

7. The method according to claim 1, characterized in that the base composition by weight of the metal bath for coating comprises from 2% to 4% iron.

8. The method according to claim 1, characterized in that the base composition by weight of the metal bath for coating comprises from 0 to 50% zinc.

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TRANSLATION

2,833,504

[logo]

INSTITUT NATIONAL DE LA PROPRIÉTÉ INDUSTRIELLE [NATIONAL INSTITUTE OF INDUSTRIAL PROPERTY]

PRELIMINARY SEARCH REPORT

prepared on the basis of the latest claims filed before beginning the search

NATIONAL REGISTRATION NUMBER

FA 611824
FR 0116185

	DOCUMENTS FOUND TO BE PERTINENT	Claims relevant to the examined application	Classification assigned to the invention by INPI
Category	Document citations with indication of the pertinent parts if necessary		
D,X	FR 2 780 984 A (LORRAINE LAMINAGE) 14 janvier 2000 (2000-01-14) * le document en entier * ---	1-8	B21D53/26 C21D8/02 C22C38/32 C22C38/38
D,X	FR 2,787,735 A (LORRAINE LAMINAGE) June 30, 2000 (2000-06-30) * the entire document * ---	1	
A	US 4,397,345 A (RAMARATNAM KRISHNASWAMY ET AL) August 9, 1983 (1983-08-09)		
			TECHNICAL DOMAINS SEARCHED (Int.CL.7)
			B21D

Date search completed:	Examiner
August 14, 2002	Peeters, L

CATEGORY OF THE DOCUMENTS CITED

X: particularly pertinent on its own
Y: particularly relevant in combination with another document in the same category
A: pertinent to the background of at least one claim or general technology background
O: un-written disclosure
P: document insert

T: theory or principal underlying the invention
E: patent document having a date earlier than the filling date and which had only been published on the filling date or on a later date
D: cited in the application
L: cited for other reasons
.....
&: member of the same family; corresponding document

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TRANSLATION

2,833,504

ATTACHMENT TO THE PRELIMINARY SEARCH REPORT CONCERNING THE FRENCH PATENT APPLICATION NUM.: FR 0116185 FA 611824

The present attachment indicates the members of the patent family concerning the patent documents cited in the preliminary group search report given above.
The said members are contained in the computer file of the European Patent Office as of August 14, 2002.
The information provided is given for information and does not incur the responsibility of the European Patent Office, or the French Authority.

Patent Documents Cited in the Search Report	Publication Date	Member(s) of the Patent Family(ies)	Publication Date
FR 2,780,984 A	14-01-2000	FR 2,780,984 A1	14-01-2000
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For complete information concerning this attachment: see Official Journal of the European Patent Office, number 12/82

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DECLARATION OF BRUCE D. POPP

I, Bruce D. Popp, declare the following:

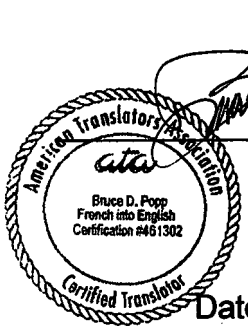
1. I am over 18 years of age and competent to make this declaration.

2. I am a qualified French to English translator as certified by the American Translators Association.

3. I have translated the attached patent application bearing Publication No. 2,833,504 and a filing date of December 14, 2001, regarding "Hot-forming method and in particular obtaining all or part of an automotive vehicle wheel."

4. I affirm that the translated text has been translated and edited to the best of my ability and knowledge to accurately reflect the content, meaning, and style of the original text. I hereby certify under penalty of perjury under the laws of the United States of America that the foregoing constitutes, pursuant to my knowledge and belief, a true and correct translation of the original document.

5. I declare that all statements made herein of my knowledge are true, and that all statements made on information and belief are believed to be true, and that these statements were made with the knowledge that willful false statements and the like are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code.



Bruce D. Popp

Dated and signed on May 10, 2019.

(19) RÉPUBLIQUE FRANÇAISE

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DE LA PROPRIÉTÉ INDUSTRIELLE

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(56) **Liste des documents cités dans le rapport de recherche préliminaire :** *Se reporter à la fin du présent fascicule*

(60) **Références à d'autres documents nationaux apparentés :**

(71) **Demandeur(s) :** *USINOR Société anonyme* — FR.

(72) **Inventeur(s) :** LAURENT JEAN PIERRE, DERUY SYLVAIN et DEVROC JACQUES.

(73) **Titulaire(s) :**

(74) **Mandataire(s) :**

(54) PROCEDE DE MISE EN FORME A CHAUD ET NOTAMMENT L'OBTENTION DE TOUT OU PARTIE D'UNE ROUE DE VEHICULE AUTOMOBILE.

(57) Procédé de mise en forme à chaud et notamment, obtention de tout ou partie d'une roue de véhicule automobile comme par exemple un voile de roue, caractérisé en ce qu'on utilise, dans une opération d'emboutissage à chaud, une tôle d'acier laminée à chaud pour traitement thermique pré revêtu.

FR 2 833 504 - A1

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Procédé de mise en forme à chaud et notamment l'obtention de tout ou partie d'une roue de véhicule automobile.

La présente invention concerne l'obtention d'une pièce par un procédé de mise en forme à chaud et notamment l'obtention de tout ou partie d'une roue de véhicule automobile.

Actuellement, les voiles de roues sont obtenus soit par emboutissage à froid d'un flan de tôle soit par fluotournage.

Dans le cas de l'obtention d'un voile par emboutissage d'un flan de tôle, il est nécessaire de réaliser plusieurs opérations de mise en forme, ce qui impose la réalisation de plusieurs outils d'emboutissage. Le nombre d'outils d'emboutissage est de l'ordre de 7, 8 ou 9.

Les principaux inconvénients de la présente technique citée sont les suivants :

- Tout changement de forme nécessite l'usinage ou la fabrication de 7 à 9 paires d'outils différents.
- Tout changement de fabrication occasionne le démontage puis le montage et le réglage de 7 à 9 outils ainsi que le réglage des presses associées.
- Ces nombreux outils doivent être stockés.
- Le coût de fabrication des outils ne permet pas la réalisation de petites séries de manière économique.
- Il n'est pas possible de réaliser des pièces de forte épaisseur.

Dans le cas de l'obtention, par exemple, d'un voile de roue par fluotournage, la productivité est réduite comparativement à l'emboutissage, ce qui limite la fabrication en grandes séries.

Dans les deux techniques citées :

- L'utilisation d'huile d'emboutissage ou de lubrifiant est impératif et nécessite un dégraissage avant mise en peinture.
- Il faut stocker et traiter ces huiles ainsi que les effluents.

Du point de vue des caractéristiques recherchées :

- L'augmentation des caractéristiques mécaniques entraîne une diminution de la formabilité, ce qui limite la forme des voiles, et génère un retour élastique accru, pénalisant les garanties dimensionnelles.
- L'augmentation des caractéristiques mécaniques impose d'utiliser des presses de plus en plus puissantes.

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- La protection temporaire contre la corrosion, avant peinture par exemple d'un voile embouti, nécessite d'huiler la pièce puis de la dégraisser. Il est également nécessaire de retirer l'huile d'emboutissage avant peinture, ce qui comporte un coût et un risque écologique.

Le but de l'invention est la réalisation d'une pièce par emboutissage à chaud, en une seule passe, en respectant les garanties dimensionnelles, tout en ayant la possibilité d'obtenir des formes complexes.

L'invention a pour objet l'obtention d'une pièce par un procédé de mise en forme à chaud et notamment l'obtention de tout ou partie d'une roue de véhicule automobile comme par exemple un voile de roue, caractérisée en ce qu'on utilise, dans une opération d'emboutissage à chaud, une tôle d'acier laminée à chaud pour traitement thermique, pré revêtue.

Les autres caractéristiques de l'invention sont :

- la tôle d'acier est une tôle d'acier laminée à chaud ou à froid pré revêtue de composition générale pondérale suivante :

0,15% < carbone < 0,5%
0,5% < manganèse < 3%
0,1% < silicium < 0,5%
0% < chrome < 1%
titane < 0,2%
aluminium < 0,1%
phosphore < 0,1%
soufre < 0,05%
0,0005% < bore < 0,08%

les autres caractéristiques de l'invention sont :

- le revêtement est à base d'aluminium,
- de préférence, la tôle d'acier est une tôle d'acier laminée à chaud ou à froid pré revêtue de la composition pondérale suivante :

0,15% < carbone < 0,5%
0,8% < manganèse < 1,5%
0,1% < silicium < 0,35%
0% < chrome < 1%
titane < 0,1%
aluminium < 0,1%

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phosphore < 0,05%

soufre < 0,03%

0,0005% < bore < 0,01%

- dans la composition pondérale de la tôle, la teneur en titane par rapport à la teneur en azote est supérieure à 3,42,
- le bain métallique du revêtement comprend dans sa composition pondérale de base, de 9% à 10% de silicium, de 2% à 3,5% de fer, le reste du bain étant composé d'aluminium et des impuretés,
- le bain métallique du revêtement comprend dans sa composition pondérale de base de 2% à 4% de fer,
- le bain métallique du revêtement peut contenir dans sa composition pondérale de base, de 0 à 50% de zinc.

La description qui suit fera bien comprendre l'invention.

Le problème posé est de réaliser une pièce par un procédé de mise en forme à chaud et notamment l'obtention de tout ou partie d'une roue de véhicule automobile comme par exemple, un voile de roue de VL ou PL (voiture légère ou poids lourd) ou un voile de roue et une partie de la jante de roue, en une seule passe, en respectant les garanties dimensionnelles, tout en réalisant des formes complexes.

Il est connu de la demande de brevet FR N° 98 08793 une tôle d'acier à chaud et à froid revêtue et comportant une très haute résistance après traitement thermique. Il est également connu de la demande de brevet FR N° 98 16477 un procédé de réalisation d'une pièce à partir d'une bande de tôle d'acier laminée et notamment laminée à chaud.

Selon l'invention, une utilisation particulièrement importante d'une tôle et du procédé présentés a été démontrée, dans l'obtention d'une pièce par un procédé de mise en forme à chaud et, notamment, l'obtention de tout ou partie d'une roue de véhicule automobile, en une seule passe d'emboutissage à chaud, alors que les techniques utilisées à ce jour, demande des outillages nombreux, complexes, ainsi que des opérations nombreuses de mise en forme.

A l'encontre des habitudes industrielles connues, les inventeurs ont obtenu, en une seule passe, par emboutissage à chaud d'une tôle d'acier laminée à chaud pré revêtu, un voile de roue, qui antérieurement, était réalisé en 7 ou 8 opérations d'emboutissage, le plan de tôle prédécoupé ayant la composition pondérale générale suivante :

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0,15% < carbone < 0,5%

0,5% < manganèses < 3%

0,1% < silicium < 0,5%

0,01% < chrome < 1%

titane < 0,2%

aluminium < 0,1%

phosphore < 0,1%

soufre < 0,05%

0,0005% < bore < 0,08%

L'utilisation d'un acier pour traitement thermique pré revêtu permet d'obtenir un gain notable en résistance à la fatigue sans poser de problème de soudage et en présentant une résistance accrue à la corrosion après peinture.

De plus, le procédé et l'acier utilisé permettent un allègement notable et une augmentation de la durée de vie en fatigue. Enfin, le voile obtenu peut être soudé puis peint sans modification des lignes existantes.

De préférence l'acier de la tôle a la composition pondérale suivante :

0,15% < carbone < 0,5%

0,8% < manganèses < 1,5%

0,1% < silicium < 0,35%

0,01% < chrome < 1%

titane < 0,1%

aluminium < 0,1%

phosphore < 0,05%

soufre < 0,03%

0,0005% < bore < 0,01%

la tôle assurant une très haute résistance mécanique après traitement thermique et le revêtement à base d'aluminium assurant une haute tenue à la corrosion et à la fatigue.

Pour l'obtention de la pièce, en une seule passe, par emboutissage à chaud de la tôle laminée à chaud revêtue, il est préférable que la teneur en titane par rapport à la teneur en azote soit supérieure à 3,42.

Le revêtement de la tôle laminée à chaud revêtue, à base d'aluminium, comprend dans sa composition pondérale de base, de 9% à 10% de silicium, de 2% à 3,5% de fer.

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Le revêtement de la tôle laminée à chaud revêtue peut également comprendre dans sa composition pondérale de base, de 2% à 4% de fer. Le bain métallique peut contenir dans sa composition pondérale de base de 0 à 50% de zinc.

Dans un exemple de réalisation, l'acier selon l'invention contenant 0,231% de carbone ; 1,145% de manganèse ; 0,020% de phosphore ; 0,0038% de soufre ; 0,239% de silicium ; 0,043% d'aluminium ; 0,009% de cuivre ; 0,020% de nickel ; 0,179% de chrome ; 0.0042% d'azote ; 0.032% de titane ; 0,0028% de bore ; 0,0051% de calcium, sous la forme d'une tôle est revêtue d'une couche à base d'aluminium ayant environ 25 µm d'épaisseur avant traitement thermique.

Le flan de tôle est chauffé dans un four, à une température comprise entre 750°C et 1000°C et plus généralement à une température comprise entre 850°C et 950°C pendant un temps variant en fonction de l'épaisseur. Pour une épaisseur de 2 mm, le flan de tôle séjourne pendant 6 minutes dans le four. La vitesse de montée en température est supérieure à 3°C/s. Du fait du revêtement, il n'est pas nécessaire d'utiliser un four à atmosphère inerte.

Lors du réchauffage du flan de tôle, le revêtement s'allie avec le substrat pour former un alliage intermétallique. L'alliation entraîne, par inter diffusion, une augmentation de l'épaisseur de la couche qui, pour le traitement ci-dessus spécifié, correspond généralement à une augmentation de 50%.

Le flan de tôle chaud est ensuite transféré dans l'outil refroidi ou non, en fonction de la cadence, de l'épaisseur de la tôle et de la vitesse de refroidissement visée, pour être mis en forme. Il ne doit pas y avoir de pression de serre flan afin d'éviter le déchirement de la tôle dû à sa faible résistance à haute température. La vitesse de déformation doit être suffisante pour éviter de déformer l'acier à une température inférieure à 400°C.

Le voile de roue ainsi obtenu est maintenu dans l'outil jusqu'à atteindre une température inférieure à 200°C et de préférence inférieure à 100°C afin de respecter les garanties de dimension. La vitesse de refroidissement moyenne doit être supérieure a 27°C/s, entre la température de sortie du four et 400°C, si la structure visée pour le substrat est une structure martensitique. Si la vitesse moyenne de refroidissement est inférieure à cette valeur, de la bainite, de la ferrite, voire de la perlite peuvent apparaître. Il est ainsi possible d'obtenir différentes structures et donc différentes propriétés en fonction de la vitesse de refroidissement visée. Néanmoins, les meilleurs

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résultats en fatigue sont obtenus avec une structure de l'acier, totalement martensitique.

Du fait du formage à chaud, il n'y a pas d'endommagement de la structure métallurgique. Ceci a un effet bénéfique sur la tenue en fatigue du fait de la suppression des défauts internes pouvant servir d'initiation des fissures en fatigue. Il n'est pas nécessaire d'ajouter de lubrifiant d'emboutissage car le pré revêtement fait office de lubrifiant.

La pièce ainsi obtenue peut subir directement le cycle de peinture. Si ce n'est pas le cas, il n'est pas nécessaire d'appliquer une protection temporaire contre la corrosion car la couche alliée ralentit l'apparition de la corrosion. Lors du cycle thermique, le revêtement, alliée ou non, protège l'acier de l'oxydation et de la décarburation.

La couche alliée réalisée sur la pièce présente un gradient de dureté. En partant de la couche extrême et en se déplaçant vers la tôle, la dureté varie de 750HV0,1 à 300 HV0,1 à l'interface couche de revêtement - tôle, puis augmente jusqu'à environ 500HV0,1 dans la tôle, lorsque la structure de l'acier est totalement martensitique. C'est la couche à 300HV0,1 qui, en arrêtant les fissures, confère à la pièce une tenue en fatigue accrue.

Si on utilise l'acier de la solution proposée mais non pré revêtu, on note une dégradation importante de limite d'endurance moyenne, comme matérialisé sur le tableau 1 ci-dessous liée principalement à la décarburation de l'acier. La solution proposée, de part la présence de la pré protection, évite ce phénomène. Les essais de fatigue en flexion plane alternée montre un gain notable.

Tableau 1.

Acier	Rp0.2 (MPa) Travers	Rm (MPa) Travers	Nombre de cycles de validation de la limitation de la limite d'endurance (millions de cycles)	Limite d'endurance Moyenne (MPa)
USIDUR 355 exemple de comparaison	432	514	1. 106	279
USIFORM 800 exemple de comparaison	766	872	2. 106	388
Obtention selon l'invention, non pré revêtue	980	1490	2. 106	249
Obtention selon l'invention	980	1480	2. 106	439

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Par rapport à la tôle USIDUR 355, couramment utilisé industriellement pour la réalisation des voiles de roues, le gain est de 40% en durée de vie ou en allègement. Par rapport à la nuance citée, utilisée pour les voiles de roues, la limite d'endurance présente un gain supérieur à 12%.

Les avantages de l'obtention d'une pièce par un procédé de mise en forme à chaud et notamment l'obtention de tout ou partie d'une roue de véhicule automobile sont les suivants :

- une réalisation de voile de roue en une seule passe de formage,
- du fait de la formabilité importante à chaud, un seul outil est nécessaire. il est donc possible de faire des pièces de formes complexes en série de manière économique telles que les roues de style,
- une très bonne garantie dimensionnelle car il n'y a pas de retour élastique comme dans le cas de l'emboutissage à froid ou du fluotournage,
- les caractéristiques mécaniques élevées après trempe dans l'outil d'emboutissage permettent un allègement significatif,
- le pré revêtement assure une garantie accrue à la corrosion et à l'usure,
- une formabilité accrue lors de la chauffe du flan de tôle permet de former à chaud des épaisseurs ne pouvant habituellement être mise en forme que par fluotournage,
- une déformation peut avoir lieu dans la phase austénitique à chaud, sans endommagement, ce qui garantie une meilleure tenue à la fatigue par élimination des défauts internes généralement créés lors d'une déformation à froid,
- du fait du pré revêtement, il est inutile de lubrifier la tôle lors du formage à chaud, supprimant ainsi l'étape de dégraissage avant peinture,
- grâce au revêtement, il est inutile d'appliquer une protection temporaire contre la corrosion sur les pièces en attente de peinture,
- le pré revêtement non traité thermiquement, contrairement aux revêtements à base de zinc, ne dégrade pas la tenue à la fatigue et même l'augmente,
- le comportement aux chocs est renforcé par l'utilisation du type d'acier choisi,
- le pré revêtement traité thermiquement ne nécessite pas de matériel de soudage et de précaution particuliers.

D'autres pièces peuvent bénéficier de cette méthode d'obtention. On peut citer en particulier les pièces de liaison au sol dimensionnées en fatigue telles que : les bras de suspension, bras de roue...

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REVENDICATIONS.

1. Procédé de mise en forme à chaud et notamment, obtention de tout ou partie d'une roue de véhicule automobile comme par exemple un voile de roue, caractérisé en ce qu'on utilise, dans une opération d'emboutissage à chaud, une tôle d'acier laminée à chaud ou à froid pour traitement thermique pré revêtu.

2. Procédé selon la revendication 1, caractérisé en ce que la tôle d'acier est une tôle d'acier laminée à chaud pré revêtu de la composition générale pondérale suivante :

0,15% < carbone < 0,5%
0,5% < manganèse < 3%
0,1% < silicium < 0,5%
0% < chrome < 1%
titane < 0,2%
aluminium < 0,1%
phosphore < 0,1%
soufre < 0,05%
0,0005% < bore < 0,08%

3. Procédé selon la revendication 1, caractérisé en ce que le revêtement est à base d'aluminium.

4. Procédé selon la revendication 1, caractérisé en ce que de préférence, la tôle d'acier est une tôle d'acier laminée à chaud ou à froid pré revêtue de la composition pondérale suivante :

0,15% < carbone < 0,5%
0,8% < manganèse < 1,5%
0,1% < silicium < 0,35%
0,01% < chrome < 1%
titane < 0,1%
aluminium < 0,1%
phosphore < 0,05%
soufre < 0,03%
0,0005% < bore < 0,01%

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5. Procédé selon la revendication 1, caractérisé en ce que dans la composition pondérale de la tôle, la teneur en titane par rapport à la teneur en azote est supérieure à 3,42.

6. Procédé selon la revendication 1, caractérisé en ce que le bain métallique du revêtement comprend dans sa composition pondérale de base, de 9% à 10% de silicium, de 2% à 3,5% de fer, le reste du bain étant composé d'aluminium et des impuretés.

7. Procédé selon la revendication 1, caractérisé en ce que le bain métallique du revêtement comprend dans sa composition pondérale de base, de 2% à 4% de fer.

8. Procédé selon la revendication 1, caractérisé en ce que le bain métallique du revêtement peut contenir dans sa composition pondérale de base, de 0 à 50% de zinc.

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INPI
INSTITUT NATIONAL DE LA PROPRIETE INDUSTRIELLE

2833504

N° d'enregistrement national

FA 611824
FR 0116185

RAPPORT DE RECHERCHE PRÉLIMINAIRE

établi sur la base des dernières revendications déposées avant le commencement de la recherche

DOCUMENTS CONSIDÉRÉS COMME PERTINENTS		Revendication(s) concernée(s)	Classement attribué à l'invention par l'INPI
Catégorie	Citation du document avec indication, en cas de besoin, des parties pertinentes		
D,X	FR 2 780 984 A (LORRAINE LAMINAGE) 14 janvier 2000 (2000-01-14) * le document en entier *	1-8	B21D53/26 C21D8/02 C22C38/32 C22C38/38
D,X	FR 2 787 735 A (LORRAINE LAMINAGE) 30 juin 2000 (2000-06-30) * le document en entier *	1	
A	US 4 397 345 A (RAMARATNAM KRISHNASWAMY ET AL) 9 août 1983 (1983-08-09)		
			DOMAINES TECHNIQUES RECHERCHÉS (Int.CL.7)
			B21D

Date d'achèvement de la recherche	Examinateur
14 août 2002	Peeters, L

CATÉGORIE DES DOCUMENTS CITÉS

X : particulièrement pertinent à lui seul
Y : particulièrement pertinent en combinaison avec un autre document de la même catégorie
A : arrière-plan technologique
O : divulgation non-écrite
P : document intercalaire

T : théorie ou principe à la base de l'invention
E : document de brevet bénéficiant d'une date antérieure à la date de dépôt et qui n'a été publié qu'à cette date de dépôt ou qu'à une date postérieure.
D : cité dans la demande
L : cité pour d'autres raisons

& : membre de la même famille, document correspondant

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ANNEXE AU RAPPORT DE RECHERCHE PRÉLIMINAIRE RELATIF A LA DEMANDE DE BREVET FRANÇAIS NO. FR 0116185 FA 611824

La présente annexe indique les membres de la famille de brevets relatifs aux documents brevets cités dans le rapport de recherche préliminaire visé ci-dessus.
Les dits membres sont contenus au fichier informatique de l'Office européen des brevets à la date du 14-08-2002
Les renseignements fournis sont donnés à titre indicatif et n'engagent pas la responsabilité de l'Office européen des brevets, ni de l'Administration française

Document brevet cité au rapport de recherche	Date de publication	Membre(s) de la famille de brevet(s)	Date de publication
FR 2780984 A	14-01-2000	FR 2780984 A1	14-01-2000
		BR 9902712 A	08-03-2000
		EP 0971044 A1	12-01-2000
		JP 2000038640 A	08-02-2000
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US 4397345 A	09-08-1983	AUCUN	

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Pour tout renseignement concernant cette annexe : voir Journal Officiel de l'Office européen des brevets, No.12/82

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[Document Name]Description

[Title of the invention]Hot pressing method for high strength member using steel sheet and hot pressed parts

[Technical field]

[0001]The present invention relates to a hot pressing method and a hot press part for manufacturing a strength member such as a pillar, a door impact beam, a bumper beam, etc. of an automobile using cold rolling, hot rolled steel sheet or Al based or Zn based plated steel sheet.

[Background of the invention]

[0002]In order to reduce the weight of an automobile which comes to an end of global environmental problem, it is necessary to increase the strength of steel plates used in automobiles as high as possible, but as the steel plate is increased in strength, elongation and r value decrease and moldability deteriorates.In order to solve such a problem, Japanese Unexamined Patent Publication No. 2000 (1999) - 234153 discloses a technique in which hot molding is performed and the strength is increased by utilizing heat at that time.In this technique, it is intended to appropriately control a component in steel, heat in a temperature range of ferrite, and increase in strength using precipitation strengthening in this temperature range.In addition, Japanese Patent Application Laid-open No. 87183 (2000) proposes a high-strength steel sheet which has a yield strength at a molding temperature which is much lower than a yield strength at room temperature for the purpose of improving press forming accuracy.However, with such technology, a limit may be in the strength obtained. On the other hand, Japanese Unexamined Patent Publication No. Hei 2000 (1999) - 38640 proposes a technique in which, for the purpose of obtaining higher strength, heat is applied to a high temperature austenite single phase region after molding, and then transformed into a hard phase in a subsequent cooling step.

[0003]However, if heat and rapid cooling is performed after molding, there is a possibility of causing a problem in shape accuracy.As a technique for overcoming this drawback, there is disclosed a technique in which a steel sheet is heated to an austenite single phase region and is then cooled at a rate higher than or equal to a critical cooling rate of martensitic transformation determined by a steel component in a press forming process (SAE, 2001 - 01 0078) and Japanese Unexamined Patent Publication No. Hei 2001 - 181833.In the former document, it is disclosed to use an Al plated steel sheet in order to suppress generation of scale on heating.This pressing step is referred to as hot pressing in the present invention.

[0004]As a prior art relating to a hot press using such a plated steel sheet, there is the following.Japanese Patent Application Laid-open No. 147499 2003 discloses an example in which a steel plate coated with a plating layer made of Fe - Zn alloy is used for hot pressing, and Japanese Unexamined Patent Publication No. Hei 2003 (1999) - 41343 discloses an example in which an Al-based plating steel sheet coated with a plating layer made of Fe - Al alloy is used for hot pressing.Further, as a method of pressing a heated metal plate material using a die and a punch in Japanese Patent Laid-Open No. 2002 282951, an example is disclosed in which a clearance of a mold is

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defined from the viewpoint of formability and hardenability.

[Patent document 1]JP 2000-87183A

[Patent document 2]JP 2000-38640A

[Patent document 3]JP 2001-181833A

[Patent document 4]JP 2003-147499A

[Patent document 5]JP 2003-41343A

[Patent document 6]JP 2002-282951A

[Non-patent document1]SAE, 2001 - 01 - 0078

[Disclosure of the invention]

[Problem to be solved by the invention]

[0005]As described above, a high-strength steel sheet used in an automobile or the like has an essential problem of the above mentioned moldability, particularly, a hydrogen embrittlement (sometimes referred to as a placement or delayed fracture) of a high strength material having a strength of more than 1000 MPa.Therefore, when used as a steel sheet for hot pressing, it is important to reduce the amount of hydrogen in a raw material.It is an object of the present invention to solve the above problems and to provide a hot rolling and cold rolled steel sheet which is capable of obtaining a strength of 1200 MPa or more after high temperature molding, and which has extremely little fear of hydrogen embrittlement, and a hot pressing method and a press part using an Al based plated steel sheet or a Zn based plated steel sheet.

[Means for solving the problem]

[0006]In order to solve the above problems, the present inventors have conducted various studies.As a result, it has been found that it is extremely important to control the atmosphere and the temperature at the time of heating to an austenite single phase region before pressing to produce a plated steel sheet for hot pressing excellent in hydrogen embrittlement resistance.In other words, if hydrogen is contained in an atmosphere at the time of heating, it is important to reduce these components because the hydrogen penetrates into the steel plate and the hydrogen possibly enters the steel plate even if moisture is contained.It has also been found that it is important to properly select the clearance of the mold to prevent hydrogen embrittlement.The gist of the present invention based on such knowledge is as follows.

(1) A steel sheet containing a C:0.05~0.5% as a steel component as a steel component, or a steel sheet plated with Al or Zn as a main component is manufactured by a hot pressing method. A hot pressing method of the high strength automobile component the heating temperature before a press being three or more Ac(s) and 1100 degrees C or less, and making hydrogen concentration in a heated atmosphere below into the 6 volume %, and the dew point being 10 degrees C or less.

(2) A hot pressing method for a high strength automobile member according to claim 1, wherein a hydrogen concentration in a heating atmosphere is 1 vol% or less and a dew point is 10 ° C. or less.

(3) The present invention is characterized in that a gap (a clearance) between a die

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and a punch is 1.0 to 1.8 times as large as a thickness of a steel material to be used, when a steel sheet is introduced into a press and is molded after heating (1). A hot pressing method according to item 2).
(4) A hot press part comprising the hot press method according to any one of (1) to (3).

[Effect of the invention]

[0007]According to the present invention, a high-strength member can be manufactured by hot pressing using a hot rolling, a cold rolled steel sheet, an Al based plated steel sheet, or a Zn based plated steel sheet, and can be used without hydrogen embrittlement, and its industrial significance is extremely large.

[Best mode for carrying out the invention]

[0008]Next, a limitation of the present invention will be described.As described above, according to the present invention, hot rolling, cold rolled steel sheet, or Al based, Zn based plated steel sheet is heated to 700 ° C. or higher and then hot molded and immediately cooled by a mold and quenched to obtain desired strength, and in the present invention, a steel sheet before heating, press forming is defined.As a steel sheet component, it is necessary to be excellent in hardenability, and for this purpose, it is necessary to have a C content of 0.05% or more, and preferably 0.1% or more.For other elements in the steel, elements such as Si,Mn,Ti,B,Cr,Mo,Al,P,S,N may be added.Si is effective in fatigue characteristics, and is preferably 0.05 to 1% by weight.Since Mn,B,Cr,Mo contributes to improvement in hardenability, when making it contain, it is [below Mn:0.5~3%,B:0.05%] desirable to use less than Cr:2% and less than Mo:0.5%. Ti and Al improve the oxidation resistance of an Al based plated steel sheet, and it is desirable to contain Ti in an amount of 0.5% or less and Al in an amount of 0.1% or less, when contained.

[0009]As the plating type, a steel plate or a steel plate plated with Zn is considered, and when these steel plates are used for hot pressing, formation of iron oxide on the surface can be suppressed and corrosion resistance can be imparted.The composition of Al system plating layer is described first. An Al-based plated steel sheet is currently manufactured for various applications, and the present invention is applicable to these steel sheets.As a configuration of the Al-based plating layer, there is a steel plate containing Al as a main component and preferably containing 3 to 15% of Si in order to suppress generation of an alloy layer during hot-dip Al plating.In addition, Cr,Mg,Ti,Sn or the like is used as an element for further improving corrosion resistance of the plating layer, and it is also possible to add these elements.In this case, it is desirable to contain a Cr:0.1~1%,Mg:0.5~10%,Ti:0.1~1%,Sn:1~5%.In addition, Fe is contained as an impurity in the Al-based plating layer, and this amount is usually 0.05 to 0.5%.In addition, an intermetallic compound such as FeAl3,Fe2Al5,Fe3Al,Fe2Al8Si may be formed on the surface after heating.These phases tend to have a multilayer structure which is typically a 5 layer structure, but these phase structures do not detract from the spirit of the invention.Further, as the composition thereof, Al, Fe is mainly used, and Si is also contained in the Al plating bath when Si is added in an amount of 5 to 10%.The composition of these elements accounts for 90% or more in total.In addition, there may be a small amount of Al that is not alloyed, but a small amount of Al does not affect performance particularly.After heating, an Al-based oxide or a nitride covers the surface, and the amount thereof is not particularly limited.

[0010]Next, a structure of the Zn-based plating layer will be described.The Zn-based

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plated steel sheet has various compositions now, and the present invention is applicable to these steel sheets.As a typical structure of the Zn plating layer, the following may be mentioned.Zn - 0.2% Al, Zn - 5% Al - 0.1% Mg, Zn - 5% Al - 0.1% Mg - Misch metal, Zn - 7% Al - 3% Mg, Zn - 11% Al - 3% Mg - 0.1% Si, Zn - 55% Al - 1.6% Si, etc.In addition, there are some which were changed to Zn-10% Fe by heating after plating with Al bath Zn-0.1%. In addition, Cr,Mg,Ti,Sn or the like is used as an element for further improving corrosion resistance of the plating layer, and it is also possible to add these elements.In this case, it is desirable to contain a Cr:0.1~1%,Mg:0.5~10%,Ti:0.1~1%,Sn:1~5%.In addition, a ferrite phase containing ζ, δ 1, Γ, Γ 1, and so on or a ferrite phase in which Zn is dissolved can be formed on the surface after heating.These phases may be distributed in layers or distributed in the form of granules, which does not detract from the spirit of the invention.In addition, as long as Al contains Al, the Fe - Al based compound may be generated.In the case of Zn plating, a Zn based or Al based oxide film is formed after heating, but even if these films are generated, the gist of the present invention is not impaired.

[0011]Although there is no particular limitation on the deposition amount of Al based, Zn based plating, the plating pretreatment, and the post treatment, it is desirable that the plating deposition amount is 50 g / m 2 or more of one side.This is because, as the amount of plating applied increases, an effect of suppressing oxidation at the time of heating, a heating, and a corrosion resistance at the time of forming a molded rear part are improved.As a post-plating treatment, a chromate treatment, a resin coating treatment, or the like may be used for the purpose of primary rust prevention and lubricity, but it is not preferable because the organic resin is lost when heated.In consideration of the 6 valent chromium regulation in recent years, a 3 valent treatment film such as electrolytic chromate is preferred.It is possible to use only an oil coating without applying a chromate film in the case of an Al-based plated steel sheet excellent in corrosion resistance.Specifying the temperature and atmosphere at the time of heating in the present invention, the temperature shall be three or more Ac(s) and 1100 degrees C or less. This is due to the fact that an Ac 3 temperature or higher is required for completely transforming the steel sheet into an austenite single phase region, while an excessively high heating temperature leads to an oxidation of the surface and an active entry of hydrogen into the steel.In addition, when Zn plating is used, it is desirable to set the temperature at 1000 ° C. as an upper limit because Zn is completely evaporated at a temperature of about 910 ° C. and Zn is completely evaporated at a high temperature.More preferably, the upper limit temperature is 920 ° C.The lower limit temperature is preferably 800 ° C.This is because, even when heating is performed at an Ac 3 temperature or higher, the temperature of the steel sheet is lowered during the transfer of the steel sheet from the furnace to the press machine after the heating, and thus, the ferrite may be generated.

[0012]The heating atmosphere has a hydrogen concentration of 6 vol% or less.This is to increase the possibility of hydrogen embrittlement due to intrusion of hydrogen into the steel as described above.A lower limit is not particularly provided, and a lower limit is preferable.More preferably, the amount of hydrogen is 1% or less.It has also been found in the present invention that moisture in the atmosphere can easily enter into the steel as hydrogen.For this reason, it is preferred that the moisture content in the atmosphere is low, and the dew point is measured to measure the water content, but the upper limit of the dew point is set to 10 ° C.In addition, as for the conversion of the dew point and the water content, the following formula is known, and the water content at this time is 1.2 vol%.In particular, when a Zn based plated steel sheet is used, oxygen is contained in an atmosphere, and Zn

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oxide tends to be formed on the surface of the steel sheet to suppress evaporation of Zn. For this reason, when a Zn-based plated steel sheet is used, oxygen is preferably contained in an atmosphere of 1 to 21%. In addition, it is necessary to control the hydrogen concentration and the moisture content in a heated atmosphere because of the presence of hydrogen penetration during heating of a steel plate (bare material) without plating.

[Mathematical formula 1]

$$pH2O = \exp\left(-\frac{44016 - 118.774 * Tdp}{8.314 * Tdp}\right)$$

pH2O:水素濃度(体積分率) Tdp:露点(絶対温度)

[0013]The heating method is not particularly limited, and an induction heating, a radiant heating, an induction heating, or the like may be used. In this case, the heating rate is not limited. This of course depends largely on the thickness and shape of the plate. A hot press is characterized in that it cools from an austenite phase to obtain a hardened structure, and, of course, a cooling rate after heating is large. In the present invention, it is necessary to cool at least a critical cooling rate for obtaining a martensitic structure determined by a steel component, but as a guideline, it is desirable that an average cooling temperature from 700 ° C. to 350 ° C. is 15 ° C. / sec or more. It is considered that this cooling rate depends on the steel component, and in a steel having good hardenability, a desired martensite is obtained as a main component even at a cooling rate of about 20 ° C. / sec, and a cooling rate of about 30 ° C. / sec is required depending on the type of steel. While a gap (clearance) between a die and a punch is one of important factors at the time of pressing, in the present invention, this clearance is preferably 1.0 to 1.8 times the thickness of the plate thickness. Since a board cannot flow easily and it will become ironing if clearance is narrow, galling occurs in a steel sheet surface, and it is thought that it may become a starting point of hydrogen embrittlement. When wide, it is in the tendency which becomes that it is hard to be tempered, and strength unevenness arises in parts and it is thought that remaining stress remains and concern of hydrogen embrittlement increases into parts.

[Examples]

[0014]Hereinafter, the present invention will be described in more detail with reference to Examples.

(Example 1)

A cold rolled steel sheet having a steel component shown in Table 1 and having a thickness of 1.4 was heated under various conditions, and then molded by a hat-shaped mold shown in FIG. 1. The clearance was 1.1 times the thickness of the plate. Then, punching of 5 ϕ and 0.5 of clearance (both sides) was performed on the flange portion of the hat at 10 points, and after 7 days, the punched portion was observed by a loupe of 20 times to determine presence / absence of fine cracks. Heating was performed by inserting a sample into an atmosphere controlled electric furnace. A temperature rise time of up to 900 ° C. was approximately 4 minutes, a time from the furnace to the press was approximately 10 seconds, and a press start temperature was approximately 750 ° C. Cooling was performed with a mold, and average cooling speed from 700 ° C. to 350 ° C. was 40 ° C. / sec. Table 2 shows the heating conditions and the presence or absence of microcracks. In addition, when the Vickers hardness was measured at a partial cutting load of 10 kgf after molding, all of the samples were

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in the range of Hv:410~510, and the microstructure showed a martensitic structure.After hot pressing, iron oxide was generated on the surfaces of these steel sheets.In No. 8 of Example 1, there were 5 or more microcracks due to the high dew point.In No. 1 and No. 3, since the amount of hydrogen was 1% or more, small cracks occurred.

[0015]

[Table 1]

表 1

符号	C	Si	Mn	P	S	Al	N	Ti	Cr	Mo	B
A	0.15	0.1	2.1	0.01	0.004	0.03	0.004	0.02	0.4	0.01	0.003
B	0.21	0.2	0.9	0.02	0.005	0.015	0.005	0.01	0.9	0.4	0.004
C	0.27	0.15	0.88	0.01	0.002	0.02	0.004	0.02	0.23	0.5	0.003

[Table 2]

表2

番号	鋼	温度 (℃)	保定時間(分)	加熱雰囲気			微小クラックの発生	
				水素 (vol%)	露点 (℃)	酸素 (vol%)		
1	A	950	1	5	8	0.01	△	本発明例
2	A	900	1	0.1	2	0.3	◎	本発明例
3	B	800	2	2	-10	0.5	○	本発明例
4	B	850	3	0.5	0	21	◎	本発明例
5	C	1000	1	0.1	-30	21	◎	本発明例
6	C	850	5	0.05	2	21	◎	本発明例
7	A	900	10	0.07	6	21	◎	本発明例
8	B	850	8	0.1	13	21	×	比較例
9	B	850	5	0.2	0	21	◎	本発明例
10	C	850	2	0.1	-10	21	◎	本発明例

微小クラックの発生評点

10 点中の微小クラックの個数の合計　◎:0 個、○:1 個、△:5 個未満、×5 個以上

(Example 2)

[0016]Molten Al plating was performed using a cold-rolled steel sheet (thickness of 1.4) as shown in Table 3, which has undergone a conventional hot rolling process and a cold rolling process, as a material.In the hot-dip Al plating, a line of an

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oxidation furnace - a reduction furnace flag was used, and a plating amount was adjusted to 80 g / m 2 by a gas wiping method after plating, followed by cooling.At this time, the plating bath composition was Al - 10% Si - 2% Fe, and the bath temperature was 660 ° C.Fe in the bath is unavoidable from plating equipment and strips.The plating appearance was good without non-plating.The molten Al plated steel sheet thus prepared was heated under various conditions and then molded by a hat-shaped mold shown in FIG. 1.The clearance was 1.1 times the thickness of the plate.Then, punching of 5 ϕ and 0.5 of clearance (both sides) was performed on the flange portion of the hat at 10 points, and after 7 days, the punched portion was observed by a loupe of 20 times to determine presence / absence of fine cracks.Heating was performed by inserting a sample into an atmosphere controlled electric furnace.A temperature rise time of up to 900 ° C. was approximately 4 minutes, a time from the furnace to the press was approximately 10 seconds, and a press start temperature was approximately 750 ° C.Cooling was performed with a mold, and average cooling speed from 700 ° C. to 350 ° C. was 40 ° C. / sec.Table 4 shows the heating conditions and the presence or absence of microcracks.In addition, when the Vickers hardness was measured at a partial cutting load of 10 kgf after molding, all of the samples were in the range of Hv:410~510, and the microstructure showed a martensitic structure.After hot pressing, no iron oxide was generated on the surfaces of these steel sheets.

[0017]

[Table 3]

表 3

C	Si	Mn	P	S	Al	N	Ti	Cr	Mo	B
0.22	0.21	1.20	0.02	0.003	0.027	0.003	0.002	0.18	0.02	0.0018

[Table 4]

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表 4

番号	温度 (℃)	保定時間 (分)	加熱雰囲気			微小クラックの発生	
			水素 (vol%)	露点 (℃)	酸素 (vol%)		
1	800	5	0.01	2	0.3	◎	本発明例
2	900	3	0.02	1	0.5	◎	本発明例
3	1000	2	0.1	3	0.8	◎	本発明例
4	1100	2	N.D.	1	1	◎	本発明例
5	900	2	10	0	0.01	×	比較例
6	900	2	4	1	0.01	△	本発明例
7	900	2	1	-1	0.01	◎	本発明例
8	900	2	0.1	15	0.01	×	比較例
9	900	2	0.1	6	0.1	◎	本発明例
10	900	2	0.05	2	0.1	◎	本発明例
11	900	2	2	-20	0.5	○	本発明例
12	900	2	0.01	7	21	◎	本発明例
13	900	2	0.01	1	21	◎	本発明例
14	980	8	0.01	1	21	◎	本発明例
15	1050	5	0.01	1	21	◎	本発明例
16	900	10	5	6	0.06	△	本発明例

微小クラックの発生評点

10 点中の微小クラックの個数の合計　◎:0 個、○:1 個、△:5 個未満、×5 個以上

[0018]As shown in Table 4, the amount of hydrogen that penetrates into the steel varies according to the heating atmosphere and temperature, and the sensitivity to the microcracks changes.In No. 5 with a hydrogen concentration of 10 vol% and No. 8 with a dew point of 15 ° C., 5 or more cracks were observed.As the hydrogen concentration and dew point decreased, the occurrence of cracks was suppressed, but in the case of a No.6,11,16, some cracks occurred.
(Example 3)

[0019]Various Zn based plating was applied using a cold rolled steel sheet having a steel content of 1.4 as shown in Table 5.Table 6 shows the plating type, bath component and bath temperature at this time.Using these Zn based plated steel sheets, a hat molding was performed in the same manner as in Example 1, and the way in which the minute cracks after punching were observed was observed.Table 7 shows the relationship between the heating conditions and the occurrence of cracks.Cooling was performed with a mold, and average cooling speed from 700 ° C. to 350 ° C. was 20 ° C. / sec.When the cross section hardness after molding was measured in the same manner as in Example 1, all of the cross section was located between the Hv:410~510 and the microstructure showed a martensite structure.After hot pressing, no iron oxide was generated on the surfaces of these steel sheets.

[0020]

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[Table 5]

表 5

符号	C	Si	Mn	P	S	Al	N	Ti	Cr	Mo	B
A	0.15	0.1	2.1	0.01	0.004	0.03	0.004	0.02	0.4	0.01	0.003
B	0.21	0.2	0.9	0.02	0.005	0.015	0.005	0.01	0.9	0.4	0.004
C	0.27	0.15	0.88	0.01	0.002	0.02	0.004	0.02	0.23	0.5	0.003

[Table 6]

表 6

符号	めっき組成	片面付着量(g/m²)	浴温(℃)
GI	Zn-0.2%Al	85	460
GA	Zn-10.5%Fe	70	460
GL	Zn-55%Al-1.6%Si	75	610
GAM	Zn-6%Al-3%Mg	65	420
GAMS	Zn-11%Al-3%Mg-0.1%Si	80	430

[Table 7]

表 7

番号	鋼	めっき	温度(℃)	保定時間(分)	加熱雰囲気			微小クラックの発生	
					水素(vol%)	露点(℃)	酸素(vol%)		
1	A	GI	950	1	5	8	0.01	△	本発明例
2	A	GA	900	1	0.1	2	0.3	◎	本発明例
3	B	GL	800	2	2	-10	0.5	○	本発明例
4	B	GAM	850	3	0.5	0	21	◎	本発明例
5	C	GAMS	1000	1	0.1	-30	21	◎	本発明例
6	C	GI	850	5	0.05	2	21	◎	本発明例
7	A	GI	900	10	0.07	6	21	◎	本発明例
8	B	GA	850	8	0.1	13	21	×	比較例
9	B	GA	850	5	0.2	0	21	◎	本発明例
10	C	GL	850	2	0.1	-10	21	◎	本発明例

微小クラックの発生評点

10 点中の微小クラックの個数の合計　◎:0 個、○:1 個、△:5 個未満、×5 個以上

[0021]In the same manner as in Examples 1 and 2, No. 8 in Table 7 had a high dew point, and thus microcracks occurred. In Nos. 1 and 3, since the amount of hydrogen was larger than 1%, slight cracks occurred slightly. In addition, since the oxygen concentration of Nos. 1 to 3 is low, contamination in the furnace and deterioration of the surface of the steel sheet caused by evaporation of Zn in the furnace were observed.

(Example 4)

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[0022]A cold-rolled steel sheet (thickness : 1.4) as shown in Table 8 was used as a material.A part thereof was subjected to hot-dip Al plating or hot-dip Zn plating.In the hot dip plating, a line of an oxidation-free furnace and a reduction furnace was used, and the amount of plating was adjusted by a gas wiping method after plating, and then, the appearance of the cooled plating was good without non-plating.The plating species, bath components, and bath temperature are shown in Table 9.

[0023]

[Table 8]

表 8

C	Si	Mn	P	S	Al	N	Ti	Cr	Mo	B
0.22	0.21	1.20	0.02	0.003	0.027	0.003	0.002	0.18	0.02	0.0018

[Table 9]

表 9

符号	めっき組成	片面付着量(g/㎡)	浴温(℃)
AL	Al-10%Si-2%Fe	80	660
GI	Zn-0.2%Al	85	460
GA	Zn-10.5%Fe	70	460

[0024]The steel sheet thus produced was heated under various conditions and then molded with a hat-shaped mold shown in FIG. 1.The clearance during hot pressing is shown in Table 10.Then, punching of 5 ϕ and 0.5 of clearance (both sides) was performed on the flange portion of the hat at 10 points, and after 7 days, the punched portion was observed by a loupe of 20 times to determine presence / absence of fine cracks.Heating was performed by inserting a sample into an atmosphere controlled electric furnace.A temperature rise time of up to 900 ° C. was approximately 4 minutes, a time from the furnace to the press was approximately 10 seconds, and a press start temperature was approximately 750 ° C.Cooling was performed with a mold, and average cooling speed from 700 ° C. to 350 ° C. was 40 ° C. / sec.Table 10 shows the heating conditions and the presence or absence of microcracks.In addition, when the Vickers hardness was measured at a partial cutting load of 10 kgf after molding, all of the samples were in the range of Hv:410~510, and the microstructure showed a martensitic structure.

[0025]

[Table 10]

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表 10

番号	熱間プレスでのクリアランス（板厚比）	めっき種	温度（℃）	保定時間（分）	加熱雰囲気			微小クラックの発生	酸化鉄の発生	
					水素（vol%）	露点（℃）	酸素（vol%）			
1	0.8	冷延	900	3	0.02	1	0.5	×	有り	比較例
2	1.0	冷延	900	3	0.02	1	0.5	◎	有り	本発明例
3	1.1	冷延	900	3	0.02	1	0.5	◎	有り	本発明例
4	1.4	冷延	900	3	0.02	1	0.5	◎	有り	本発明例
5	1.7	冷延	900	3	0.02	1	0.5	○	有り	本発明例
6	1.9	冷延	900	3	0.02	1	0.5	×	有り	比較例
7	0.8	GI	900	10	0.07	6	21	×	無し	比較例
8	1.0	GI	900	10	0.07	6	21	◎	無し	本発明例
9	1.1	GI	900	10	0.07	6	21	◎	無し	本発明例
10	1.4	GI	900	10	0.07	6	21	◎	無し	本発明例
11	1.7	GI	900	10	0.07	6	21	○	無し	本発明例
12	1.9	GI	900	10	0.07	6	21	×	無し	比較例
13	0.8	GA	850	5	0.2	0	21	×	無し	比較例
14	1.0	GA	850	5	0.2	0	21	◎	無し	本発明例
15	1.1	GA	850	5	0.2	0	21	◎	無し	本発明例
16	1.4	GA	850	5	0.2	0	21	◎	無し	本発明例
17	1.7	GA	850	5	0.2	0	21	○	無し	本発明例
18	1.9	GA	850	5	0.2	0	21	×	無し	比較例

微小クラックの発生評点

10 点中の微小クラックの個数の合計　◎:0 個、○:1 個、△:5 個未満、×5 個以上

[0026]In the No.1, 7, 13 of Table 10, since the clearance of the mold during hot pressing was less than or equal to the limit, 5 or more microcracks were observed.In the No.6, 12 , 18 of Table 10, since the clearance of the mold at the time of hot pressing was larger than or equal to the limit, the strength unevenness occurred and residual stress remained in the component, and 5 or more microcracks were recognized.In the No.5, 11, 17, since the clearance of the mold at the time of hot pressing was large, unevenness in strength occurred and residual stress remained in the component, so that slight cracks were generated.

[Brief description of the drawings]

[0027]

FIG. 1 is an external view of a hat-shaped mold used for a working test of an embodiment ;.

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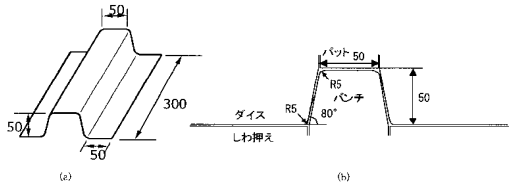
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(54)【発明の名称】冷延、熱延鋼板もしくはＡｌ系、Ｚｎ系めっき鋼板を使用した高強度自動車部材の熱間プレス方法および熱間プレス部品

(57)【要約】　(修正有)
【課題】高温成形後に１２００ＭＰａ以上の強度を得ることができ、かつ水素脆化の懸念の極めて少ない熱延・冷延鋼板、またAl系めっき鋼板あるいはZn系めっき鋼板を使用した熱間プレス方法および熱間プレス部品を提供する。
【解決手段】鋼成分として質量%でC:0.05~ 0.5%を含有する鋼板、またはAlもしくはZnを主体とするめっきを施した鋼板を使用して自動車部材を熱間プレス法で製造するに際し、プレス前の加熱温度をAc3以上、1100℃以下とし、加熱雰囲気中の水素濃度を6体積%以下、露点を10℃以下とすることを特徴とする高強度自動車部材の熱間プレス方法および熱間プレス部品。
【選択図】図１



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【特許請求の範囲】
【請求項１】
鋼成分として質量%でC:0.05~ 0.5%を含有する鋼板、またはAlもしくはZnを主体とするめっきを施した鋼板を使用して自動車部材を熱間プレス法で製造するに際し、プレス前の加熱温度をAc3以上、1100℃以下とし、加熱雰囲気中の水素濃度を6体積%以下、露点を10℃以下とすることを特徴とする高強度自動車部材の熱間プレス方法。
【請求項２】
加熱雰囲気中の水素濃度が1体積%以下、露点が10℃以下であることを特徴とする請求項１に記載の高強度自動車部材の熱間プレス方法。
【請求項３】
加熱後鋼板をプレス機に導入し、成形する際のダイスとパンチ間の間隙（クリアランス）が使用する鋼材の板厚の1.0~ 1.8倍であることを特徴とする請求項１または請求項２に記載の熱間プレス方法。
【請求項４】
請求項１乃至請求項３のいずれか一項に記載の熱間プレス方法を用いることを特徴とする熱間プレス部品。

【発明の詳細な説明】
【技術分野】
【０００１】
本発明は冷延、熱延鋼板もしくはＡｌ系またはZn系めっき鋼板を使用して自動車のピラー、ドアインパクトビーム、バンパービーム等の強度部材を製造する際の熱間プレス方法および熱間プレス部品に関する。
【背景技術】
【０００２】
地球環境問題に端を発する自動車の軽量化のためには、自動車に使用される鋼板をできるだけ高強度化することが必要となるが、一般に鋼板を高強度化していくと伸びやｒ値が低下し、成形性が劣化していく。このような課題を解決するために、温間で成形し、その際の熱を利用して強度上昇を図る技術が、特開２０００－２３４１５３号公報に開示されている。この技術では、鋼中成分を適切に制御し、フェライト温度域で加熱し、この温度域での析出強化を利用して強度を上昇させることを狙っている。
また、特開２０００－８７１８３号公報では、プレス成形精度を向上させる目的で成形温度での降伏強度を常温での降伏強度より大きく低下する高強度鋼板が提案されている。しかしながら、これらの技術では得られる強度に限度がある可能性がある。一方、より高強度を得る目的で、成形後に高温のオーステナイト単相域に加熱し、その後の冷却過程で硬質の相に変態させる技術が特開２０００－３８６４０号公報に提案されている。
【０００３】
しかしながら、成形後に加熱・急速冷却を行うと形状精度に問題が生じる可能性がある。この欠点を克服する技術としては、鋼板をオーステナイト単相域に加熱し、その後プレス成形過程にて鋼成分により決まるマルテンサイト変態の臨界冷却速度以上の冷却速度にて冷却を施す技術が文献（SAE、2001-01-0078）や、特開2001-181833号公報に開示されている。前者の文献においては加熱する際の表面のスケール発生を抑制するためにAlめっき鋼板を使用することが開示されている。このようなプレス工程を本発明においては熱間プレスと呼ぶ。
【０００４】
このようなめっき鋼板を使用した熱間プレスに関する先行技術としては、以下が挙げられる。特開2003-147499号公報において、Fe-Zn合金からなるめっき層で被覆した鋼板を熱間プレスに使用する例が、また特開2003-41343号公報にはFe-Al合金からなるめっき層で

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被覆されたAl系めっき鋼板を熱間プレスに使用する例がそれぞれ開示されている。
また、特開2002-282951号公報にてダイスとパンチを用いて、加熱された金属板材をプレスする方法として、成形性と焼き入れ性の観点で金型のクリアランスを規定した例が開示されている。

【特許文献１】特開2000-87183号公報
【特許文献２】特開2000-38640号公報
【特許文献３】特開2001-181833号公報
【特許文献４】特開2003-147499号公報
【特許文献５】特開2003-41343号公報
【特許文献６】特開2002-282951号公報
【非特許文献１】SAE、2001-01-0078

【発明の開示】
【発明が解決しようとする課題】
【０００５】
このように、自動車等に使用される高強度鋼板は高強度化されるほど上述した成形性の問題や特に１０００ＭＰａを超えるような高強度材においては従来から知られているように水素脆化（置きわれや遅れ破壊と呼ばれることもある）という本質的な課題がある。従って熱間プレス用鋼板として用いられる場合、素材の水素量を下げることが重要となる。
本発明は、上記課題を解決するためになされたものであり、高温成形後に１２００ＭＰａ以上の強度を得ることができ、かつ水素脆化の懸念の極めて少ない熱延・冷延鋼板、またAl系めっき鋼板あるいはZn系めっき鋼板を使用した熱間プレス方法およびプレス部品を提供するものである。

【課題を解決するための手段】
【０００６】
本発明者らは、上記課題を解決するために種々の検討を実施した。その結果、プレス前のオーステナイト単相域に加熱する際の雰囲気及び温度を制御することが耐水素脆性に優れた熱間プレス用めっき鋼板が製造するために極めて重要であることを見出した。つまりこの加熱の際の雰囲気中に水素が含有されているとこの水素が鋼板に侵入し、また水分が含有されていても同様に水素が鋼板に侵入する可能性があることから、これらの成分を少なくすることが重要である。また水素脆化を防止するために金型のクリアランスを適正に選択することが重要であることも見出した。かかる知見に基づく本発明の要旨とするところは下記のとおりである。

（１）鋼成分として質量%でC:0.05~ 0.5%を含有する鋼板、またはAlもしくはZnを主体とするめっきを施した鋼板を使用して自動車部材を熱間プレス法で製造するに際し、プレス前の加熱温度をAc3以上、1100℃以下とし、加熱雰囲気中の水素濃度を6体積%以下、露点を10℃以下とすることを特徴とする高強度自動車部材の熱間プレス方法。
（２）加熱雰囲気中の水素濃度が1体積%以下、露点が10℃以下であることを特徴とする請求項（１）に記載の高強度自動車部材の熱間プレス方法。
（３）加熱後鋼板をプレス機に導入し、成形する際のダイスとパンチ間の間隙（クリアランス）が使用する鋼材の板厚の1.0~ 1.8倍であることを特徴とする請求項（１）または（２）に記載の熱間プレス方法。
（４）（１）乃至（３）のいずれか一に記載の熱間プレス方法を用いることを特徴とする熱間プレス部品。

【発明の効果】
【０００７】
本発明によると、熱延、冷延鋼板、またＡｌ系めっき鋼板あるいはZn系めっき鋼板を使用して熱間プレス工法により高強度部材を製造することができ、なおかつ水素脆化なく使用することが可能となるものであり、その工業的意義は極めて大きい。

【発明を実施するための最良の形態】
【０００８】

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次に本発明の限定理由について説明する。

前述したように、本発明は熱延、冷延鋼板、またはＡｌ系、Zn系めっき鋼板を700℃以上に加熱後、熱間で成形して直ちに金型で冷却、焼入れして所望の強度を得るもので、本発明においては加熱、プレス成形前の鋼板を規定するものとする。鋼板成分としては焼入れ性に優れていることが必要で、このためにはC量0.05%以上が必要であり、望ましくは0.1%以上である。他の鋼中元素については、Si、Mn、Ti、B、Cr、Mo、Al、P、S、N等の元素が添加される場合がある。Siは疲労特性に効果があり含有させる場合は0.05~ 1%とするのが望ましい。Mn、B、Cr、Moは焼入れ性の向上に寄与するので含有させる場合はMn：0.5~ 3%、B：0.05%以下、Cr：2%以下、Mo：0.5%以下とするのが望ましい。Ti、AlはAl系めっき鋼板の耐酸化性を向上させるので含有させる場合はTi：0.5%以下、Al：0.1%以下とするのが望ましい。

【０００９】

めっき種としてはＡｌ系、またはZn系めっきを施した鋼板が考えられ、これらを熱間プレスに用いると、表面の酸化鉄の生成を抑制し、耐食性を付与することが可能となる。

まずAl系めっき層の構成について述べる。現在種々の用途向けにAl系めっき鋼板が製造されており、本発明はこれらの鋼板の適用が可能である。Al系めっき層の構成としては、Alを主成分とし、溶融Alめっき時の合金層の生成を抑制するためにSiを望ましくは3~ 15%含有させた鋼板がある。この他にめっき層の耐食性をより向上させる元素としてCr、Mg、Ti、Sn等があり、これらを添加することも可能である。この際にはCr：0.1~ 1%、Mg：0.5~ 10%、Ti：0.1~ 1%、Sn：1~ 5%含有させるのが望ましい。なおAl系めっき層中にはFeが不純物として含有され、この量は通常0.05~ 0.5%である。

なお、加熱後表面には$FeAl_3$、Fe_2Al_5、Fe_3Al、Fe_2Al_8Si等の金属間化合物が生成し得る。これらの相は代表的には５層構造となる複層構造をとる傾向にあるが、これらの相構造がどのようなものになろうと本願発明の主旨が損なわれるものではない。またその組成としてはAl、Feを主成分とし、Alめっき浴にSiを添加したときにはSiも5~ 10%程度含有される。これらの元素の組成が合計で90%以上を占める。また微量の合金化していないAlが残存することもありうるが、少量であれば特に性能には影響しない。加熱後Al系の酸化物や窒化物が表面を覆うがこれらの量については特に規定しない。

【００１０】

次にZn系めっき層の構成について述べる。Zn系めっき鋼板は現在種々の組成のものが製造されており、本発明はこれらの鋼板の適用が可能である。代表的なZn系めっき層の構成としては、次のようなものが挙げられる。Zn-0.2%Al、Zn-5%Al-0.1%Mg、Zn-5%Al-0.1%Mg-ミッシュメタル、Zn-7%Al-3%Mg、Zn-11%Al-3%Mg-0.1%Si、Zn-55%Al-1.6%Si等。この他にZn-0.1%Al浴でめっきした後に加熱することでZn-10%Feに変化させたようなものもある。この他にめっき層の耐食性をより向上させる元素としてCr、Mg、Ti、Sn等があり、これらを添加することも可能である。この際にはCr：0.1~ 1%、Mg：0.5~ 10%、Ti：0.1~ 1%、Sn：1~ 5%含有させるのが望ましい。

なお、加熱後表面にはζ、δ1、Γ、Γ1相等の金属間化合物やZnを固溶したフェライト相が生成し得る。これらの相は層状に分布したり、あるいは粒状に分布し得るがこれらの相構造がどのようなものになろうと本願発明の主旨が損なわれるものではない。またその組成としてはAlを含有するめっきであれば前記したFe-Al系化合物が生成することもありうる。Zn系めっきの場合、加熱後にZn系、あるいはAl系の酸化膜が生成するがこれらが生成しても本発明の趣旨を損なうものではない。

【００１１】

Al系、Zn系めっきの付着量、めっき前処理、後処理については特に限定するものではないが、めっき付着量は片面50g/m^2以上であることが望ましい。めっき付着量が多いほど、加熱時の酸化抑制効果、加熱、成形後部品にした際の耐食性が向上するためである。めっき後処理として一次防錆、潤滑性を目的としてクロメート処理、樹脂被覆処理等ありうるが、有機樹脂は加熱すると消失してしまうため好ましくない。クロメート処理も近年の6価クロム規制を考慮すると、電解クロメート等の3価の処理皮膜が好ましい。クロメート

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皮膜を付与せず、塗油だけとすることも耐食性に優れたAl系めっき鋼板の場合には可能である。

本発明において加熱時の温度と雰囲気を規定するものであり、その温度はAc3以上、1100℃以下とする。これは鋼板が完全にオーステナイト単相域に変態するためにAc3温度以上が必要であり、一方加熱温度が高すぎると表面が酸化したり、鋼中への水素の侵入が活発になることによる。Zn系めっきを使用する場合にはこれに加えてZnの沸点が約910℃であまり高温ではZnが完全に蒸散して鋼板の酸化が激しくなるために1000℃を上限とすることが望ましい。さらに望ましくは、上限温度920℃である。下限温度は800℃とすることが望ましい。Ac3温度以上に加熱しても加熱後に鋼板を炉から出してプレス機に移送する間に温度が低下してフェライトが生成してしまうことがあるためである。

【００１２】

加熱雰囲気は水素濃度を6体積%以下とする。これは前述したように鋼中に水素が侵入することで水素脆化の懸念を高めるためである。下限は特に設けず、低い方が好ましい。より好ましくは水素量が1%以下である。同様に雰囲気中の水分も容易に鋼中に水素として侵入し得ることを本発明において知見した。このため雰囲気中水分も低い方が好ましく、実用上露点を測定して水分量を測定するが、露点の上限を10℃とする。なお、露点と水分量の換算については下の式が知られ、この時の水分量としては1.2体積%である。特にZn系めっき鋼板を使用するときには雰囲気中に酸素が含有されている方が、鋼板表面にZnの酸化物を形成してZnの蒸発を抑制する傾向にある。このためZn系めっき鋼板を使用するときには雰囲気中に酸素を1~ 21%含有することが好ましい。また、めっき鋼板だけでなく、めっきを施さない鋼板（裸材）についても加熱中の水素侵入があるので加熱雰囲気中の水素濃度と水分量の管理が必要である。

【数１】

$$pH2O = \exp\left(-\frac{44016 - 118.774 * Tdp}{8.314 * Tdp}\right)$$

pH2O:水素濃度(体積分率) Tdp:露点(絶対温度)

【００１３】

加熱方法については特に規定を設けず、ラジアントチューブ等で輻射加熱しても、誘導加熱、通電加熱等を使用してもよい。このときの加熱速度も限定しない。これは当然板厚、形状に大きく依存する。

熱間プレスはオーステナイト相から冷却して焼入組織を得ることに特徴があり、当然加熱後の冷却速度の影響が大きい。本発明においては鋼成分により決まるマルテンサイト組織を得るための臨界冷却速度以上で冷却することが必要となるが、目安として700℃から350℃までの平均冷却温度が15℃/sec以上であることが望ましい。この冷却速度は鋼成分に依存し、焼入れ性の良好な鋼では20℃/sec程度の冷却速度でも所望のマルテンサイトを主体とする組織が得られるし、鋼種によっては30℃/sec程度の冷却速度が必要となると考えられる。

プレス時にはダイスとパンチの間隙（クリアランス）が重要な因子の１つであるが、本発明においてはこのクリアランスが板厚の1.0~ 1.8倍であることが望ましい。クリアランスが狭いと板が流入し難く、しごき加工となるため鋼板表面にカジリが発生し、水素脆化の起点となる可能性があると考えられる。また広いと焼入され難くなる傾向にあり、部品中にて強度むらが生じて部品内に残留応力が残って水素脆化の懸念が高まると考えられる。

【実施例】

【００１４】

次に実施例で本発明をより詳細に説明する。

（実施例１）

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表１に示すような鋼成分を有する板厚1.4mmの冷延鋼板を種々の条件で加熱し、その後第１図に示すハット形状の金型で成形した。クリアランスは板厚の1.1倍とした。その後ハットのフランジ部に5mmφ、クリアランス0.5mm(両側)の打抜きを10点行い、７日経過後に20倍のルーペで打抜き部を観察して微小クラックの有無判定した。加熱は試料を雰囲気制御した電気炉内に挿入することで行った。900℃までの昇温時間はほぼ4分、炉からプレスまでの時間は約10秒で、プレス開始温度は約750℃だった。冷却は金型で行い、700℃から350℃までの平均冷速は40℃/秒であった。加熱条件と微小クラックの有無を表２に示す。なお、ハット成形後一部の切出し荷重10kgfでビッカース硬度を測定したところ、全ての水準においてHv：410~ 510の範囲にあり、組織はマルテンサイト組織を示した。また熱間プレス後にはこれらの鋼板の表面には酸化鉄が発生した。

実施例１のNo.8は露点が高いために微小クラックが5個以上発生した。No.1とNo.3は水素量が1%以上であったため、微小クラックが少量発生した。

【００１５】

【表１】

表1

符号	C	Si	Mn	P	S	Al	N	Ti	Cr	Mo	B
A	0.15	0.1	2.1	0.01	0.004	0.03	0.004	0.02	0.4	0.01	0.003
B	0.21	0.2	0.9	0.02	0.005	0.015	0.005	0.01	0.9	0.4	0.004
C	0.27	0.15	0.88	0.01	0.002	0.02	0.004	0.02	0.23	0.5	0.003

【表２】

表2

番号	鋼	温度(℃)	保定時間(分)	加熱雰囲気			微小クラックの発生	
				水素(vol%)	露点(℃)	酸素(vol%)		
1	A	950	1	5	8	0.01	△	本発明例
2	A	900	1	0.1	2	0.3	◎	本発明例
3	B	800	2	2	-10	0.5	○	本発明例
4	B	850	3	0.5	0	21	◎	本発明例
5	C	1000	1	0.1	-30	21	◎	本発明例
6	C	850	5	0.05	2	21	◎	本発明例
7	A	900	10	0.07	6	21	◎	本発明例
8	B	850	8	0.1	13	21	×	比較例
9	B	850	5	0.2	0	21	◎	本発明例
10	C	850	2	0.1	-10	21	◎	本発明例

微小クラックの発生評点

10点中の微小クラックの個数の合計　◎:0個、○:1個、△:5個未満、×5個以上

（実施例２）

【００１６】

通常の熱延、冷延工程を経た、表３に示すような鋼成分の冷延鋼板（板厚1.4mm）を材料として溶融Alめっきを行った。溶融Alめっきは無酸化炉－還元炉タイプのラインを使用し、めっき後ガスワイピング法でめっき付着量を片面80g/m^{2}に調節し、その後冷却した。この際のめっき浴組成としてはAl-10%Si-2%Fe、浴温は660℃であった。浴中のFeは

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めっき機器やストリップから供給される不可避のものである。めっき外観は不めっき等なく良好であった。このようにして製造した溶融Alめっき鋼板を種々の条件で加熱し、その後第１図に示すハット形状の金型で成形した。クリアランスは板厚の1.1倍とした。その後ハットのフランジ部に5mmφ、クリアランス0.5mm(両側)の打抜きを10点行い、7日経過後に20倍のルーペで打抜き部を観察して微小クラックの有無判定した。加熱は試料を雰囲気制御した電気炉内に挿入することで行った。900℃までの昇温時間はほぼ4分、炉からプレスまでの時間は約10秒で、プレス開始温度は約750℃だった。冷却は金型で行い、700℃から350℃までの平均冷速は40℃/秒であった。加熱条件と微小クラックの有無を表４に示す。なお、ハット成形後一部の切出し荷重10kgfでビッカース硬度を測定したところ、全ての水準においてHv：410~ 510の範囲にあり、組織はマルテンサイト組織を示した。また熱間プレス後にはこれらの鋼板の表面には酸化鉄が発生しなかった。

【００１７】

【表３】

表3

C	Si	Mn	P	S	Al	N	Ti	Cr	Mo	B
0.22	0.21	1.20	0.02	0.003	0.027	0.003	0.002	0.18	0.02	0.0018

【表４】

表4

番号	温度 (℃)	保定時間 (分)	加熱雰囲気			微小クラックの発生	
			水素 (vol%)	露点 (℃)	酸素 (vol%)		
1	800	5	0.01	2	0.3	◎	本発明例
2	900	3	0.02	1	0.5	◎	本発明例
3	1000	2	0.1	3	0.8	◎	本発明例
4	1100	2	N.D.	1	1	◎	本発明例
5	900	2	10	0	0.01	×	比較例
6	900	2	4	1	0.01	△	本発明例
7	900	2	1	-1	0.01	◎	本発明例
8	900	2	0.1	15	0.01	×	比較例
9	900	2	0.1	6	0.1	◎	本発明例
10	900	2	0.05	2	0.1	◎	本発明例
11	900	2	2	-20	0.5	○	本発明例
12	900	2	0.01	7	21	◎	本発明例
13	900	2	0.01	1	21	◎	本発明例
14	980	8	0.01	1	21	◎	本発明例
15	1050	5	0.01	1	21	◎	本発明例
16	900	10	5	6	0.06	△	本発明例

微小クラックの発生評点

10点中の微小クラックの個数の合計　◎:0個、○:1個、△:5個未満、×5個以上

【００１８】

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表４に示すように加熱雰囲気及び温度により鋼中に侵入する水素量が変化して微小クラックに対する感受性が変化する。水素濃度が10vol%のNo.５、露点が15℃のNo.８には５個以上のクラック発生が認められた。水素濃度、露点を下げるにつれてクラックの発生は抑制されていくが、No.６、11、16のような場合には若干のクラックが発生した。

（実施例3）

【００１９】

表５に示すような鋼成分を有する板厚1.4mmの冷延鋼板を用いて種々のZn系めっきを施した。このときのめっき種と浴成分、浴温を表６に示す。これらのZn系めっき鋼板を使用して実施例１と同様にハット成形を行い、打抜き加工後の微小クラックの入り方を観察した。この時の加熱条件とクラック発生状況の関係を表７に示す。冷却は金型で行い、700℃から350℃までの平均冷速は20℃/秒であった。実施例１と同様に成形後の断面硬度を測定したところ、全てHv：410~ 510の間にあり、組織もマルテンサイト組織を示した。また熱間プレス後にはこれらの鋼板の表面には酸化鉄が発生しなかった。

【００２０】

【表５】

表５

符号	C	Si	Mn	P	S	Al	N	Ti	Cr	Mo	B
A	0.15	0.1	2.1	0.01	0.004	0.03	0.004	0.02	0.4	0.01	0.003
B	0.21	0.2	0.9	0.02	0.005	0.015	0.005	0.01	0.9	0.4	0.004
C	0.27	0.15	0.88	0.01	0.002	0.02	0.004	0.02	0.23	0.5	0.003

【表６】

表６

符号	めっき組成	片面付着量(g/m²)	浴温(℃)
GI	Zn-0.2%Al	85	460
GA	Zn-10.5%Fe	70	460
GL	Zn-55%Al-1.6%Si	75	610
GAM	Zn-6%Al-3%Mg	65	420
GAMS	Zn-11%Al-3%Mg-0.1%Si	80	430

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【表７】

表７

番号	鋼	めっき	温度(℃)	保定時間(分)	加熱雰囲気			微小クラックの発生	
					水素(vol%)	露点(℃)	酸素(vol%)		
1	A	GI	950	1	5	8	0.01	△	本発明例
2	A	GA	900	1	0.1	2	0.3	◎	本発明例
3	B	GL	800	2	2	-10	0.5	○	本発明例
4	B	GAM	850	3	0.5	0	21	◎	本発明例
5	C	GAMS	1000	1	0.1	-30	21	◎	本発明例
6	C	GI	850	5	0.05	2	21	◎	本発明例
7	A	GI	900	10	0.07	6	21	◎	本発明例
8	B	GA	850	8	0.1	13	21	×	比較例
9	B	GA	850	5	0.2	0	21	◎	本発明例
10	C	GL	850	2	0.1	-10	21	◎	本発明例

微小クラックの発生評点

10点中の微小クラックの個数の合計　◎:0個、○:1個、△:5個未満、×5個以上

【００２１】

実施例１、２と同様に表７のNo.8は露点が高いために微小クラックが発生した。No.1、３は水素量が1%よりも大きいため、微小クラックが若干発生した。 またNo.１～３は酸素濃度が低いために、炉内でのZnの蒸発に伴う炉内の汚れ、鋼板表面の劣化が認められた。

（実施例４）

【００２２】

通常の熱延、冷延工程を経た、表８に示すような鋼成分の冷延鋼板（板厚1.4mm）を材料として用いた。その一部は溶融Alめっき、または溶融Zn系めっきを施した。溶融めっきは無酸化炉－還元炉タイプのラインを使用し、めっき後ガスワイピング法でめっき付着量を調節し、その後冷却しためっき外観は不めっき等なく良好であった。めっき種と浴成分、浴温を表９に示す。

【００２３】

【表８】

表８

C	Si	Mn	P	S	Al	N	Ti	Cr	Mo	B
0.22	0.21	1.20	0.02	0.003	0.027	0.003	0.002	0.18	0.02	0.0018

【表９】

表９

符号	めっき組成	片面付着量(g/m²)	浴温(℃)
AL	Al-10%Si-2%Fe	80	660
GI	Zn-0.2%Al	85	460
GA	Zn-10.5%Fe	70	460

【００２４】

このようにして製造した鋼板を種々の条件で加熱し、その後第１図に示すハット形状の

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金型で成形した。熱間プレス時のクリアランスを表１０に示す。その後ハットのフランジ部に5mmφ、クリアランス0.5mm(両側)の打抜きを10点行い、7日経過後に20倍のルーペで打抜き部を観察して微小クラックの有無判定した。加熱は試料を雰囲気制御した電気炉内に挿入することで行った。900℃までの昇温時間はほぼ4分、炉からプレスまでの時間は約10秒で、プレス開始温度は約750℃だった。冷却は金型で行い、700℃から350℃までの平均冷速は40℃/秒であった。加熱条件と微小クラックの有無を表１０に示す。なお、ハット成形後一部の切出し荷重10kgfでビッカース硬度を測定したところ、全ての水準においてHv：410~ 510の範囲にあり、組織はマルテンサイト組織を示した。

【００２５】

【表１０】

表10

番号	熱間プレスでのクリアランス(板厚比)	めっき種	温度(℃)	保定時間(分)	加熱雰囲気			微小クラックの発生	酸化鉄の発生	
					水素(vol%)	露点(℃)	酸素(vol%)			
1	0.8	冷延	900	3	0.02	1	0.5	×	有り	比較例
2	1.0	冷延	900	3	0.02	1	0.5	◎	有り	本発明例
3	1.1	冷延	900	3	0.02	1	0.5	◎	有り	本発明例
4	1.4	冷延	900	3	0.02	1	0.5	◎	有り	本発明例
5	1.7	冷延	900	3	0.02	1	0.5	○	有り	本発明例
6	1.9	冷延	900	3	0.02	1	0.5	×	有り	比較例
7	0.8	GI	900	10	0.07	6	21	×	無し	比較例
8	1.0	GI	900	10	0.07	6	21	◎	無し	本発明例
9	1.1	GI	900	10	0.07	6	21	◎	無し	本発明例
10	1.4	GI	900	10	0.07	6	21	◎	無し	本発明例
11	1.7	GI	900	10	0.07	6	21	○	無し	本発明例
12	1.9	GI	900	10	0.07	6	21	×	無し	比較例
13	0.8	GA	850	5	0.2	0	21	×	無し	比較例
14	1.0	GA	850	5	0.2	0	21	◎	無し	本発明例
15	1.1	GA	850	5	0.2	0	21	◎	無し	本発明例
16	1.4	GA	850	5	0.2	0	21	◎	無し	本発明例
17	1.7	GA	850	5	0.2	0	21	○	無し	本発明例
18	1.9	GA	850	5	0.2	0	21	×	無し	比較例

微小クラックの発生評点

10点中の微小クラックの個数の合計　◎:0個、○:1個、△:5個未満、×5個以上

【００２６】

表１０のNo.1、 7、 13は熱間プレス時の金型のクリアランスが制限以下であったため5個以上の微小クラックが認められた。表１０のNo.6、 12 、 18は熱間プレス時の金型のクリアランスが制限以上であったため、強度むらが生じて部品内に残留応力が残って5個以上の微小クラックが認められた。No.5、 11、 17は熱間プレス時の金型のクリアランスが大きめであったため強度むらが生じて部品内に残留応力が残る傾向を示すため、微小クラックが若干発生した。

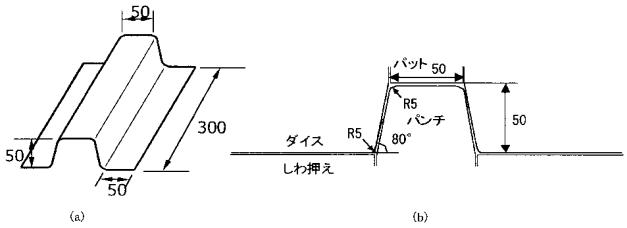
【図面の簡単な説明】

【００２７】

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【図１】実施例の加工試験に用いるハット形状の金型の外形図である。

【図１】



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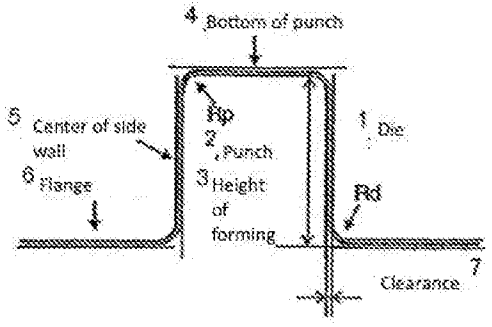
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[Continued]

(54) Title of the Invention: METHOD FOR HOT FORMING AND HOT-FORMED MEMBERS



1...DIE
2...PUNCH
3...HEIGHT OF FORMING
4...BOTTOM OF PUNCH
5...CENTER OF SIDE WALL
6...FLANGE
7...CLEARANCE

(57) Abstract: A method for hot forming, wherein in the cooling step of hot pressing, a formed product is first cooled at a rate of a critical cooling rate or higher down to the Ms point thereof and then cooled at a rate of 25 to 150°C/s from the Ms point to 200°C; and a hot pressed member which has been formed by the method and has a Vickers hardness of less than (the maximum quench hardness - 10) and (the maximum quench hardness - 100) or more. The hot pressed member is manufactured from a high strength steel sheet by means of hot pressing and exhibits a stable strength and toughness in combination.

[Continued]

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(81) Designated Nations (all kinds of international protection are possible unless otherwise specified):

AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

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ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasiasia (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), Europe (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

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For the 2-letter codes and other abbreviations, refer to the "Guidance Notes for Codes and Abbreviations," which are published in the prefaces of the respective *PCT Gazettes* that are issued periodically.

(57) Abstract: Hot-pressed members with both stable strength and toughness are manufactured from a high-strength steel sheet by means of hot pressing. In the cooling step of hot pressing, the formed product is first cooled to the Ms point at a rate of the critical cooling rate or higher and then cooled in the temperature range from the Ms point to 200°C at a cooling rate of 25–150°C/sec. The Vickers hardnesses of the hot-pressed members are less than the maximum quench hardness – 10 and equal to or greater than the maximum quench hardness – 100.

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Specifications

Method for Hot Forming and Hot-Formed Members

Field of Technology

This invention concerns hot-formed members, including mechanical structural parts, such as automobile body structural parts, suspension parts, etc., and a method for hot forming which is used in manufacturing them. More specifically, this invention concerns hot-pressed members and a hot-pressing method for that purpose.

Below, this invention will be explained by using hot-press forming as an example, but this invention can also be applied to hot-forming methods other than press forming, such as roll forming, forging, etc.

Prior Art

In recent years, in order to reduce the weights of automobiles, efforts have been made to increase the strengths of the steel materials by giving them tensile strengths of 590 MPa or higher, for example, and reducing their weights. In this kind of trend, as the strengths of the thin steel plates that are widely used in automobiles have been increased, their press-forming abilities have decreased, and it has been difficult to produce complex shapes. Specifically, as their strengths have increased, their ductilities have decreased and fractures are caused in places which have high degrees of working. The spring-back and wall camber have become larger, and the problem of worsening dimensional accuracy has arisen.

Therefore, in the case of steel plates with high strengths, especially ones with tensile strengths of 780 MPa or higher, it is not easy to produce parts by using press forming as a method of cold working. These high-strength steel plates can be worked by using roll forming instead of press forming, but roll forming can only be employed with parts which have uniform cross sections in the longitudinal direction, so that the shapes of the products to which it can be employed are limited.

On the other hand, as disclosed in UK Patent No. 1490535, in a hot press method in which heated steel plates are press formed, the steel plates are heated to high temperatures so that the steel plate material is softened and becomes highly ductile. As a result, complex shapes can be formed with good dimensional accuracy in the heated state. Furthermore, by the method of die cooling, that is, heating the steel plates to the austenitic temperature range and quenching them in dies, increasing the strengths of the plates by martensitic transformation, that is, hardening, can be accomplished at the same time.

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However, when die cooling is used in the hot press method, the quench hardness of the material is in the range of Hv 400–490, which is insufficient, in the case of 0.2% C materials. In addition, there is the problem that the hardness of the material has an extremely large dispersion.

A hot press technique which was developed by the Swedish company Plunger was disclosed in Advanced Materials & Processes, Vol. 146, No. 6, 12/94, p. 16. In this technique, the die quenching is done starting from 980°C. The die temperature is assumed to be in the range of room temperature to several tens of °C, since it is not stated that the die is heated in that disclosure.

In the Japanese Unexamined Patent Application Heisei 8 [1996]-269615, rapid-quenching hot rolled steel plates are disclosed containing C: 0.18–0.30%, Si: 0.01–1.0%, Mn: 0.2–1.5%, P: ≤0.03%, S: ≤0.02%, sol. Al: ≤0.08%, Cr: 0.1–0.5%, B: 0.0006–0.0040%, and N: ≤0.01%, and in some cases also at least one of Cu: ≤0.5%, Ni: ≤0.3%, and Ti: 0.01–0.05%, with the remaining content being iron. These steel plates are given high strengths by high-frequency quenching after they have been cold worked.

Disclosure of the Invention

This invention provides hot-formed members which can be produced from high-strength steel plates by using a hot-forming method and which also have stabilized strengths and toughnesses, as well as a hot-forming method for producing them.

More specifically, this invention provides hot-pressed members, including mechanical structural parts, such as automobile body structural parts, suspension parts, etc., and a method for hot pressing which is used in manufacturing them.

By means of this method, it is possible to produce hot-formed members that also have stabilized strengths and toughnesses from hot forming; in this method, when the members are cooled after forming, for example, when they are die-cooled, the average cooling rate in the temperature range below the Ms point (the temperature at which martensite begins to be formed from austenite) is kept within a specific range.

In one embodiment, this invention concerns a method of hot forming in which a steel plate that has a composition essentially containing C: 0.15–0.45%, Mn: 0.5–3.0%, Cr: 0.1–0.5%, Ti: 0.01–0.1%, B: 0.0002–0.004%, Si: ≤0.5%, P: ≤0.05%, S: ≤0.05%, Al: ≤1%, and N: ≤0.01%, as well as one or two or more of Ni: ≤2%, Cu: ≤1%, Mo: ≤1%, V: ≤1%, and Nb: ≤1%, with the remaining content being Fe and unavoidable impurities, is heated and kept at the Ac_3 point or

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higher, after which it is formed to the final product shape. By means of this invention, during the forming or when the material is cooled from the forming temperature after forming, a quenching process is performed in which the cooling rate to the Ms point of the formed member is at or above the critical cooling rate, and the average cooling rate from the Ms point to 200°C is 25–150°C/sec. Furthermore, in this invention, the term "critical cooling rate" means the upper critical cooling rate.

In another embodiment, this invention concerns hot-formed members that have been formed from a steel plate which has the aforementioned steel composition. These hot-formed members have a hardness after the hot forming which is less than the maximum quench hardness – 10 and equal to or greater than the maximum quench hardness – 100.

In a favorable embodiment of this invention, the hot forming is hot-press forming which is performed by using a die for press forming.

By means of this invention, it is possible to make hot-press members which have both stabilized strength and toughness. Therefore, this invention contributes greatly to expanding the applications of high-strength steel plates as a material for press-formed members.

Simple Explanation of the Drawings

Fig. 1 is a schematic explanatory drawing of the hot-forming method.

Fig. 2 is a schematic drawing which shows the shape of a test piece for measuring the critical cooling rate.

Detailed Explanation of the Invention

The reasons for employing the aforementioned steel composition and forming conditions in this invention are as follows. In this invention, "%" in the steel composition, that is, the chemical composition of the steel, means "wt %."

1. Composition of the base steel plate

C: 0.15–0.45%

Carbon (C) is an extremely important element which raises the hardening ability of the steel plate and principally determining its strength after hardening. Furthermore, it is an element which lowers the Ac_3 point and furthers the lowering of the hardening treatment temperature. However, if the C content is less than 0.15%, its effect will be insufficient, and if it exceeds 0.45%, there will be a deterioration in the toughness of the hardened parts. The lower limit of

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the desirable C content is 0.16% and its upper limit is 0.35%.

Mn: 0.5–3.0%

Manganese (Mn) is an extremely effective element for raising the hardening ability of the steel plate and stabilizing and maintaining its strength after hardening. Furthermore, it is an element which lowers the Ac_3 point and furthers the lowering of the hardening treatment temperature. However, if the Mn content is less than 0.5%, its effect will be insufficient, and if it exceeds 3.0%, there will be a deterioration in the toughness of the hardened parts. The range of the desirable Mn content is 0.8–2.0%.

Cr: 0.1–0.5%

Chromium (Cr) is an effective element for raising the hardening ability of the steel plate and stabilizing and maintaining its strength after hardening. However, if the Cr content is less than 0.1%, its effect will be insufficient, and if it exceeds 0.5%, its effectiveness will be saturated and a useless increase in cost will be invited. The range of the desirable Cr content is 0.15–0.30%.

Ti: 0.01–0.1%

Titanium (Ti) is an effective element for raising the hardening ability of the steel plate and stabilizing and maintaining its strength after hardening. However, if the Ti content is less than 0.01%, its effect will be insufficient, and if it exceeds 0.1%, its effectiveness will be saturated and a useless increase in cost will be invited. The range of the desirable Ti content is 0.015–0.03%.

B: 0.0002–0004%

Boron (B) is an important element for raising the hardening ability of the steel plate and further raising the stabilizing and maintaining of its strength after hardening. However, if the B content is less than 0.0002%, its effect will be insufficient, and if it exceeds 0.004%, its effectiveness will be saturated and an increase in cost will be invited. The range of the desirable B content is 0.0005–0.0025%.

Si: ≤0.5%, P: ≤0.05%, S: ≤0.05%, Al: ≤1%, and N: ≤0.01%

All of these elements are also effective in raising the hardening ability of the steel plate and raising the stabilizing of its strength after hardening. However, if their contents are above the respective upper limits mentioned above, their effectiveness will be saturated and cost increases will be invited.

1 or 2 or more of Ni: ≤2%, Cu: ≤1%, Mo: ≤1%, V: ≤1%, and Nb: ≤1%

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All of these elements are also effective in raising the hardening ability of the steel plate and raising the stabilizing of its strength after hardening; therefore, 1 or 2 or more of them are contained in the composition of the steel plate. However, even if their contents are above their respective upper limits, the effectiveness will be small and useless cost increases will be invited. Therefore, the contents of these alloy elements are made within the aforementioned ranges.

The steel plate which is used in this invention is heated to the austenite temperature range and an austenite transformation is caused when it is heated before the forming; therefore, its mechanical properties at room temperature before the heating are not important and its metal structure before the heating is not particularly limited. Consequently, the basic steel plate that is used may be a hot rolled steel plate, cold rolled steel plate, or plated sheet steel, and the method for producing it is not particularly limited. Examples of the plated sheet steels are aluminum-based plating steel sheet (that is, aluminized and aluminum alloy plating steel sheets) and zinc-based plating steel sheet (that is, zincified and zinc alloy plating steel sheets). The plated steel sheets may be electroplated steel sheets or molten plated sheet steels. Moreover, alloyed hot dip galvanized steel sheets may also be used.

2. Heating conditions and holding time

In the die cooling at the time of the hot pressing, in order to perform the hardening treatment after forming the formed members, that is, the hot-pressed members, the base steel plate must first be heated to the austenite temperature range and put into the austenite phase. For this, it is heated at or above the Ac_3 point and held for 1 minute or more at this temperature under the ordinary conditions. No particular upper limit is set for the holding time, but it is desirable for the upper limit to be about 10 minutes, considering the efficiency of the actual production.

3. Cooling rate at the time of the hot pressing

The cooling rate during the hot pressing (in the die) or after the hot pressing (after deforming) is a parameter which plays an extremely important role in obtaining stabilized strength and toughness in the hot-pressed members.

In order to give the hot-pressed members stabilized strength and toughness, it is not essential to make the structure after the hot pressing a complete martensite structure, but rather to make it an auto-tempered martensite structure. In order to make this auto-tempered martensite structure, in the cooling step during or after the hot pressing, it is cooled to the Ms

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point at a cooling rate at or above the critical cooling rate, so that a diffusion transformation does not occur, and in the temperature range from the Ms point to 200°C, it is cooled at a slow cooling rate, that is, an average cooling rate of 25–150°C/sec. By performing this kind of cooling, the tempering is performed at the same time that the martensite transformation occurs; therefore, there is little variation in strength and a martensite structure with excellent toughness is obtained. Desirable cooling rates from the Ms point to 200°C are in the range of 30–120°C/sec.

4. The method of forming in the hot-pressing method

Shapes of the forming in the hot-pressing method include bending, drawing, stretch forming, hole expansion, and flanging. Furthermore, if a means for cooling the steel plate simultaneously with or immediately after the forming is provided, this invention may also be applied to forming methods other than hot pressing, for example, roll forming.

5. Hot-pressed members

The members which are produced by the hot-pressing method described above have tempered martensite structures with little variation in strength and excellent toughness. Moreover, since the strength obtained is the strength of the tempered martensite structure, the hardness is lower than the hardness (Hv), that is, the maximum quench hardness – 10, and since they are not excessively tempered, it is equal to or greater than the maximum quench hardness – 100. If the value of Hv becomes higher than the maximum quench hardness – 10, the toughness will be lowered, and if it is less than the maximum quench hardness – 100, the strength will be lowered. Desirable values of Hv are in the range of less than the maximum quench hardness – 20 or lower and the maximum quench hardness – 80 or higher.

Here, the "maximum quench hardness" is the hardness that is obtained when a water-cooling treatment is performed after the material is kept for 10 minutes in a salt bath heated to 900°C.

6. The method of cooling at the time of the hot-press forming

Ordinarily, since steel dies are kept at room temperature or several tens of degrees Celsius, cooling of the formed members is accomplished by these steel dies when hot-press forming is done. Therefore, in order to change the cooling rate, it is understood that the die dimensions may be changed and the thermal capacity changed.

Moreover, the cooling rate can also be changed by changing the die material to a dissimilar metal (for example, copper, etc.). Moreover, if the die dimensions or material are not changed, the cooling rate can also be changed by changing the quantity of cooling water, when a water-

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cooled die is used. In this case, also, the cooling rate of the press-formed members can also be changed by, for example, using a die which has a number of grooves cut in it beforehand and causing water to flow through the grooves during the pressing, or raising the pressing machine during the press formation and causing water to flow between the dies.

Therefore, the following means are considered for changing the cooling rate before and after the Ms point:

(1) transferring to a die with a different thermal capacity or a room-temperature die immediately after the Ms point is reached;

(2) in the case of using a water-cooled die, changing the quantity of water flowing in the die immediately after the Ms point is reached; and

(3) changing the quantity of water flowing between the die and the member immediately after the Ms point is reached.

Working Examples

The following working examples are examples of this invention, but the invention is not limited in any way by them.

In these examples, steel plates (1.0 mm thick) with the composition shown in Table 1 are used as the base steel plates. These steel plates were made by hot or cold rolling slab ingots which were made in the laboratory. Furthermore, for steel No. 2, hot dip galvanizing (60 g/m^2 of Zn adhering per side) was performed, after which an alloying treatment was performed (Fe content in the plating film 15 mass %).

These steel plates were cut into pieces 40 W x 60 L (mm) and heated at 900°C x 5 minutes in a furnace with an air atmosphere, after which they were removed from the furnace and hot-press forming was performed immediately thereafter with a flat plate steel die. For steel No. 2, the hot-press forming was performed by changing the cooling conditions (tests Nos. 2, 5, and 6).

The Vickers hardnesses of the hot-pressed members that were obtained were measured (load 9.8 N, number of measurements: 5). Moreover, the cooling rates after the press forming were measured by attaching thermocouples to the steel plates. The cooling rates were primarily changed by changing the die dimensions.

Furthermore, for test No. 2, the cooling rate was adjusted by injecting water between the dies immediately after the steel plate temperature reached the Ms point.

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The maximum quench hardness was taken to be the hardness that was obtained when a water-cooling treatment was performed after the material was kept for 10 minutes in a salt bath heated to 900°C.

Table 2 shows the results that were obtained, in terms of the Ac_3 points, Ms points, and critical cooling rates of each kind of steel, which were measured by the following methods.

Cylindrical test pieces 3.0 mm in diameter and 10 mm long (Fig. 2) were cut from the hot-rolled plates and heated in air to 950°C at a temperature rise rate of 10°C/sec. After they were kept at this temperature for 5 minutes, they were cooled to room temperature at various cooling rates. The Ac_3 and Ms points were measured by measuring the changes in the thermal expansions of the test pieces during the heating and cooling. Moreover, the Vickers hardnesses (load 49 N, number of measurements: 5) of the test pieces that were obtained were measured, and their structures were observed, and the critical cooling rates were estimated from these results.

Table 1

Steel No.	Chemical composition (mass %; remainder: essentially Fe)														
	C	Si	Mn	P	S	Cu	Ni	Cr	Mo	V	Ti	Nb	Al	B	N
1	0.16	0.02	1.36	0.019	0.004	0.01	0.01	0.19	–	0.01	0.03	–	0.06	0.0013	0.008
2	0.21	0.25	1.20	0.008	0.002	0.01	0.02	0.20	–	0.01	0.02	0.01	0.05	0.0007	0.005
3	0.33	0.11	1.53	0.001	0.001	–	–	0.20	–	–	0.02	–	0.04	0.0015	0.001
4	0.42	0.11	1.51	0.001	0.001	–	–	0.20	0.01	–	0.02	–	0.04	0.0014	0.001

Table 2

Test No.	Steel No.	Ac_3 point (°C)	Ms point (°C)	Critical cooling rate (°C/sec)	Measured cooling rate to Ms point (°C/sec)	Average cooling rate from Ms point to 200°C	Hardness after hot pressing (HV)	Maximum quench hardness (HV)	Die size (t x W x L mm)	Notes
1	1	860	450	25	60	40	418	461	50 x 400 x 400	Working Examples
2	2	823	410	17	60	100	451	501	50 x 400 x 400*1	
3	3	823	390	10	60	40	560	652	50 x 400 x 400	
4	4	785	370	10	60	30	683	750	50 x 400 x 400	
5	2	823	410	17	60	22*3	390	501	50 x 50 x 400	Comparison Examples
6	2	823	410	17	60	200*3	500	501	50 x 50 x 400*2	

*1 Water injected between dies immediately after the Ms point
*2 Pressing machine raised immediately after the Ms point and test pieces immediately put into a water bath
*3 Conditions outside the range of this invention

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In Tests Nos. 1–4 in these examples of the invention, since the average cooling rate from the Ms point to 200°C was correct, the hardnesses obtained were lower than the maximum quench hardness – 10 and higher than the maximum quench hardness – 100.

In Test No. 5, a comparison example, the cooling rate was above the critical cooling rate but the average cooling rate from the Ms point to 200°C was slow; therefore, sufficient hardness was not obtained. Moreover, in Test No. 6, another comparison example, the average cooling rate from the Ms point to 200°C was too rapid; therefore, it was too hard. Here, the meaning of "too hard" is not that the absolute value of the hardness was high, but that it was near the maximum quench hardness.

In the case of the steel plate of Test No. 2, an example of this invention, the plate was heated at 900°C x 5 minutes in a furnace with an air atmosphere, removed from the furnace and hat-type hot-press forming was performed [blank size: 1.0 T x 80 W x 320 L (mm)].

A schematic drawing of the hat-forming method used in this case is shown in Fig. 1. The hot-press forming conditions used were: forming height 70 mm, Rd (die shoulder R) 8 mm, Rp (punch shoulder R) 8 mm, clearance 1.0 mm, and blank holding force 12.7 kN.

Moreover, the Vickers hardnesses were measured in the bottom punch part, middle side wall part, and flange part of the hot-press formed member (load 9.8 N, number of measurements: 5). The cooling rates at these locations were measured by attaching thermocouples at each location. The results are shown in Table 3.

Table 3

	Average cooling rate from Ms point to 200°C (°C/sec)	Hardness after hot pressing (HV)
Bottom of punch	55	460
Center of side wall	100	471
Flange	120	480

Since the average cooling rate from the Ms point to 200°C was correct in each location, good hardnesses were obtained. Moreover, it can be seen that the variation in hardness within the same member was small.

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Claims

1. A method of hot forming which is a method in which steel plates having essentially the steel compositions of C: 0.15–0.45%, Mn: 0.5–3.0%, Cr: 0.1–0.5%, Ti: 0.01–0.1%, B: 0.0002–0.004%, Si: ≤0.5%, P: ≤0.05%, S: ≤0.05%, Al: ≤1%, and N: ≤0.01%, as well as one or two or more of Ni: ≤2%, Cu: ≤1%, Mo: ≤1%, V: ≤1%, and Nb: ≤1%, with the remaining content being Fe and unavoidable impurities, are heated and kept at a temperature of the Ac_3 point or higher, after which they are formed to the final product shape; moreover, when they are cooled from the forming temperature during or after the forming, the cooling rate to the Ms point of the formed member is at or above the critical cooling rate and a quenching treatment is performed in which they are cooled at an average cooling rate from the Ms point to 200°C in the range of 25–150°C/sec.

2. The method of hot forming in Claim 1 in which the aforementioned forming is performed by using a press-forming die.

3. The method of hot forming in Claim 1 or Claim 2 in which, after the aforementioned forming is performed by using a die for press forming, the cooling is performed by injecting water between the dies.

4. Hot-formed members, characterized in that they are constituted from steel plates which have essentially the steel compositions of C: 0.15–0.45%, Mn: 0.5–3.0%, Cr: 0.1–0.5%, Ti: 0.01–0.1%, B: 0.0002–0.004%, Si: ≤0.5%, P: ≤0.05%, S: ≤0.05%, Al: ≤1%, and N: ≤0.01%, as well as one or two or more of Ni: ≤2%, Cu: ≤1%, Mo: ≤1%, V: ≤1%, and Nb: ≤1%, with the remaining content being Fe and unavoidable impurities, and their hardnesses after the hot forming are Vickers hardnesses which are less than the maximum quench hardness – 10 and equal to or greater than the maximum quench hardness – 100.

5. Hot-formed members of Claim 4 in which the aforementioned hot forming is hot-press forming.

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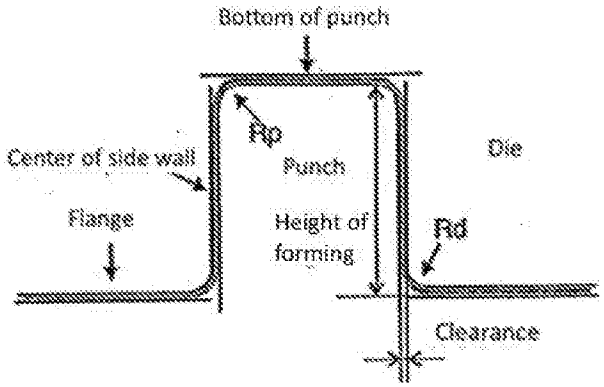


Fig. 1

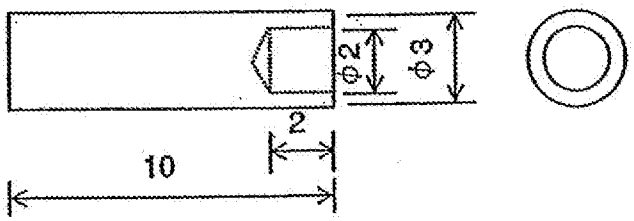


Fig. 2

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DECLARATION OF JON JOHANNING

I, Jon Johanning, declare the following:

1. I am over 18 years of age and competent to make this declaration.

2. I am a qualified Japanese to English translator as certified by the American Translators Association.

3. I have translated the attached patent application regarding International Publication No. WO 2004/106573 A1 (PCT/JP2004/007654), bearing a publication date of December 9, 2004.

4. I affirm that the translated text has been translated and edited to the best of my ability and knowledge to accurately reflect the content, meaning, and style of the original text. I hereby certify under penalty of perjury under the laws of the United States of America that the foregoing constitutes, pursuant to my knowledge and belief, a true and correct translation of the original document.

5. I declare that all statements made herein of my knowledge are true, and that all statements made on information and belief are believed to be true, and that these statements were made with the knowledge that willful false statements and the like are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code.



Jon Johanning

Dated and signed on May 3, 2019.

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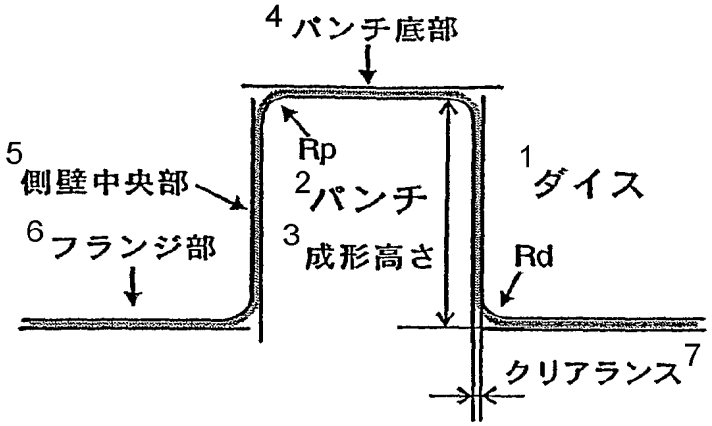
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[続葉有]

(54) Title: METHOD FOR HOT FORMING AND HOT FORMED MEMBER

(54) 発明の名称: 熱間成形法と熱間成形部材



1...DIE
2...PUNCH
3...HEIGHT OF FORMING
4...BOTTOM OF PUNCH
5...CENTER OF SIDE WALL
6...FLANGE
7...CLEARANCE

(57) Abstract: A method for hot forming, wherein in the cooling step of hot pressing, a formed product is first cooled at a rate of a critical cooling rate or higher down to the Ms point thereof and then cooled at a rate of 25 to 150°C/s from the Ms point to 200°C; and a hot pressed member which has been formed by the method and has a Vickers hardness of less than (the maximum quench hardness - 10) and (the maximum quench hardness - 100) or more. The hot pressed member is manufactured from a high strength steel sheet by means of hot pressing and exhibits a stable strength and toughness in combination.

[続葉有]

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(81) 指定国 (表示のない限り、全ての種類の国内保護が可能): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

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(57) 要約: 高強度鋼板から、安定した強度と靭性を併せ持つ熱間プレス部材を熱間プレスにより作製する。熱間プレス時の冷却過程において、Ms点までは臨界冷却速度以上で冷却し、Ms点から200℃までの温度範囲の冷却速度を25～150℃/sとする。熱間プレス部材のビッカース硬さは、（最高焼入れ硬さ−10）未満、かつ（最高焼入れ硬さ−100)以上である。

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明　細　書

熱間成形法と熱間成形部材

技術分野

本発明は、自動車のボディー構造部品、足回り部品等を初めとする機械構造部品等の熱間成形部材と、その製造に使用される熱間成形方法に関する。さらに詳述すれば、本発明は、熱間プレス部材とそのための熱間プレス方法に関する。

以下では、熱間プレス成形を例にとって本発明を説明するが、本発明はロール成形、鍛造等のプレス成形以外の熱間成形にも適用可能である。

背景技術

近年、自動車の軽量化のため、例えば引張強さ590 MPa 以上というように鋼材の高強度化を図り、使用重量を減ずる努力が進んでいる。自動車に広く使用される薄鋼板では、そのような傾向の下、鋼板強度の増加に伴って、プレス成形性が低下し、複雑な形状を製造することが困難になってきている。具体的には、強度増加に伴って延性が低下し、加工度が高い部位で破断が生じたり、スプリングバックや壁反りが大きくなり、寸法精度が劣化するという問題が発生する。

従って、高強度、特に引張強さ780 MPa 級以上の鋼板の場合、冷間加工手段としてプレス成形を利用して部品を製造することは容易ではない。プレス成形ではなくロール成形を利用すれば、上記の高強度鋼板の加工が可能であるが、ロール成形は長手方向に一様な断面を有する部品にしか適用できず、適用できる製品の形状が限定される。

一方、英国特許第1490535 号に開示されているように、加熱した鋼板をプレス成形する熱間プレス法では、鋼板を高温で加熱することから、鋼板の材質は軟化して高延性になっているため、加熱状態で複雑な形状を寸法精度よく成形することが可能である。さらに、鋼板をオーステナイト域温度に加熱しておき、金型内で急冷するという金型冷却により、マルテンサイト変態による鋼板の高強度化、即ち、焼入れ、が同時に達成できる。

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しかし、熱間プレス法における金型冷却では、部材の焼入れ硬さが、0.2 %C材の場合でHv 400～490 と十分ではなく、しかも部材中の硬さのばらつきが非常に大きいという問題がある。

Advanced Materials & Processes, Vol. 146, No. 6, 12/94, p. 16 には、スェーデンのプランジャ社により開発されたホットプレス技術が紹介されており、980 ℃からダイクエンチ（金型内急冷）することが記載されている。金型温度は、加熱との記載がないので、常温～数十℃と推定される。

特開平 8 －269615号には、C：0.18～0.30%、Si：0.01～1.0 %、Mn： 0.2～1.5 %、P：0.03%以下、S：0.02%以下、sol.Al：0.08%以下、Cr： 0.1～0.5 %、B：0.0006～0.0040%、N：0.01%以下を含み、場合によりCu：0.5 %以下、Ni：0.3 %以下、Ti：0.01～0.05%の少なくとも 1 種をさらに含み、残部鉄からなる、急速焼入れ用熱延鋼板が開示されている。この鋼板は、冷間加工した後、高周波焼入れにより高強度化させるものである。

発明の開示

本発明は、熱間成形法により高強度鋼板から製造でき、かつ安定した強度と靱性を併せ持つ熱間成形部材と、それを作製する熱間成形法を提供する。

より具体的には、本発明は、自動車のボディー構造部品、足回り部品等を初めとする機械構造部品等の熱間プレス部材と、その製造に使用される熱間プレス方法を提供する。

本発明によれば、成形後の冷却時、例えば金型冷却時に、Ms点（オーステナイトからマルテンサイトが生成し始める温度）以下の温度域での平均冷却速度を一定範囲内に収めることにより、熱間成形によって安定した強度および靱性を併せ持つ熱間成形部材を製造することができる。

1 態様において、本発明は、質量%で、C：0.15～0.45%、Mn： 0.5～3.0 %、Cr： 0.1～0.5 %、Ti：0.01～0.1 %、B：0.0002～0.004 %、Si：0.5 %以下、P：0.05%以下、S：0.05%以下、Al： 1 %以下、N：0.01%以下を含有し、かつNi： 2 %以下、Cu： 1 %以下、Mo： 1 %以下、V： 1 %以下、およびNb： 1 %以下の 1 種または 2 種以上を含有し、残部Feおよび不可避的不純物から本質

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的になる鋼組成を有する鋼板を、Ac_3 点以上に加熱・保持した後、最終製品形状への成形を行う熱間成形方法に関する。本発明によれば、成形中または成形後の成形温度からの冷却に際して、成形部材のMs点までの冷却速度が臨界冷却速度以上で、かつ、Ms点から200 ℃までの平均冷却速度が25～150 ℃/sで冷却して焼入れ処理を行う。なお、本発明では、臨界冷却速度は上部臨界冷却速度の意味である。

別の態様において、本発明は、上記鋼組成を有する鋼板から構成された熱間成形部材に関する。この熱間成形部材は、熱間成形後の硬さが、ビッカース硬さで、（最高焼入れ硬さ－10）未満、かつ（最高焼入れ硬さ－100)以上、である。

本発明の好適態様において、熱間成形は、プレス成形用金型を用いて行う熱間プレス成形である。

本発明によれば、安定した強度と靱性を併せ持つ熱間プレス部材の作製が可能となる。従って、本発明は、高強度鋼板のプレス成形部材としての用途拡大に大きく寄与する。

図面の簡単な説明

図 1 はハット成形法の模式的説明図である。

図 2 は臨界冷却速度の測定用試験片の形状を示す模式図である。

発明の詳細な説明

本発明において前述した鋼組成および成形条件を採用する理由は次の通りである。本発明において、鋼組成、つまり鋼の化学組成を示す「%」は「質量%」を表す。

1. 素地鋼板の組成

C ：0.15～0.45%

炭素（C）は、鋼板の焼入れ性を高め、かつ焼入れ後、強度を主に決定する非常に重要な元素である。さらにAc_3 点を下げ、焼入れ処理温度の低温化を促進する元素である。しかし、C含有量が0.15%未満ではその効果は十分ではなく、一方でC含有量が0.45%を超えると、焼入れ部の靱性劣化が著しくなる。好ましい

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C含有量の下限は0.16%、上限は0.35%である。

Mn： 0.5～3.0 %

マンガン（Mn）は、鋼板の焼入れ性を高め、かつ焼入れ後に強度を安定して確保するために非常に効果のある元素である。さらに、Ac_3 点を下げ、焼入れ処理温度の低温化を促進する元素である。しかし、Mn含有量が0.5 %未満ではその効果は十分ではなく、一方でMn含有量が3.0 %を超えるとその効果は飽和し、さらに焼入れ部の靱性劣化を招く。好ましいMn含有量は 0.8～2.0 %である。

Cr： 0.1～0.5 %

クロム（Cr）は、鋼板の焼入れ性を高め、かつ焼入れ後、強度を安定して確保するために効果のある元素である。しかし、Cr含有量が0.1 %未満ではその効果は十分ではなく、一方でCr含有量が0.5 %をこえるとその効果は飽和し、いたずらにコスト増を招く。好ましいCr含有量は0.15～0.30%である。

Ti：0.01～0.1 %

チタン（Ti）は、鋼板の焼入れ性を高め、かつ焼入れ後、強度を安定して確保するために効果のある元素である。さらに焼入れ部の靱性も向上させる効果を有する。しかし、Ti含有量が0.01%未満ではその効果は十分ではなく、一方でTi含有量が0.1 %を超えるとその効果は飽和し、いたずらにコスト増を招く。好ましいTi含有量は 0.015～0.03%である。

B：0.0002～0.004 %

ホウ素（B）は、鋼板の焼入れ性を高め、かつ焼入れ後、強度の安定確保効果をさらに高める重要な元素である。しかし、B含有量が0.0002%未満ではその効果は十分ではなく、一方でB含有量が0.004 %を超えるとその効果は飽和し、かつコスト増を招く。好ましいB含有量は0.0005～0.0025%である。

Si：0.5 %以下、P：0.05%以下、S：0.05%以下、Al：1%以下、N：0.01%以下

これらの元素も、いずれも鋼板の焼入れ性を高め、かつ焼入れ後の強度の安定化を高める効果を有する。しかし、それらの含有量が上記のそれぞれの上限を超えると、その効果は飽和し、かえってコスト増を招く。

Ni：2%以下、Cu：1%以下、Mo：1%以下、V：1%以下、Nb：1%以下の

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1種または2種以上

これらの元素も、鋼板の焼入れ性を高め、かつ焼入れ後、強度の安定確保に効果のある元素であるので、1種または2種以上を含有させる。しかし、それぞれ上限値を越えて含有させてもその効果は小さく、かついたずらにコスト増を招くため、各合金元素の含有量は上述の範囲とする。

本発明で使用する鋼板については、成形に先立つ加熱の際にオーステナイト温度域に加熱し、オーステナイト変態をさせるため、加熱前の室温での機械的性質は重要ではなく、加熱前の金属組織については特に制限されない。従って、素地鋼板としては、熱延鋼板、冷延鋼板、めっき鋼板のいずれを使用してもよく、その製造方法については特に限定はしない。めっき鋼板としては、アルミ系めっき鋼板（即ち、アルミめっきおよびアルミ合金めっき鋼板）と亜鉛系めっき鋼板（即ち、亜鉛めっきおよび亜鉛合金めっき鋼板）が例示される。めっき鋼板は、電気めっき鋼板でも、溶融めっき鋼板でもよい。また、合金化溶融亜鉛めっき鋼板も使用できる。

2.加熱条件および保持時間

熱間プレス時の金型冷却において、成形部材、つまり熱間プレス部材に成形後焼入れ処理を行うためには、まず素地鋼板をオーステナイト温度域まで加熱し、素地鋼板を一度、オーステナイト相にする必要がある。そのためには、Ac_3点以上に加熱し、その温度で通常の条件では1分以上保持する。保持時間の上限は特には設けないが、実際の生産上の効率を考えて、保持時間の上限を10分程度にするのが望ましい。

3.熱間プレス時の冷却速度

熱間プレス中（金型内）または熱間プレス後（脱型後）の冷却速度は、熱間プレス部材において安定した強度および靱性を得るために非常に重要な役割を果たすパラメータである。

安定した強度および靱性を熱間プレス部材に付与するためには、熱間プレス後の組織を、完全マルテンサイト組織とするのではなく、自動焼き戻しマルテンサイト組織とすることが肝要である。この自動焼き戻しマルテンサイト組織にするためには、熱間プレス時または熱間プレス後の冷却段階でMs点までは拡散変態が

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起きないように臨界冷却速度以上で冷却し、かつMs点から200 ℃までの温度範囲は平均冷却速度25～150 ℃/sという、遅い冷却速度で冷却する。このような冷却により、マルテンサイト変態が起こると同時に焼き戻しされるため、強度のばらつきが少なく、かつ靱性に優れたマルテンサイト組織が得られる。Ms点から200 ℃までの好ましい平均冷却速度は30～120 ℃/sである。

4.熱間プレス法における成形方法

熱間プレス法における成形の形態としては、曲げ加工、絞り成形、張出し成形、穴拡げ成形、フランジ成形等がある。また、成形と同時またはその直後に鋼板を冷却する手段を備えていれば、プレス成形以外の成形法、例えばロール成形に本発明を適用してもよい。

5.熱間プレス部材

前述の熱間プレス法にて作製された部材は、強度のばらつきが少なく、かつ靱性に優れた焼き戻しマルテンサイト組織を有する部材となる。また、得られる強度は、焼き戻しマルテンサト組織の強度であるため、硬さ（Hv）で言い換えると、（最高焼入れ硬さ－10）よりも低いが、過度に焼き戻されていないため、（最高焼入れ硬さ－100)以上の硬さを有する。Hvの値が（最高焼入れ硬さ－10）より高くなると靱性が低下し、（最高焼入れ硬さ－100)より低くなると強度が低下する。好ましいHvの値は、（最高焼入れ硬さ－20）以下、（最高焼入れ硬さ－80）以上である。

ここに「最高焼入れ硬さ」とは、900 ℃に加熱した塩浴中でその材料を10分間保持後、水冷処理を施した時に得られる硬さである。

6.熱間プレス成形時の冷却方法

通常、鋼製金型は常温または数十℃程度の温度に保持されているから、熱間プレス成形に際して、この鋼製金型によりプレス成形部材の冷却が達成される。従って、冷却速度を変化させるためには、金型寸法を変え熱容量を変化させればよいことが分かる。

また、金型材質を異種金属（例えば銅など）に変えることでも冷却速度を変化させることができる。金型寸法も、材質も変えられない場合、水冷型の金型を用いてそのときの冷却水量を変えることによっても、冷却速度を変えることができ

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る。その場合でも、例えば、予め溝を数カ所切った金型を用い、プレス中に水を溝に通すことによって冷却速度を変えたり、プレス成形途中でプレス機を上げ、その間に水を流すことでもプレス成形部材の冷却速度を変えることができる。

従って、Ms点の前後で冷却速度を変化させる手段には次のような手段が考えられる。

(1) MS点到達直後に、熱容量の異なる金型または室温状態の金型に移動させて、冷却速度を変える。

(2) 水冷金型の場合、MS点到達直後に、金型中を流れる水量を変化させて、冷却速度を変える。

(3) Ms点到達直後に金型と部材の間に水を流し、その水量を変化させることで、冷却速度を変える。

実施例

以下の実施例は本発明を例示するものであるが、本発明はそれによりいかなる制限も受けない。

本例では、表1に示した組成を有する鋼板（板厚：1.0 mm）を素地鋼板とした。これらの鋼板は、実験室にて溶製したスラブを、熱間圧延、冷間圧延により製造した鋼板である。さらに鋼種No.2には、めっきシミュレータを用いて溶融亜鉛めっき（片面あたりのZn付着量は60 g/m²）を施し、その後、合金化処理（めっき皮膜中のFe含有量は15質量%）を行った。

これらの鋼板を40 W×60 L（mm）の寸法に切断し、大気雰囲気の加熱炉内で、900 ℃×5分の加熱を行ってから、加熱炉より取り出し、その直後に、平板の鋼製金型を用いて、熱間プレス成形を行った。鋼種No.2については、冷却条件を変化させて熱間プレス成形を行った（試験No.2, 5, 6）。

得られた熱間プレス部材について、ビッカース硬さ測定（荷重9.8 N、測定数：5）を行った。また鋼板に熱電対を貼付し、プレス成形後の冷却速度の測定も行った。冷却速度については、主に金型寸法を変えて冷却速度を変化させた。

なお、試験No.2については、鋼板温度がMs点に到達した直後に金型間に水を注入し冷却速度を調節した。

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最高焼入れ硬さについては、900 ℃に加熱した塩浴中でその材料を10分間保持後、水冷処理を施した時に得られる硬さを最高焼入れ硬さとした。

得られた結果を、次の方法で測定した各鋼種のAc_3 点、Ms点、および臨界冷却速度と共に表 2 にまとめて示す。

熱延鋼板から直径3.0 mm、長さ10 mm の円柱試験片（図 2 ）を切り出し、大気中で950 ℃まで10℃/sの昇温速度にて加熱し、その温度で 5 分間保持したのち、種々の冷却速度で室温まで冷却した。そのときの加熱、冷却中の試験片の熱膨張変化を測定することにより、Ac_3 点、Ms点を測定した。また、得られた試験片のビッカース硬度測定（荷重49N 、測定数： 5）および組織観察を行い、それらの結果から臨界冷却速度を見積もった。

表 1

鋼種No.	化学組成（質量%、残部：実質的にFe）														
	C	Si	Mn	P	S	Cu	Ni	Cr	Mo	V	Ti	Nb	Al	B	N
1	0.16	0.02	1.36	0.019	0.004	0.01	0.01	0.19	—	0.01	0.03	—	0.06	0.0013	0.008
2	0.21	0.25	1.20	0.008	0.002	0.01	0.02	0.20	—	0.01	0.02	0.01	0.05	0.0007	0.005
3	0.33	0.11	1.53	0.001	0.001	—	—	0.20	—	—	0.02	—	0.04	0.0015	0.001
4	0.42	0.11	1.51	0.001	0.001	—	—	0.20	0.01	—	0.02	—	0.04	0.0014	0.001

表 2

試験No.	鋼種No.	Ac_3 点 (℃)	Ms 点 (℃)	臨界冷却速度 (℃/s)	Ms点迄の実測冷却速度 (℃/s)	Ms点～200℃の平均冷却速度 (℃/s)	熱間プレス後の硬さ (HV)	最高焼入れ硬さ (HV)	金型サイズ (t×W×Lmm)	備考
1	1	860	450	25	60	40	418	461	50×400 ×400	発明例
2	2	823	410	17	60	100	451	501	50×400 ×400 *1	
3	3	823	390	10	60	40	560	652	50×400 ×400	
4	4	785	370	10	60	30	683	750	50×400 ×400	
5	2	823	410	17	60	22*3	390	501	50×50×400	比較例
6	2	823	410	17	60	200*3	500	501	50×50×400 *2	

*1 Ms点直後に金型間へ水を注入。
*2 Ms点直後にプレス機を上昇させ、試験片を直ちに水槽へ投入。
*3 本発明の範囲外の条件

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本発明例である試験No. 1～4では、Ms点から200 ℃までの平均冷却速度が適正であるため、得られた硬さは（最高焼入れ硬さ－10）よりも低く、また（最高焼入れ硬さ－100)よりも高い。

比較例である試験No. 5は、臨界冷却速度以上で冷却しているが、Ms点から200 ℃までの平均冷却速度が遅いため、十分な硬さが得られていない。また、やはり比較例である試験No. 6は、Ms点から200 ℃までの平均冷却速度が速すぎるため、硬くなりすぎている。ここに、「硬すぎる」との意味は、硬さの絶対値が高いということではなく、最高焼き入れ硬さに近いということである。

本発明例である試験No. 2の鋼板について、大気雰囲気の加熱炉内で900 ℃×5分加熱して、加熱炉より取り出し、ハット型の熱間プレス成形［ブランクサイズ：1.0 t ×80 W×320 L (mm)］を行った。

このときのハット成形法の模式図を図1に示す。採用した熱間プレス成形条件は、成形高さ70 mm 、Rd（ダイス肩部R） 8 mm、Rp（パンチ肩部R） 8 mm、クリアランス1.0 mm、しわ押さえ力12.7 kN であった。

また、熱間プレス成形品のパンチ底部、側壁中央部、フランジ部について、ビッカース硬さ測定（荷重9.8 N 、測定数：5)を行った。さらに、各部位に熱電対を貼付し、その部位の冷却速度も測定した。結果を表3にまとめて示す。

表3

	Ms点～200 ℃までの平均冷却速度 (℃/s)	熱間プレス後の硬さ (HV)
パンチ底部	55	460
側壁中央部	100	471
フランジ部	120	480

各部位でのMs点から200 ℃までの平均冷却速度が適正であるため、良好な硬さが得られている。また同じ部材中での硬さのばらつきも小さいことがわかる。

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請 求 の 範 囲

1．質量%で、C：0.15～0.45%、Mn： 0.5～3.0 %、Cr： 0.1～0.5 %、Ti：0.01～0.1 %、B：0.0002～0.004 %、Si：0.5 %以下、P：0.05%以下、S：0.05%以下、Al：1%以下、N：0.01%以下を含有し、かつNi：2%以下、Cu：1%以下、Mo：1%以下、V：1%以下、およびNb：1%以下の1種または2種以上を含有し、残部Feおよび不可避的不純物から本質的になる鋼組成を有する鋼板を、Ac_3 点以上の温度に加熱・保持した後、最終製品形状への成形を行う方法であって、成形中または成形後の成形温度からの冷却に際して、成形部材のMs点までの冷却速度が臨界冷却速度以上で、かつMs点から200 ℃までの平均冷却速度が25～150 ℃/sで冷却して焼入れ処理を行う、熱間成形法。

2．前記成形をプレス成形用金型を用いて行う請求項1記載の熱間成形法。

3．前記成形をプレス成形用金型を用いて成形後、金型間に水を注入して冷却する請求項1または2記載の熱間成形法。

4．質量%で、C：0.15～0.45%、Mn： 0.5～3.0 %、Cr： 0.1～0.5 %、Ti：0.01～0.1 %、B：0.0002～0.004 %、Si：0.5 %以下、P：0.05%以下、S：0.05%以下、Al：1%以下、N：0.01%以下を含有し、かつNi：2%以下、Cu：1%以下、Mo：1%以下、V：1%以下、およびNb：1%以下の1種または2種以上を含有し、残部Feおよび不可避的不純物から本質的になる鋼組成を有する鋼板から構成され、熱間成形後の硬さが、ビッカース硬さで、（最高焼入れ硬さ－10）未満、かつ（最高焼入れ硬さ－100)以上であることを特徴とする、熱間成形部材。

5．前記熱間成形が熱間プレス成形である請求項4記載の熱間成形部材。

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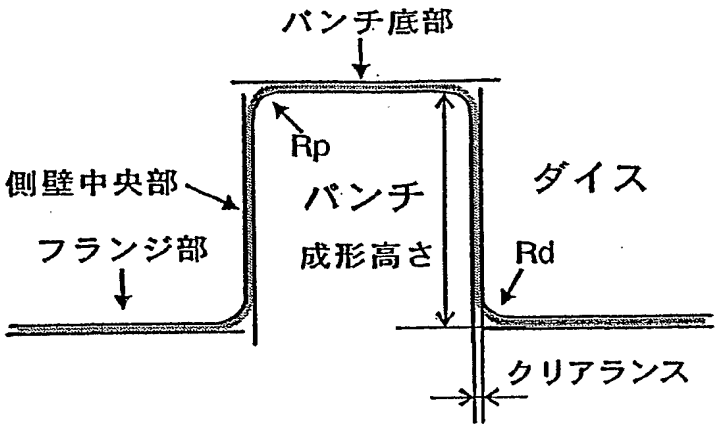


Fig. 1

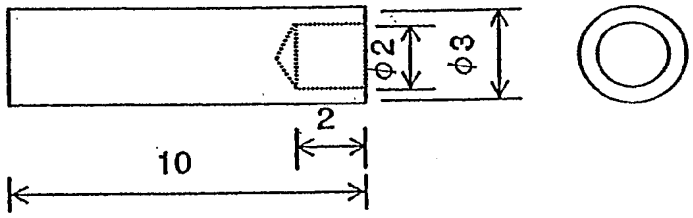


Fig. 2

ArcelorMittal Ex. 2001
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POSCO Exhibit 1062 Page 1376
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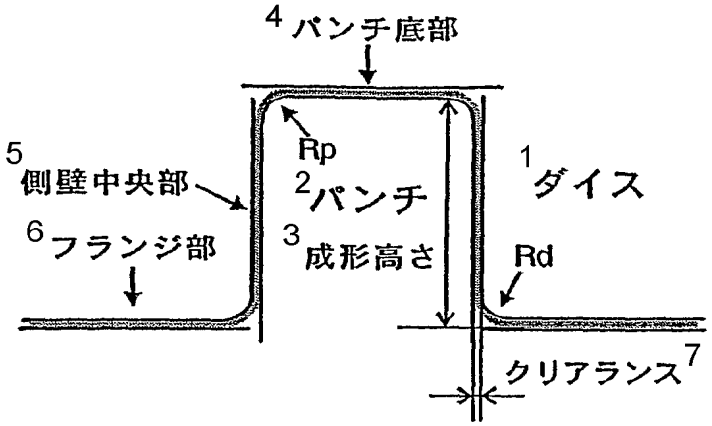
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[続葉有]

(54) Title: METHOD FOR HOT FORMING AND HOT FORMED MEMBER

(54) 発明の名称: 熱間成形法と熱間成形部材



1...DIE
2...PUNCH
3...HEIGHT OF FORMING
4...BOTTOM OF PUNCH
5...CENTER OF SIDE WALL
6...FLANGE
7...CLEARANCE

(57) Abstract: A method for hot forming, wherein in the cooling step of hot pressing, a formed product is first cooled at a rate of a critical cooling rate or higher down to the Ms point thereof and then cooled at a rate of 25 to 150°C/s from the Ms point to 200°C; and a hot pressed member which has been formed by the method and has a Vickers hardness of less than (the maximum quench hardness - 10) and (the maximum quench hardness - 100) or more. The hot pressed member is manufactured from a high strength steel sheet by means of hot pressing and exhibits a stable strength and toughness in combination.

[続葉有]

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(84) 指定国 (表示のない限り、全ての種類の広域保護が可能): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), ユーラシア (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), ヨーロッパ (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

添付公開書類:
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(57) 要約: 高強度鋼板から、安定した強度と靭性を併せ持つ熱間プレス部材を熱間プレスにより作製する。熱間プレス時の冷却過程において、Ms点までは臨界冷却速度以上で冷却し、Ms点から200℃までの温度範囲の冷却速度を25～150℃/sとする。熱間プレス部材のビッカース硬さは、（最高焼入れ硬さ−10）未満、かつ（最高焼入れ硬さ−100)以上である。

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Posco Co. LTD. v. ArcelorMittal
POSCO Exhibit 1003-0021376
Filed with Petition for IPR of U.S. Patent No. 9,708,683
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明　細　書

熱間成形法と熱間成形部材

技術分野

本発明は、自動車のボディー構造部品、足回り部品等を初めとする機械構造部品等の熱間成形部材と、その製造に使用される熱間成形方法に関する。さらに詳述すれば、本発明は、熱間プレス部材とそのための熱間プレス方法に関する。

以下では、熱間プレス成形を例にとって本発明を説明するが、本発明はロール成形、鍛造等のプレス成形以外の熱間成形にも適用可能である。

背景技術

近年、自動車の軽量化のため、例えば引張強さ590 MPa 以上というように鋼材の高強度化を図り、使用重量を減ずる努力が進んでいる。自動車に広く使用される薄鋼板では、そのような傾向の下、鋼板強度の増加に伴って、プレス成形性が低下し、複雑な形状を製造することが困難になってきている。具体的には、強度増加に伴って延性が低下し、加工度が高い部位で破断が生じたり、スプリングバックや壁反りが大きくなり、寸法精度が劣化するという問題が発生する。

従って、高強度、特に引張強さ780 MPa 級以上の鋼板の場合、冷間加工手段としてプレス成形を利用して部品を製造することは容易ではない。プレス成形ではなくロール成形を利用すれば、上記の高強度鋼板の加工が可能であるが、ロール成形は長手方向に一様な断面を有する部品にしか適用できず、適用できる製品の形状が限定される。

一方、英国特許第1490535 号に開示されているように、加熱した鋼板をプレス成形する熱間プレス法では、鋼板を高温で加熱することから、鋼板の材質は軟化して高延性になっているため、加熱状態で複雑な形状を寸法精度よく成形することが可能である。さらに、鋼板をオーステナイト域温度に加熱しておき、金型内で急冷するという金型冷却により、マルテンサイト変態による鋼板の高強度化、即ち、焼入れ、が同時に達成できる。

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POSCO Exhibit 1003 Page 1376
Filed with Petition for IPR of U.S. Patent No. 9,796,031 Page 1430

しかし、熱間プレス法における金型冷却では、部材の焼入れ硬さが、0.2 %C材の場合でHv 400～490 と十分ではなく、しかも部材中の硬さのばらつきが非常に大きいという問題がある。

Advanced Materials & Processes, Vol. 146, No. 6, 12/94, p. 16 には、スェーデンのプランジャ社により開発されたホットプレス技術が紹介されており、980 ℃からダイクエンチ（金型内急冷）することが記載されている。金型温度は、加熱との記載がないので、常温～数十℃と推定される。

特開平 8 －269615号には、C：0.18～0.30%、Si：0.01～1.0 %、Mn： 0.2～1.5 %、P：0.03%以下、S：0.02%以下、sol.Al：0.08%以下、Cr： 0.1～0.5 %、B：0.0006～0.0040%、N：0.01%以下を含み、場合によりCu：0.5 %以下、Ni：0.3 %以下、Ti：0.01～0.05%の少なくとも 1 種をさらに含み、残部鉄からなる、急速焼入れ用熱延鋼板が開示されている。この鋼板は、冷間加工した後、高周波焼入れにより高強度化させるものである。

発明の開示

本発明は、熱間成形法により高強度鋼板から製造でき、かつ安定した強度と靱性を併せ持つ熱間成形部材と、それを作製する熱間成形法を提供する。

より具体的には、本発明は、自動車のボディー構造部品、足回り部品等を初めとする機械構造部品等の熱間プレス部材と、その製造に使用される熱間プレス方法を提供する。

本発明によれば、成形後の冷却時、例えば金型冷却時に、Ms点（オーステナイトからマルテンサイトが生成し始める温度）以下の温度域での平均冷却速度を一定範囲内に収めることにより、熱間成形によって安定した強度および靱性を併せ持つ熱間成形部材を製造することができる。

1 態様において、本発明は、質量%で、C：0.15～0.45%、Mn： 0.5～3.0 %、Cr： 0.1～0.5 %、Ti：0.01～0.1 %、B：0.0002～0.004 %、Si：0.5 %以下、P：0.05%以下、S：0.05%以下、Al： 1 %以下、N：0.01%以下を含有し、かつNi： 2 %以下、Cu： 1 %以下、Mo： 1 %以下、V： 1 %以下、およびNb： 1 %以下の 1 種または 2 種以上を含有し、残部Feおよび不可避的不純物から本質

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的になる鋼組成を有する鋼板を、Ac_3 点以上に加熱・保持した後、最終製品形状への成形を行う熱間成形方法に関する。本発明によれば、成形中または成形後の成形温度からの冷却に際して、成形部材のMs点までの冷却速度が臨界冷却速度以上で、かつ、Ms点から200 ℃までの平均冷却速度が25～150 ℃/sで冷却して焼入れ処理を行う。なお、本発明では、臨界冷却速度は上部臨界冷却速度の意味である。

別の態様において、本発明は、上記鋼組成を有する鋼板から構成された熱間成形部材に関する。この熱間成形部材は、熱間成形後の硬さが、ビッカース硬さで、（最高焼入れ硬さ－10）未満、かつ（最高焼入れ硬さ－100)以上、である。

本発明の好適態様において、熱間成形は、プレス成形用金型を用いて行う熱間プレス成形である。

本発明によれば、安定した強度と靱性を併せ持つ熱間プレス部材の作製が可能となる。従って、本発明は、高強度鋼板のプレス成形部材としての用途拡大に大きく寄与する。

図面の簡単な説明

図 1 はハット成形法の模式的説明図である。

図 2 は臨界冷却速度の測定用試験片の形状を示す模式図である。

発明の詳細な説明

本発明において前述した鋼組成および成形条件を採用する理由は次の通りである。本発明において、鋼組成、つまり鋼の化学組成を示す「%」は「質量%」を表す。

1. 素地鋼板の組成

C ：0.15～0.45%

炭素（C）は、鋼板の焼入れ性を高め、かつ焼入れ後、強度を主に決定する非常に重要な元素である。さらにAc_3 点を下げ、焼入れ処理温度の低温化を促進する元素である。しかし、C含有量が0.15%未満ではその効果は十分ではなく、一方でC含有量が0.45%を超えると、焼入れ部の靱性劣化が著しくなる。好ましい

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C含有量の下限は0.16%、上限は0.35%である。

Mn： 0.5～3.0 %

マンガン（Mn）は、鋼板の焼入れ性を高め、かつ焼入れ後に強度を安定して確保するために非常に効果のある元素である。さらに、Ac_3 点を下げ、焼入れ処理温度の低温化を促進する元素である。しかし、Mn含有量が0.5 %未満ではその効果は十分ではなく、一方でMn含有量が3.0 %を超えるとその効果は飽和し、さらに焼入れ部の靱性劣化を招く。好ましいMn含有量は 0.8～2.0 %である。

Cr： 0.1～0.5 %

クロム（Cr）は、鋼板の焼入れ性を高め、かつ焼入れ後、強度を安定して確保するために効果のある元素である。しかし、Cr含有量が0.1 %未満ではその効果は十分ではなく、一方でCr含有量が0.5 %をこえるとその効果は飽和し、いたずらにコスト増を招く。好ましいCr含有量は0.15～0.30%である。

Ti：0.01～0.1 %

チタン（Ti）は、鋼板の焼入れ性を高め、かつ焼入れ後、強度を安定して確保するために効果のある元素である。さらに焼入れ部の靱性も向上させる効果を有する。しかし、Ti含有量が0.01%未満ではその効果は十分ではなく、一方でTi含有量が0.1 %を超えるとその効果は飽和し、いたずらにコスト増を招く。好ましいTi含有量は 0.015～0.03%である。

B：0.0002～0.004 %

ホウ素（B）は、鋼板の焼入れ性を高め、かつ焼入れ後、強度の安定確保効果をさらに高める重要な元素である。しかし、B含有量が0.0002%未満ではその効果は十分ではなく、一方でB含有量が0.004 %を超えるとその効果は飽和し、かつコスト増を招く。好ましいB含有量は0.0005～0.0025%である。

Si：0.5 %以下、P：0.05%以下、S：0.05%以下、Al：1%以下、N：0.01%以下

これらの元素も、いずれも鋼板の焼入れ性を高め、かつ焼入れ後の強度の安定化を高める効果を有する。しかし、それらの含有量が上記のそれぞれの上限を超えると、その効果は飽和し、かえってコスト増を招く。

Ni：2%以下、Cu：1%以下、Mo：1%以下、V：1%以下、Nb：1%以下の

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1種または2種以上

これらの元素も、鋼板の焼入れ性を高め、かつ焼入れ後、強度の安定確保に効果のある元素であるので、1種または2種以上を含有させる。しかし、それぞれ上限値を越えて含有させてもその効果は小さく、かついたずらにコスト増を招くため、各合金元素の含有量は上述の範囲とする。

本発明で使用する鋼板については、成形に先立つ加熱の際にオーステナイト温度域に加熱し、オーステナイト変態をさせるため、加熱前の室温での機械的性質は重要ではなく、加熱前の金属組織については特に制限されない。従って、素地鋼板としては、熱延鋼板、冷延鋼板、めっき鋼板のいずれを使用してもよく、その製造方法については特に限定はしない。めっき鋼板としては、アルミ系めっき鋼板（即ち、アルミめっきおよびアルミ合金めっき鋼板）と亜鉛系めっき鋼板（即ち、亜鉛めっきおよび亜鉛合金めっき鋼板）が例示される。めっき鋼板は、電気めっき鋼板でも、溶融めっき鋼板でもよい。また、合金化溶融亜鉛めっき鋼板も使用できる。

2.加熱条件および保持時間

熱間プレス時の金型冷却において、成形部材、つまり熱間プレス部材に成形後焼入れ処理を行うためには、まず素地鋼板をオーステナイト温度域まで加熱し、素地鋼板を一度、オーステナイト相にする必要がある。そのためには、Ac_3点以上に加熱し、その温度で通常の条件では1分以上保持する。保持時間の上限は特には設けないが、実際の生産上の効率を考えて、保持時間の上限を10分程度にするのが望ましい。

3.熱間プレス時の冷却速度

熱間プレス中（金型内）または熱間プレス後（脱型後）の冷却速度は、熱間プレス部材において安定した強度および靱性を得るために非常に重要な役割を果たすパラメータである。

安定した強度および靱性を熱間プレス部材に付与するためには、熱間プレス後の組織を、完全マルテンサイト組織とするのではなく、自動焼き戻しマルテンサイト組織とすることが肝要である。この自動焼き戻しマルテンサイト組織にするためには、熱間プレス時または熱間プレス後の冷却段階でMs点までは拡散変態が

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起きないように臨界冷却速度以上で冷却し、かつMs点から200 ℃までの温度範囲は平均冷却速度25～150 ℃/sという、遅い冷却速度で冷却する。このような冷却により、マルテンサイト変態が起こると同時に焼き戻しされるため、強度のばらつきが少なく、かつ靱性に優れたマルテンサイト組織が得られる。Ms点から200 ℃までの好ましい平均冷却速度は30～120 ℃/sである。

4.熱間プレス法における成形方法

熱間プレス法における成形の形態としては、曲げ加工、絞り成形、張出し成形、穴拡げ成形、フランジ成形等がある。また、成形と同時またはその直後に鋼板を冷却する手段を備えていれば、プレス成形以外の成形法、例えばロール成形に本発明を適用してもよい。

5.熱間プレス部材

前述の熱間プレス法にて作製された部材は、強度のばらつきが少なく、かつ靱性に優れた焼き戻しマルテンサイト組織を有する部材となる。また、得られる強度は、焼き戻しマルテンサト組織の強度であるため、硬さ（Hv）で言い換えると、（最高焼入れ硬さ－10）よりも低いが、過度に焼き戻されていないため、（最高焼入れ硬さ－100)以上の硬さを有する。Hvの値が（最高焼入れ硬さ－10）より高くなると靱性が低下し、（最高焼入れ硬さ－100)より低くなると強度が低下する。好ましいHvの値は、（最高焼入れ硬さ－20）以下、（最高焼入れ硬さ－80）以上である。

ここに「最高焼入れ硬さ」とは、900 ℃に加熱した塩浴中でその材料を10分間保持後、水冷処理を施した時に得られる硬さである。

6.熱間プレス成形時の冷却方法

通常、鋼製金型は常温または数十℃程度の温度に保持されているから、熱間プレス成形に際して、この鋼製金型によりプレス成形部材の冷却が達成される。従って、冷却速度を変化させるためには、金型寸法を変え熱容量を変化させればよいことが分かる。

また、金型材質を異種金属（例えば銅など）に変えることでも冷却速度を変化させることができる。金型寸法も、材質も変えられない場合、水冷型の金型を用いてそのときの冷却水量を変えることによっても、冷却速度を変えることができ

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る。その場合でも、例えば、予め溝を数カ所切った金型を用い、プレス中に水を溝に通すことによって冷却速度を変えたり、プレス成形途中でプレス機を上げ、その間に水を流すことでもプレス成形部材の冷却速度を変えることができる。

従って、Ms点の前後で冷却速度を変化させる手段には次のような手段が考えられる。

(1) MS点到達直後に、熱容量の異なる金型または室温状態の金型に移動させて、冷却速度を変える。

(2) 水冷金型の場合、MS点到達直後に、金型中を流れる水量を変化させて、冷却速度を変える。

(3) Ms点到達直後に金型と部材の間に水を流し、その水量を変化させることで、冷却速度を変える。

実施例

以下の実施例は本発明を例示するものであるが、本発明はそれによりいかなる制限も受けない。

本例では、表1に示した組成を有する鋼板（板厚：1.0 mm）を素地鋼板とした。これらの鋼板は、実験室にて溶製したスラブを、熱間圧延、冷間圧延により製造した鋼板である。さらに鋼種No.2には、めっきシミュレータを用いて溶融亜鉛めっき（片面あたりのZn付着量は60 g/m²）を施し、その後、合金化処理（めっき皮膜中のFe含有量は15質量%）を行った。

これらの鋼板を40 W×60 L（mm）の寸法に切断し、大気雰囲気の加熱炉内で、900 ℃×5分の加熱を行ってから、加熱炉より取り出し、その直後に、平板の鋼製金型を用いて、熱間プレス成形を行った。鋼種No.2については、冷却条件を変化させて熱間プレス成形を行った（試験No.2, 5, 6）。

得られた熱間プレス部材について、ビッカース硬さ測定（荷重9.8 N、測定数：5）を行った。また鋼板に熱電対を貼付し、プレス成形後の冷却速度の測定も行った。冷却速度については、主に金型寸法を変えて冷却速度を変化させた。

なお、試験No.2については、鋼板温度がMs点に到達した直後に金型間に水を注入し冷却速度を調節した。

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最高焼入れ硬さについては、900 ℃に加熱した塩浴中でその材料を10分間保持後、水冷処理を施した時に得られる硬さを最高焼入れ硬さとした。

得られた結果を、次の方法で測定した各鋼種のAc_3 点、Ms点、および臨界冷却速度と共に表 2 にまとめて示す。

熱延鋼板から直径3.0 mm、長さ10 mm の円柱試験片（図 2 ）を切り出し、大気中で950 ℃まで10℃/sの昇温速度にて加熱し、その温度で 5 分間保持したのち、種々の冷却速度で室温まで冷却した。そのときの加熱、冷却中の試験片の熱膨張変化を測定することにより、Ac_3 点、Ms点を測定した。また、得られた試験片のビッカース硬度測定（荷重49N 、測定数： 5）および組織観察を行い、それらの結果から臨界冷却速度を見積もった。

表 1

鋼種No.	化学組成（質量%、残部：実質的にFe）														
	C	Si	Mn	P	S	Cu	Ni	Cr	Mo	V	Ti	Nb	Al	B	N
1	0.16	0.02	1.36	0.019	0.004	0.01	0.01	0.19	—	0.01	0.03	—	0.06	0.0013	0.008
2	0.21	0.25	1.20	0.008	0.002	0.01	0.02	0.20	—	0.01	0.02	0.01	0.05	0.0007	0.005
3	0.33	0.11	1.53	0.001	0.001	—	—	0.20	—	—	0.02	—	0.04	0.0015	0.001
4	0.42	0.11	1.51	0.001	0.001	—	—	0.20	0.01	—	0.02	—	0.04	0.0014	0.001

表 2

試験No.	鋼種No.	Ac_3 点 (℃)	Ms 点 (℃)	臨界冷却速度 (℃/s)	Ms点迄の実測冷却速度 (℃/s)	Ms点～200℃の平均冷却速度 (℃/s)	熱間プレス後の硬さ (HV)	最高焼入れ硬さ (HV)	金型サイズ (t×W×Lmm)	備考
1	1	860	450	25	60	40	418	461	50×400 ×400	発明例
2	2	823	410	17	60	100	451	501	50×400 ×400 *1	
3	3	823	390	10	60	40	560	652	50×400 ×400	
4	4	785	370	10	60	30	683	750	50×400 ×400	
5	2	823	410	17	60	22*3	390	501	50×50×400	比較例
6	2	823	410	17	60	200*3	500	501	50×50×400 *2	

*1 Ms点直後に金型間へ水を注入。
*2 Ms点直後にプレス機を上昇させ、試験片を直ちに水槽へ投入。
*3 本発明の範囲外の条件

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本発明例である試験No. 1～4では、Ms点から200 ℃までの平均冷却速度が適正であるため、得られた硬さは（最高焼入れ硬さ－10）よりも低く、また（最高焼入れ硬さ－100)よりも高い。

比較例である試験No. 5は、臨界冷却速度以上で冷却しているが、Ms点から200 ℃までの平均冷却速度が遅いため、十分な硬さが得られていない。また、やはり比較例である試験No. 6は、Ms点から200 ℃までの平均冷却速度が速すぎるため、硬くなりすぎている。ここに、「硬すぎる」との意味は、硬さの絶対値が高いということではなく、最高焼き入れ硬さに近いということである。

本発明例である試験No. 2の鋼板について、大気雰囲気の加熱炉内で900 ℃×5分加熱して、加熱炉より取り出し、ハット型の熱間プレス成形［ブランクサイズ：1.0 t ×80 W×320 L (mm)］を行った。

このときのハット成形法の模式図を図1に示す。採用した熱間プレス成形条件は、成形高さ70 mm 、Rd（ダイス肩部R） 8 mm、Rp（パンチ肩部R） 8 mm、クリアランス1.0 mm、しわ押さえ力12.7 kN であった。

また、熱間プレス成形品のパンチ底部、側壁中央部、フランジ部について、ビッカース硬さ測定（荷重9.8 N 、測定数：5)を行った。さらに、各部位に熱電対を貼付し、その部位の冷却速度も測定した。結果を表3にまとめて示す。

表3

	Ms点～200 ℃までの平均冷却速度 (℃/s)	熱間プレス後の硬さ (HV)
パンチ底部	55	460
側壁中央部	100	471
フランジ部	120	480

各部位でのMs点から200 ℃までの平均冷却速度が適正であるため、良好な硬さが得られている。また同じ部材中での硬さのばらつきも小さいことがわかる。

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請 求 の 範 囲

1．質量%で、C：0.15～0.45%、Mn： 0.5～3.0 %、Cr： 0.1～0.5 %、Ti：0.01～0.1 %、B：0.0002～0.004 %、Si：0.5 %以下、P：0.05%以下、S：0.05%以下、Al：1%以下、N：0.01%以下を含有し、かつNi：2%以下、Cu：1%以下、Mo：1%以下、V：1%以下、およびNb：1%以下の1種または2種以上を含有し、残部Feおよび不可避的不純物から本質的になる鋼組成を有する鋼板を、Ac_3 点以上の温度に加熱・保持した後、最終製品形状への成形を行う方法であって、成形中または成形後の成形温度からの冷却に際して、成形部材のMs点までの冷却速度が臨界冷却速度以上で、かつMs点から200 ℃までの平均冷却速度が25～150 ℃/sで冷却して焼入れ処理を行う、熱間成形法。

2．前記成形をプレス成形用金型を用いて行う請求項1記載の熱間成形法。

3．前記成形をプレス成形用金型を用いて成形後、金型間に水を注入して冷却する請求項1または2記載の熱間成形法。

4．質量%で、C：0.15～0.45%、Mn： 0.5～3.0 %、Cr： 0.1～0.5 %、Ti：0.01～0.1 %、B：0.0002～0.004 %、Si：0.5 %以下、P：0.05%以下、S：0.05%以下、Al：1%以下、N：0.01%以下を含有し、かつNi：2%以下、Cu：1%以下、Mo：1%以下、V：1%以下、およびNb：1%以下の1種または2種以上を含有し、残部Feおよび不可避的不純物から本質的になる鋼組成を有する鋼板から構成され、熱間成形後の硬さが、ビッカース硬さで、（最高焼入れ硬さ－10）未満、かつ（最高焼入れ硬さ－100)以上であることを特徴とする、熱間成形部材。

5．前記熱間成形が熱間プレス成形である請求項4記載の熱間成形部材。

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1/1

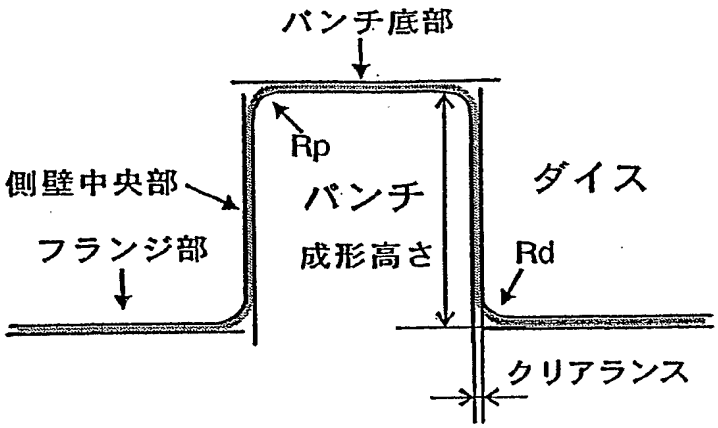


Fig. 1

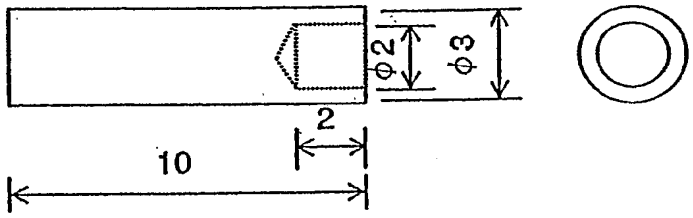


Fig. 2

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POSCO Exhibit 1003
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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2004/007654

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl[7] C22C38/00, C22C38/58, B21D5/01, B21D22/20, C21D1/02

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)
Int.Cl[7] C22C38/00, C22C38/58, B21D5/01, B21D22/20, C21D1/02

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

Jitsuyo Shinan Koho	1922-1996	Toroku Jitsuyo Shinan Koho	1994-2004
Kokai Jitsuyo Shinan Koho	1971-2004	Jitsuyo Shinan Toroku Koho	1996-2004

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	JP 2001-353548 A (USINOR), 25 December, 2001 (25.12.01), Full text & US 6564604 B2 & EP 1143029 A1	1-5
Y	JP 2003-147499 A (Sumitomo Metal Industries, Ltd.), 21 May, 2003 (21.05.03), Full text & EP 1439240 A1 & WO 03/35922 A1	1-5
Y	JP 2002-309345 A (NKK Corp.), 23 October, 2002 (23.10.02), Full text & US 2003/121576 A1 & WO 02/63058 A1 & EP 1359235 A1	1-5

[X] Further documents are listed in the continuation of Box C. [ ] 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" earlier application or patent but published on or after the international filing date
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"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"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
16 August, 2004 (16.08.04)	31 August, 2004 (31.08.04)
Name and mailing address of the ISA/ Japanese Patent Office	Authorized officer
Facsimile No.	Telephone No.

Form PCT/ISA/210 (second sheet) (January 2004)

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2004/007654

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2002-180186 A (Nippon Steel Corp.), 26 June, 2002 (26.06.02), Full text (Family: none)	1-5
A	JP 2002-241895 A (Kobe Steel, Ltd.), 28 August, 2002 (28.08.02), Full text & EP 1215297 A2 & US 2002/114724 A1	1-5
A	JP 2944540 B2 (Kobe Steel, Ltd.), 06 September, 1999 (06.09.99), Full text (Family: none)	1-5

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国際調査報告

国際出願番号　PCT／JP2004／007654

A.　発明の属する分野の分類（国際特許分類（IPC））

Int. Cl⁷　C22C38／00, C22C38／58, B21D5／01, B21D22／20
C21D　1／02

B.　調査を行った分野

調査を行った最小限資料（国際特許分類（IPC））

Int. Cl⁷　C22C38／00, C22C38／58, B21D5／01, B21D22／20
C21D　1／02

最小限資料以外の資料で調査を行った分野に含まれるもの

日本国実用新案公報　　1922－1996年
日本国公開実用新案公報　1971－2004年
日本国登録実用新案公報　1994－2004年
日本国実用新案登録公報　1996－2004年

国際調査で使用した電子データベース（データベースの名称、調査に使用した用語）

WPI

C.　関連すると認められる文献

引用文献のカテゴリー＊	引用文献名　及び一部の箇所が関連するときは、その関連する箇所の表示	関連する請求の範囲の番号
Y	JP　2001－353548　A（ユジノール） 2001．12．25，全文 & US　6564604　B2 & EP　1143029　A1	1-5
Y	JP　2003－147499　A（住友金属工業株式会社） 2003．05．21，全文 & EP　1439240　A1 & WO　03／35922　A1	1-5

☒ C欄の続きにも文献が列挙されている。　　☐ パテントファミリーに関する別紙を参照。

＊　引用文献のカテゴリー
「A」特に関連のある文献ではなく、一般的技術水準を示すもの
「E」国際出願日前の出願または特許であるが、国際出願日以後に公表されたもの
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「&」同一パテントファミリー文献

国際調査を完了した日	国際調査報告の発送日
16．08．2004	31.8.2004

国際調査機関の名称及びあて先	特許庁審査官（権限のある職員）		
日本国特許庁（ISA／JP） 郵便番号100－8915 東京都千代田区霞が関三丁目4番3号	鈴木　正紀	4K	3237
	電話番号　03－3581－1101　内線　3435		

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Ｃ（続き）．　関連すると認められる文献

引用文献のカテゴリー＊	引用文献名　及び一部の箇所が関連するときは、その関連する箇所の表示	関連する請求の範囲の番号
Ｙ	ＪＰ　２００２－３０９３４５　Ａ（日本鋼管株式会社） ２００２．１０．２３，全文 ＆　ＵＳ　２００３／１２１５７６　Ａ１ ＆　ＷＯ　０２／６３０５８　Ａ１ ＆　ＥＰ　１３５９２３５　Ａ１	1-5
Ｙ	ＪＰ　２００２－１８０１８６　Ａ（新日本製鐵株式会社） ２００２．０６．２６，全文（ファミリーなし）	1-5
Ａ	ＪＰ　２００２－２４１８９５　Ａ（株式会社神戸製鋼所） ２００２．０８．２８，全文 ＆　ＥＰ　１２１５２９７　Ａ２ ＆　ＵＳ　２００２／１１４７２４　Ａ１	1-5
Ａ	ＪＰ　２９４４５４０　Ｂ２（株式会社神戸製鋼所） １９９９．０９．０６，全文（ファミリーなし）	1-5

ArcelorMittal Ex. 2001
Posco Co. LTD. v. ArcelorMittal
POSCO Exhibit IPR2024-01376
Filed with Petition for IPR of U.S. Patent No. 7,880,681
Page 8 of 31430

Electronic Acknowledgement Receipt

EFS ID:	36519894
Application Number:	16413799
International Application Number:	
Confirmation Number:	7637
Title of Invention:	Coated Steel Strips, Coated Stamped Products and Methods
First Named Inventor/Applicant Name:	Pascal DRILLET
Customer Number:	23280
Filer:	William C. Gehris/Simon Steiner
Filer Authorized By:	William C. Gehris
Attorney Docket Number:	11020631.1028con5
Receipt Date:	08-JUL-2019
Filing Date:	16-MAY-2019
Time Stamp:	16:29:47
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Information Disclosure Statement (IDS) Form (SB08)	IDSJuly2019.PDF	1037535 1c59c0f549de6034ed43b3d4fe54e268fa64b980	no	6

Warnings:

ArcelorMittal Ex. 2001
Posco Co. LTD. v. ArcelorMittal
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Information:					
A U.S. Patent Number Citation is required in the Information Disclosure Statement (IDS) form. You may remove the form to add the required data in order to correct the Informational Message or if you chose not to, the image of the form will be processed and be made available within the Image File Wrapper (IFW) system. However, no data will be extracted from this form. Any additional data such as Foreign Patent Documents or Non Patent Literature will be manually reviewed and keyed into USPTO systems.					
2	Information Disclosure Statement (IDS) Form (SB08)	IDSltrJul2019.pdf	184893 7208e9b96ff90f415f7b9ec32fe5a3b0ee6898b7	no	2
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3	Foreign Reference	EP1013785FF.pdf	815860 7bc012e10dc047727b0333f5892ac9422d2bd7bd	no	11
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4	Foreign Reference	FR2833504FF.pdf	901310 7c635d50113a4ed4c6895e043c4c2dfb54e853c8	no	25
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5	Foreign Reference	JP2006051543FF.pdf	1545291 7ffd2c52e9520888474 88d63655f56b855875724	no	23
Warnings:					
Information:					
6	Foreign Reference	WO2004106573FF.pdf	1623008 9b27a536ff4c472364558e0bd2eb4ba81ccbd80d	no	44
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7	Non Patent Literature	1SomaniDimensionalChanges1017ff.pdf	9001584 4cd409787a8db6b9a370d3a0a3887e151e0e119d	no	7
Warnings:					
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8	Non Patent Literature	2DeclarationofDrDesart1015ff.pdf	13219789 84bf790c8789b37630fc74d6c8eed434e62ec053	no	16
Warnings:					
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9	Non Patent Literature	3DeclarationDrMiles1003ff.pdf	21865210 4dfe0851dfe682303f2d112f970089f92ea36316	no	98
Warnings:					
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10	Non Patent Literature	4DeclarationofDesartMay20191016ff.pdf	9686599 4384383f4fbdb242dc37240c4704ce012ad87115	no	16
Warnings:					
Information:					
11	Non Patent Literature	5DeclarationofKnott1018ff.pdf	15280013 80a6c01b899a5286abff1d3e610533799b5f81b0	no	15
Warnings:					
Information:					
12	Non Patent Literature	6publicationhistoryforCornette1020ff.pdf	221745 4a80d00e66d6bd1e15c0d5c398ca6b5af4ac50bc	no	4
Warnings:					
Information:					
13	Non Patent Literature	7Fekete1021ff.pdf	197621 651cb48fda4d2ecbc11a8da4fe95828259e24dd0	no	9
Warnings:					
Information:					
14	Non Patent Literature	8Mayer1022ff.pdf	984491 977a8a5a80f02c1aa08204d7a2082a40033dd441	no	13
Warnings:					
Information:					

15	Non Patent Literature	9ISIJ1025ff.pdf	956525 ae5c23107e7906714fb1ec96e22870f77f1054db	no	4
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Information:					
16	Non Patent Literature	10Webster1026ff.pdf	4566880 fa4656195ad983da5512936560a7f1aa03a491ed	no	7
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17	Non Patent Literature	11RandomHouseWebster1027ff.pdf	2864097 7f4e2d3777475d6048767823745939247f50bc1a	no	7
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Information:					
18	Non Patent Literature	12AMS1028ff.pdf	1452428 28c98b2918c03574167f54ae92991aafe1523ed7	no	5
Warnings:					
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19	Non Patent Literature	13DictofMat29ff.pdf	1458979 950fb9b60be598a69216ecb78b21371921af3033	no	3
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Information:					
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Information:					
23	Non Patent Literature	17Akerstrom1037ff.pdf	212750 112d652664e5e9419a53a1d14eb8d55254a2af36	no	18
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Information:					
24	Non Patent Literature	18ASTM1038ff.pdf	534835 caa14d545b1b8351df112cff6049cbda03e4bdd7	no	5
Warnings:					
Information:					
25	Non Patent Literature	19Chambers1039ff.pdf	353711 e969d2dbe4ca15b5baa0481fb7a77ebcf1cd7100	no	4
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Information:					
26	Non Patent Literature	20Webster1040ff.pdf	2306821 9ed72077949ae86e59f3c6d3c9628653b0a3cabf	no	3
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27	Non Patent Literature	21Engels1041ff.pdf	6061302 aa3f7140c18c028d1e6e7218a6b864f43aa9a689	no	22
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28	Non Patent Literature	22Thoms1042f.pdf	6220847 2954e6b2229899a0706685a2efd4da0208b2b79f	no	27
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30	Non Patent Literature	24PreliminaryOpinionEP06842403.PDF	1161285 be9a71c7eb86f17e79f4be34ba1f87d4c14f5888	no	24
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		Total Files Size (in bytes):	107555105		

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New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/413,799	05/16/2019	Pascal DRILLET	20631.1028CON5	7637

23280 7590 07/11/2019

Davidson, Davidson & Kappel, LLC
589 8th Avenue
16th Floor
New York, NY 10018

EXAMINER
SCHLEIS, DANIEL J

ART UNIT	PAPER NUMBER
1784	

NOTIFICATION DATE	DELIVERY MODE
07/11/2019	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

ddk@ddkpatent.com

ArcelorMittal Ex. 2001
Posco Co. LTD. v. ArcelorMittal
IPR2024-01376
Page 837 of 1430

Office Action Summary	Application No. 16/413,799	Applicant(s) DRILLET et al.	
	Examiner Daniel J Schleis	Art Unit 1784	AIA (FITF) Status No

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTHS FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☑ Responsive to communication(s) filed on 05/16/19.

☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2a)☐ This action is **FINAL.** 2b) ☑ This action is non-final.

3)☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

5) ☑ Claim(s) 25-47 is/are pending in the application.

5a) Of the above claim(s) _____ is/are withdrawn from consideration.

6) ☐ Claim(s) _____ is/are allowed.

7) ☑ Claim(s) 25-47 is/are rejected.

8) ☐ Claim(s) _____ is/are objected to.

9) ☐ Claim(s) _____ are subject to restriction and/or election requirement

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to **PPHfeedback@uspto.gov.**

Application Papers

10)☐ The specification is objected to by the Examiner.

11)☑ The drawing(s) filed on 05/16/19 is/are: a)☑ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

a)☐ All b)☐ Some** c)☐ None of the:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

** See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☑ Notice of References Cited (PTO-892)

2) ☑ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b) Paper No(s)/Mail Date 06/04/19 and 06/04/19.

3) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date _____.

4) ☐ Other: _____.

ArcelorMittal Ex. 2001
Posco Co. LTD. v. ArcelorMittal
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DETAILED ACTION

Notice of Pre-AIA or AIA Status

The present application is being examined under the pre-AIA first to invent provisions.

Information Disclosure Statement

The information disclosure statements (IDS) submitted on 4 June 2019 were considered by the examiner.

Claim Rejections - 35 USC § 112

The following is a quotation of 35 U.S.C. 112(b):
(b) CONCLUSION.—The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the inventor or a joint inventor regards as the invention.

The following is a quotation of 35 U.S.C. 112 (pre-AIA), second paragraph:
The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

Claims 25-47 are rejected under 35 U.S.C. 112(b) or 35 U.S.C. 112 (pre-AIA), second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which the inventor or a joint inventor, or for pre-AIA the applicant regards as the invention.

Claim 25 is directed to a precoated steel product having a precoating with "a controlled thickness to create a precoated steel strip heat treatable to form a coating" having an interdiffusion layer, intermediate layer, intermetallic layer, and a superficial layer wherein the coating has a thickness greater than 30 micrometers and the interdiffusion layer is less than 15 micrometers. It is unclear as to the precoating that would meet these limitations.

It is noted that the layers of the interdiffusion layer, intermediate layer, intermetallic layer, and superficial layer are not defined by the claims. It is not clear what distinguishes each of these respective layers.

Additionally, the claimed product is not the product having the layers set forth in the instant application. Rather, it must merely be capable of forming such layers. The method of producing the resulting product is not limited beyond that precoated steel strip is heat treatable. It is unclear what structure of the precoating is necessary in order to achieve these claimed layers within a final product. For example, it is unclear if it is an issue of a thickness of the layers, directed to a structure of a precoating based on a particular deposition method or processing conditions, or some other type of factor.

Therefore, the metes and bounds of the instant claims cannot be determined. It is unclear what precoating product would or would not fall within the scope of the instant claims. For the purposes of examination, the Office is unable to determine the scope of these claims.

Claims 26-47 depend from claim 25 and incorporate the limitations therein. Therefore these claims are rejected for the reasons set forth above in regards to claim 25.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Daniel J Schleis whose telephone number is (571)270-5636. The examiner can normally be reached on 10 AM to 4 PM Monday through Friday.

Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an interview, applicant is

encouraged to use the USPTO Automated Interview Request (AIR) at http://www.uspto.gov/interviewpractice.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Humera Sheikh can be reached on (571) 272-0604. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

Daniel J. Schleis
Primary Examiner
Art Unit 1784

/Daniel J. Schleis/
Primary Examiner, Art Unit 1784

Notice of References Cited	Application/Control No. 16/413,799	Applicant(s)/Patent Under Reexamination DRILLET et al.	
	Examiner Daniel J Schleis	Art Unit 1784	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	CPC Classification	US Classification
*	A	US-9708683-B2	07-2017	Drillet; Pascal	B32B15/012	1/1
	B					
	C					
	D					
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	F					
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	I					
	J					
	K					
	L					
	M					

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	CPC Classification
	N					
	O					
	P					
	Q					
	R					
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NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
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	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

ArcelorMittal Ex. 2001
Posco Co. LTD. v. ArcelorMittal
IPR2024-01376
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Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/413,799	DRILLET et al.
	Examiner	Art Unit
	Daniel J Schleis	1784

CPC - Searched*		
Symbol	Date	Examiner

CPC Combination Sets - Searched*		
Symbol	Date	Examiner

US Classification - Searched*			
Class	Subclass	Date	Examiner

* See search history printout included with this form or the SEARCH NOTES box below to determine the scope of the search.

Search Notes		
Search Notes	Date	Examiner
Inventor Name Search	07/08/2019	Schleis
Assignee Name Search	07/08/2019	Schleis
Reviewed Global Dossier	07/08/2019	Schleis
Non-Patent Literature Search - Google Scholar	07/08/2019	Schleis
EAST Text Search - See Search History	07/08/2019	Schleis
Reviewed File Wrappers of Other Applications in Patent Family	07/08/2019	Schleis

Interference Search			
US Class/CPC Symbol	US Subclass/CPC Group	Date	Examiner

ArcelorMittal Ex. 2001
Posco Co. LTD. v. ArcelorMittal
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Page 843 of 1430

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S1	13	((PASCAL) near2 (DRILLET)).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2013/02/26 09:51
S2	8	((DOMINIQUE) near2 (SPEHNER)).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2013/02/26 09:51
S3	11	((RONALD) near2 (KEFFERSTEIN)).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2013/02/26 09:51
S4	0	("2013/0029172").URPN.	USPAT	OR	ON	2013/02/26 09:51
S5	9	("20030152796" | "3240269" | "5023113" | "6296805" | "6815087" | "7137201" | "7217331" | "7503116").PN. OR ("8307680").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2013/02/26 09:51
S6	4	("20030152796" | "5023113" | "6296805" | "7137201").PN.	US-PGPUB; USPAT; USOCR	OR	ON	2013/02/26 10:05
S7	9	("4891274" | "5133815" | "5178688" | "5656102").PN. OR ("6296805").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2013/02/26 10:37
S8	4	("3214820" | "6197132" | "6296805").PN. OR ("7708843").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2013/02/26 10:40
S9	16	("20010042393" | "20070082214" | "20070163685" | "20090242086" | "20090308499" | "20110006491" | "20110165436" | "4546051" | "6017643" | "6093498" | "6296805" | "6298905" | "6564604" | "6815087" | "7137201" | "7867344").PN. OR ("8066829").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2013/02/26 10:40
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S12	10	("3632453" | "3664293" | "4751957" | "4891274" | "5518772" | "5529816").PN. OR ("6017643").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2013/02/26 10:47
S13	195	((("5209860") or ("8066829") or	US-	OR	OFF	2013/02/26

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		("8066829") or ("8307680") or ("20110006491") or ("20110165436") or ("20110214475") or ("20120064362") or ("20130029172") or ("6564604") or ("20010042393") or ("20120118437") or ("4846986") or ("20120085467") or ("20080261058") or ("4601766") or ("5248528") or ("5456953") or ("5568914") or ("5830290") or ("20040118482") or ("5287983") or ("4880481") or ("4344342") or ("4963400") or ("4999241") or ("5342672") or ("5792180") or ("6070444") or ("4353765") or ("5982073") or ("6129790") or ("6165595") or ("3798406") or ("4033918") or ("4311755") or ("4488862") or ("4508755") or ("4514264") or ("4525177") or ("4551085") or ("4554765") or ("4585519") or ("4842887") or ("4994517") or ("5273369") or ("5389452") or ("5538576") or ("5542978") or ("5639510") or ("5697715") or ("5729616") or ("5801128") or ("5837314") or ("5869160") or ("6020026") or ("6019923") or ("6251514") or ("6258425") or ("6262513") or ("6309748") or ("6340397") or ("6342108") or ("20020014181") or ("20090025836") or ("20090048127") or ("4374168") or ("4309951") or ("5810332") or ("5795661") or ("8349098") or ("20020160235") or ("20020166606") or ("20100294400") or ("20110056594") or ("20110056594") or ("20120085466") or ("5981089") or ("6197125") or ("4793867") or ("4941930") or ("4980241") or ("5238506") or ("5405427") or ("5939144") or ("6090873") or ("6241393") or ("3859239") or ("3850684") or ("3850647") or ("4316751") or ("4347085") or ("4401719") or ("4402994") or ("4533606") or ("4592958") or ("4867853") or ("5232619") or ("5242506") or ("5290362") or ("5332776") or ("5466280") or ("5608028") or ("5643474") or ("5700551") or ("5743536") or ("5783622") or ("5786098") or ("5851659") or ("5863640") or ("5890852") or ("5955201") or ("6001494") or ("6042949") or ("6083613") or ("6194088") or ("6197436") or ("6284059") or ("6329456") or ("6410626") or ("7533713") or ("8025965") or ("8025965") or ("20030150308") or ("20040129346") or ("20040216860") or ("20070209555") or ("20080090093") or ("20100175794") or ("20110300407") or	PGPUB; USPAT; USOCR			10:54

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		("20100199872") or ("4793218") or ("5584845") or ("5759304") or ("6463779") or ("7703820") or ("7926180") or ("7926180") or ("20070045384") or ("20070051434") or ("20090058111") or ("20100187291")).PN. or (("20110247467") or ("4384011") or ("5960930") or ("6120604") or ("4863650") or ("4926792") or ("4942061") or ("4035528") or ("4342418") or ("4355059") or ("4490129") or ("4611610") or ("4818570") or ("4925213") or ("5300362") or ("5728474") or ("5809628") or ("5820954") or ("6037053") or ("6132864") or ("6403192") or ("8042484") or ("20080000417") or ("20080305358") or ("20090220815") or ("20120074106") or ("20120152410") or ("4486172") or ("4537588") or ("4844327") or ("4925518") or ("7955413") or ("4283225") or ("4302515") or ("4314661") or ("4316572") or ("4358325") or ("4480016") or ("4801072") or ("4853047") or ("5018259") or ("5271318") or ("5533423") or ("5622674") or ("5660443") or ("5926516") or ("6554919") or ("6986536") or ("RE40736") or ("7955413") or ("20010049956") or ("20050285416") or ("20050285417") or ("20080257110") or ("20090173129") or ("20110266724") or ("20120120561") or ("4251549")).PN.				
S14	0	("2012/0085466").URPN.	USPAT	OR	ON	2013/02/26 10:55
S15	0	("2012/0085467").URPN.	USPAT	OR	ON	2013/02/26 10:55
S16	0	("2011/0214475").URPN.	USPAT	OR	ON	2013/02/26 10:55
S17	1	("2011/0165436").URPN.	USPAT	OR	ON	2013/02/26 10:56
S18	1	("2011/0006491").URPN.	USPAT	OR	ON	2013/02/26 10:56
S19	8085	((428/601,600,602,653) or (420/104,120,121,126) or (148/531,535,534,537,635,653) or (72/364,342.1,47) or (280/1)).CCLS.	US-PGPUB; USPAT; USOCR	OR	OFF	2013/02/26 11:01
S20	2517	S19 and (steel ferrous) same (aluminum aluminium al)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2013/02/26 11:02
S21	304	S20 and (interdiffusion intermediate intermetallic superficial) near3 layer	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2013/02/26 11:03

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S22	14	("20020068189" | "20020104876" | "20030012977" | "20030207769" | "20040028939" | "3195991" | "4957822" | "4973523" | "5112416" | "5362574" | "5384205" | "5470666" | "7074496").PN. OR ("8053087").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2013/02/26 12:13
S23	8085	((428/601,600,602,653) or (420/104,120,121,126) or (148/531,535,534,537,635,653) or (72/364,342.1,47) or (280/1)).CCLS.	US-PGPUB; USPAT; USOCR	OR	OFF	2013/02/26 12:33
S24	286	S23 and (carbon c) same (manganese Mn) same (Silicon si) same (Chromium Cr) same (titanium ti) same (aluminum al) same (Phosphorus P) same (Sulfur Sulphur S) same (Boron B)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2013/02/26 12:33
S25	59	S24 and (aluminum aluminium al) near5 (pre-coat$4 precoat$4 layer coat$5)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2013/02/26 12:35
S26	0	("2010/0294400").URPN.	USPAT	OR	ON	2013/02/26 12:36
S27	2	("2001/0001049").URPN.	USPAT	OR	ON	2013/02/26 12:40
S28	8224	((428/601,600,602,653) or (420/104,120,121,126) or (148/531,535,534,537,635,653) or (72/364,342.1,47) or (280/1)).CCLS.	US-PGPUB; USPAT; USOCR	OR	OFF	2013/09/19 16:58
S29	456	S28 and (interdiffusion intermediate intermetallic superficial) near3 layer	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2013/09/19 16:58
S30	4	S29 and (strain near3 ratio)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2013/09/19 16:59
S31	36	S28 and (strain near3 ratio)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2013/09/19 16:59
S32	16	("20060134451" | "20070113936" | "20070166565" | "20070246509" | "20090020276" | "20090165901" | "20100101688" | "20100112370" | "20100183897" | "20110014494" | "20110240280" | "20110287276" | "20110287277" | "5037707" | "6019939" | "7387844").PN. OR ("8247082").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2013/09/19 16:59
S33	0	("2010/0084057").URPN.	USPAT	OR	ON	2013/09/19 16:59
S34	13	("4673551" | "4906534" | "5037707" | "5100048").PN. OR ("6019939").URPN.	US-PGPUB;	OR	ON	2013/09/19 17:00

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S35	4	("2010/0112370").URPN.	USPAT	OR	ON	2013/09/19 17:00
S36	0	("2009/0252641").URPN.	USPAT	OR	ON	2013/09/19 17:00
S37	4	("4985196" | "4990545" | "5139832" | "6084849").PN. OR ("7060140").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2013/09/19 17:00
S38	15	("4196025" | "4309886" | "4793869" | "5507677" | "5509842" | "5618401" | "5625251" | "5629051" | "5646478").PN. OR ("5871851").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2013/09/19 17:01
S39	9	("4601766" | "5019191" | "5871851").PN. OR ("6129992").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2013/09/19 17:01
S40	4	("3795971" | "4455352" | "4956025").PN. OR ("5529644").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2013/09/19 17:01
S45	40	(("20010042393") or ("8127449") or ("7137201") or ("7708843") or ("20070163683") or ("20070175040") or ("3240269") or ("7503116") or ("7217331")).PN.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	OR	OFF	2017/03/10 08:29
S46	10	(("20010042393") or ("8127449") or ("7137201") or ("7708843") or ("20070163683") or ("20070175040") or ("3240269") or ("7503116") or ("7217331")).PN.	US-PGPUB; USPAT; USOCR	OR	OFF	2017/03/10 08:43
S47	4	("3214820" | "6197132" | "6296805").PN. OR ("7708843").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2017/03/10 08:48
S48	8872	((428/601,600,602,653) or (420/104,120,121,126) or (148/531,535,534,537,635,653) or (72/364,342.1,47) or (280/1)).CCLS.	US-PGPUB; USPAT; USOCR	OR	OFF	2019/07/08 10:56
S49	540	S48 and (interdiffusion intermediate intermetallic superficial) near3 layer	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2019/07/08 10:56
S50	13610	(C21D9/46 or C23C2/12 or C23C2/40 or C23C2/26 or B32B15/012 or Y10T428/12389 or Y10T428/12396 or Y10T428/12757).cpc.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2019/07/08 10:58
S51	977	S50 and (interdiffusion intermediate intermetallic superficial) near3 layer	US-PGPUB; USPAT; USOCR; EPO; JPO;	OR	ON	2019/07/08 11:00

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			DERWENT			
S52	2	S51 and (strain near3 ratio)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2019/07/08 11:02

EAST Search History (Interference)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S41	5246	(C21D9/46 B32B15/012 C23C2/12 C23C2/26 C23C2/40 Y10T428/12389 Y10T428/12396 Y10T428/12757).cpc.	US-PGPUB; USPAT	OR	ON	2016/12/02 11:46
S42	1776	S41 and (aluminum aluminium al) near5 (pre-coat$4 precoat$4 layer coat$5)	US-PGPUB; USPAT	OR	ON	2016/12/02 11:46
S43	888	S41 and ((aluminum aluminium al) near5 (pre-coat$4 precoat$4 layer coat$5)).clm.	US-PGPUB; USPAT	OR	ON	2016/12/02 11:46
S44	136	S43 and ((interdiffusion intermediate intermetallic superficial) near3 layer).clm.	US-PGPUB; USPAT	OR	ON	2016/12/02 11:47

7/8/2019 11:55:42 AM
C:\Users\dschleis\Documents\EAST\Workspaces\16413799.wsp

Doc code: IDS
Doc description: Information Disclosure Statement (IDS) Filed

PTO/SB/08a (03-15)
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	16413799
Filing Date	2016-05-16
First Named Inventor	Drillet
Art Unit	
Examiner Name	
Attorney Docket Number	20631.1028CON5

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Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	6296805	B1	2001-10-02	Laurent et al.	
	2	7559998	B2	2009-07-14	Nishibata et al.	
	3	8307680		2012-11-13	Drillet et al.	
	4	9708683		2017-07-18	Drillet et al.	
	5	8127449	B2	2012-03-06	Bayer et al.	
	6	7137201		2006-11-21	Brodt et al.	
	7	7708843		2010-05-04	Laurent et al.	
	8	3240269		1966-03-15	Thomas	

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	9	7503116		2009-03-17	Machrowicz et al.	
	10	7217331		2007-03-15	Jambu et al.	
	11	6296805		2001-10-02	Laurent et al.	
	12	6815087		2004-11-09	Takagi et al.	
	13	5023113		1991-06-11	Boston et al.	
	14	7137201		2006-11-21	Brodt et al.	

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	1	20080283156	A1	2008-11-20	Laurent et al.	
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	4	20110056594	A1	2011-03-10	Macherey et al.	
	5	20070175040		2007-08-02	Bayer et al.	
	6	20040009366		2004-01-15	Takagi et al.	
	7	20030152796		2003-08-14	Clancy et al.	

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Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1	3290199	EP	A1	2018-03-07	Drillet	In English	
	2	2758571	FR	A	1998-07-24	Lorraine	See English Abstract and EPO machine translation	
	3	2006097593	WO	A	2006-09-21	Laurent	See US 2008/0283156	
	4	102004007071	DE	A1	2005-09-08	Audi AG	See US 2007/0163683	
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	7	2833504	FR	A1	2003-06-20	Usinor	See English Abstract and EPO machine translation	
	8	1013785	EP	A1	2000-06-28	Lorraine Laminage	See English Abstract and EPO machine translation	
	9	2012048841	WO	A1	2012-04-19	Tata Steel IJMUIDEN B. V.	In English	
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	12	3290200	EP	A1	2018-03-07	Drillet	In English	
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	17	3931251	JP		2007-06-13	Laurent	See US 6296805	
	18	2005009642	WO		2005-02-03	Bayer	See US 8127449	
	19	2006529002	JP		2003-12-28		See US 8127449	
	20	H11156293	JP		1999-06-15	Kada	See English Abstract and EPO machine translation	
	21	2002178069	JP		2002-06-25	Brodt	See US 7137201	
	22	2008537977	JP		2008-10-02		See US 7708843	
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	25	1829813	CN		2006-09-06	Sumitomo Metal Ind	See US 7559998	
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	28	720079	FR		1995-11-24	FR DE FILETAGE INDESSERRABLE D	See English Abstract and EPO machine translation	
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	30							

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Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T5
	1	Raviere et al, Hot Stamping Experiment and Numerical Simulation of Pre-coated USIBOR1500 Quenchable Steels, SAE 2003-01-2859, 2003	
	2	Merklein, M et al., "Einflussgrößen im Presshärteprozess" Tagungsband 4. Chemnitzer Karosseriekolloquium, November 2005, ISSN: 3-937524-33-9, see English translation	
	3	Forschungsvereinigung Stahlanwendungen e. V., "Forschung für die Praxis P644 - Auslegung des Prozessfensters für die Blechumformung höchstfester Vergütungsstähle bei erhöhten Temperaturen" Düsseldorf: Verlags und Vertriebsgesellschaft mbH, 2006, ISBN: 3-937567-42-9, see partial English translation	
	4	Usinor Auto Groupe website, Product Description, USIBOR Heattreatable manganese-boron steel, bare or precoated 1/3, http://www.usinorauto.com/v_anglaise/produits/fiches/ a_usibor3.htm, Feb. 21, 2003	
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	8	Merklein M.: "Neuere Entwicklungen zur Umformung höchstfester Stahlwerkstoffe," EFB-Kolloquium 2005, see English translation	
	9	Roll et al.: "Prozesskette zum Warmumformen von Blechen," Tagungsband SFU Leichtbau durch Umformtechnik, September 2005, see English translation	
	10	Laurent J.-P. "Hot formed Pre-coated boron steels: A solution of the resistance-formability's dilemma" - 1st European Conference of Experts, 10/14/2003	
	11	Garcia Aranda L., Ravier P., Chastel Y., "Hot stamping of quenchable steels - Material data and process simulations", IDDRG conference, 2003	
	12	Merklein M., "Characterisation of the Flow Properties of the Quenchenable Ultra High Strength Steel 22MnB5", Annals of the CIRP Vol. 55/1/2006	
	13	Turetta A., Testing material formability in hot stamping operations, 2006	
	14	Babbit M., "Some Highlights on New Steel Products for Automotive Use," steel research international Col. 77, issue 9 to 10, Dec. 13, 2016	
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	16	Garcia Aranda L., Chastel Y., "Experiments and simulation of hot stamping of quenchable steels," ICTP 7th International Conference on Technology of Plasticity, Advanced Technology of Plasticity 2002, Proceedings, Vol. 2, Yokohama, JP, Oct. 27-Nov. 1, 2002	
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT
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Application Number	16413799
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First Named Inventor	Drillet
Art Unit	
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Attorney Docket Number	20631.1028CON5

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Name/Print	Jennifer L. O'Connell	Registration Number	57392

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7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

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	1	"Hot-Dip Aluminised Sheet Metal fal AS," Production information re. fire-aluminized sheet metal, August 2007, published by ThyssenKrupp Steel, see English translation	
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	25	X. Bano, et al., "Heat Treated Boron Steels in the Automobile Industry," 39"' MWSP Conf. Proc., ISS, Vol. XXXV, 1998.

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Name/Print	Jennifer L. O'Connell	Registration Number	57392

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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
16/413,799	05/16/2019	Pascal DRILLET	20631.1028CON5

CONFIRMATION NO. 7637

23280
Davidson, Davidson & Kappel, LLC
589 8th Avenue
16th Floor
New York, NY 10018

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Title: Coated Steel Strips, Coated Stamped Products and Methods

Publication No.US-2019-0271056-A1
Publication Date:09/05/2019

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The above-identified application will be electronically published as a patent application publication pursuant to 37 CFR 1.211, et seq. The patent application publication number and publication date are set forth above.

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The publication process established by the Office does not provide for mailing a copy of the publication to applicant. A copy of the publication may be obtained from the Office upon payment of the appropriate fee set forth in 37 CFR 1.19(a)(1). Orders for copies of patent application publications are handled by the USPTO's Public Records Division. The Public Records Division can be reached by telephone at (571) 272-3150 or (800) 972-6382, by facsimile at (571) 273-3250, by mail addressed to the United States Patent and Trademark Office, Public Records Division, Alexandria, VA 22313-1450 or via the Internet.

In addition, information on the status of the application, including the mailing date of Office actions and the dates of receipt of correspondence filed in the Office, may also be accessed via the Internet through the Patent Electronic Business Center at www.uspto.gov using the public side of the Patent Application Information and Retrieval (PAIR) system. The direct link to access this status information is currently https://portal.uspto.gov/pair/PublicPair. Prior to publication, such status information is confidential and may only be obtained by applicant using the private side of PAIR.

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Office of Data Managment, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101

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PTO/SB/06 (09-11)
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PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 16/413,799	Filing Date 05/16/2019	☐ To be Mailed

ENTITY: ☑ LARGE ☐ SMALL ☐ MICRO

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA		RATE ($)	FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A		N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A		N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A		N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*		x $100 =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*		x $460 =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).				
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))					
* If the difference in column 1 is less than zero, enter "0" in column 2.				TOTAL	

APPLICATION AS AMENDED - PART II

		(Column 1)		(Column 2)	(Column 3)			
AMENDMENT	11/25/2019	CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA		RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	* 30	Minus	** 24	= 6		x $100 =	600
	Independent (37 CFR 1.16(h))	* 3	Minus	*** 3	= 0		x $460 =	0
	☐ Application Size Fee (37 CFR 1.16(s))							
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							
							TOTAL ADD'L FEE	600

		(Column 1)		(Column 2)	(Column 3)			
AMENDMENT		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA		RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	*	Minus	**	=		x $0 =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=		x $0 =	
	☐ Application Size Fee (37 CFR 1.16(s))							
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							
							TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.	LIE
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".	/JAMES W TUNSTALL/
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".	
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.	

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

IN THE UNITED STATES PATENT & TRADEMARK OFFICE

Application of:	ARCELORMITTAL
Inventor(s):	Drillet et al.
Application No.:	16/413,799
Filed:	May 16, 2019
Attorney Docket No.:	20631.1028CON5
Confirmation No.:	7637
Examiner:	Daniel J. Schleis
Title:	Coated Steel Strips, Coated Stamped Products and Methods

Submitted electronically via EFS-WEB November 25, 2019

RESPONSE TO OFFICE ACTION

Dear Sir or Madam:

In response to the Office Action dated July 11, 2019, please re-consider the above-identified patent application based on the following:

IN THE CLAIMS

This listing of claims will replace all prior versions, and listings, of claims in the application:

Listing of Claims:

Claims 1 to 47 (canceled).

Claim 48 (new): A coated steel hot stamped product comprising:

a strip of base steel having a first side and a second side; and

a coating on at least one of the first side of the strip of base steel and the second side of the strip of base steel, wherein the coating results from interdiffusion between the base steel, and an aluminum or aluminum alloy pre-coating, and wherein the coating includes, proceeding from the base steel outwards:

(a) an interdiffusion layer having a first mean iron composition,

(b) an intermediate layer having a second mean iron composition different from the first mean iron composition,

(c) an intermetallic layer having a third mean iron composition different from the first and second mean iron compositions, the third mean iron composition being higher than the second mean iron composition; and

(d) a superficial layer having a fourth mean iron composition different from the third mean iron composition,

wherein the coating has a thickness greater than 30 micrometers.

Claim 49 (new): The coated steel hot stamped product as recited in claim 48 wherein the layers (c) and (d) are quasi continuous by occupying at least 90% of a level corresponding to each of the layers (c) and (d) and wherein less than 10% of layer (c) is present at an extreme surface of the product.

Claim 50 (new): The coated steel hot stamped product as recited in claim 48 wherein the base steel includes the following components by weight based on total weight:

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0.15%<carbon<0.5%;

0.5%<manganese<3%;

0.1%<silicon<0.5%;

0.01%<chromium<1%;

titanium<0.2%;

aluminum<0.1%;

phosphorus<0.1%;

sulfur<0.05%;

0.0005%<boron<0.08%;

and further comprises iron and impurities inherent in processing.

Claim 51 (new): The coated steel hot stamped product as recited in claim 48 wherein the base steel comprises the following components by weight based on total weight:

0.20%<carbon<0.5%;

0.8%<manganese<1.5%;

0.1%<silicon<0.35%;

0.01%<chromium<1%;

titanium<0.1%;

aluminum<0.1%;

phosphorus<0.05%;

sulfur<0.03%;

0.0005%<boron<0.01%;

and further comprises iron and impurities inherent in processing.

Claim 52 (new): The coated steel hot stamped product as recited in claim 48 wherein the base steel comprises 20 ppm or less of sulfur.

Claim 53 (new): The coated steel hot stamped product as recited in claim 49 wherein the base steel comprises 20 ppm or less of sulfur.

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Claim 54 (new): The coated steel hot stamped product as recited in claim 48 wherein a ratio of titanium to nitrogen in the base steel in weight % is in excess of 3.42.

Claim 55 (new): The coated steel hot stamped product as recited in claim 49 wherein a ratio of titanium to nitrogen in the base steel in weight % is in excess of 3.42.

Claim 56 (new): The coated steel hot stamped product as recited in claim 48 wherein the layer (a) has a thickness less than 15 micrometers.

Claim 57 (new): The coated steel hot stamped product as recited in claim 48 wherein the layer (a) has a thickness less than 10 micrometers.

Claim 58 (new): The coated steel hot stamped product as recited in claim 48 wherein the interdiffusion layer comprises the following components by weight based on total weight: 86 to 95% Fe, 4 to10% Al, and 0 to 5% Si.

Claim 59 (new): The coated steel hot stamped product as recited in claim 48 wherein the intermediate layer comprises the following components by weight based on total weight: 39 to 47% Fe, 53 to 61% Al, and 0 to 2% Si.

Claim 60 (new): The coated steel hot stamped product as recited in claim 48 wherein the intermetallic layer comprises the following components by weight based on total weight: 62 to 67% Fe, 30 to 34% Al, and 2 to 6% Si.

Claim 61 (new): The coated steel hot stamped product as recited in claim 48 wherein the superficial layer comprises the following components by weight based on total weight: 39 to 47% Fe, 53 to 61% Al, and 0 to 2% Si.

Claim 62 (new): The coated steel hot stamped product as recited in claim 58 wherein the intermediate layer comprises the following components by weight based on total weight: 39 to 47% Fe, 53 to 61% Al, and 0 to 2% Si.

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Claim 63 (new): The coated steel hot stamped product as recited in claim 62 wherein the intermetallic layer comprises the following components by weight based on total weight: 62 to 67% Fe, 30 to 34% Al, and 2 to 6% Si.

Claim 64 (new): The coated steel hot stamped product as recited in claim 63 wherein the superficial layer comprises the following components by weight based on total weight: 39 to 47% Fe, 53 to 61% Al, and 0 to 2% Si.

Claim 65 (new): The coated steel hot stamped product as recited in claim 48 wherein the interdiffusion layer has a thickness of from 1 micron to 15 microns.

Claim 66 (new): The coated steel hot stamped product as recited in claim 48 wherein the first mean iron composition is 90 percent, the second mean iron composition is 43 percent, the third mean iron composition is 63 percent and the fourth mean iron composition is 45 percent.

Claim 67 (new): The coated steel hot stamped product as recited in claim 48 wherein the fourth mean iron composition is lower than the third mean iron composition.

Claim 68 (new): A coated steel hot stamped product comprising:

a strip of base steel having a first side and a second side; and

a coating on at least one of the first side of the strip of base steel and the second side of the strip of base steel, wherein the coating results from interdiffusion between the base steel, and an aluminum or aluminum alloy pre-coating, and wherein the coating includes, proceeding from the base steel outwards:

(a) an interdiffusion layer having a first mean iron composition,

(b) an intermediate layer having a second mean iron composition different from the first mean iron composition,

(c) an intermetallic layer having a third mean iron composition different from the first and second mean iron compositions, the third mean iron concentration being higher than the second mean iron composition, and

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(d) a superficial layer having a fourth mean iron composition different from the first, second and third mean iron compositions,

wherein the coating has a thickness greater than 30 micrometers.

Claim 69 (new): The coated steel hot stamped product as recited in claim 68 wherein the fourth mean iron composition is lower than the third mean iron composition.

Claim 70 (new): The coated steel hot stamped product as recited in claim 69 wherein the fourth mean iron composition is higher than the second mean iron composition.

Claim 71 (new): A coated steel hot stamped product comprising:

a strip of base steel having a first side and a second side; and

a coating on at least one of the first side of the strip of base steel and the second side of the strip of base steel, wherein the coating results from interdiffusion between the base steel, and an aluminum or aluminum alloy pre-coating, and wherein the coating includes, proceeding from the base steel outwards:

(a) an interdiffusion layer having a first mean aluminum composition,

(b) an intermediate layer having a second mean aluminum composition different from the first mean aluminum composition,

(c) an intermetallic layer having a third mean aluminum composition different from the first and second mean aluminum compositions, and

(d) a superficial layer having a fourth mean aluminum composition different from the first, second and third mean aluminum compositions, the second mean aluminum composition being greater than the third mean aluminum composition;

wherein the coating has a thickness greater than 30 micrometers.

Claim 72 (new): The coated steel hot stamped product as recited in claim 71 wherein the fourth mean aluminum composition is less than the second mean aluminum composition.

Claim 73 (new): The coated steel hot stamped product as recited in claim 71 wherein the layer (a) has a thickness less than 15 micrometers.

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Claim 74 (new): The coated steel hot stamped product as recited in claim 71 wherein the interdiffusion layer comprises the following components by weight based on total weight: 86 to 95% Fe, 4 to10% Al, and 0 to 5% Si.

Claim 75 (new): The coated steel hot stamped product as recited in claim 71 wherein the intermediate layer comprises the following components by weight based on total weight: 39 to 47% Fe, 53 to 61% Al, and 0 to 2% Si.

Claim 76 (new): The coated steel hot stamped product as recited in claim 71 wherein the intermetallic layer comprises the following components by weight based on total weight: 62 to 67% Fe, 30 to 34% Al, and 2 to 6% Si.

Claim 77 (new): The coated steel hot stamped product as recited in claim 71 wherein the superficial layer comprises the following components by weight based on total weight: 39 to 47% Fe, 53 to 61% Al, and 0 to 2% Si.

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REMARKS

Claims 25 to 47 are pending. Claims 25 to 47 were rejected under 35 U.S.C. 112(b) as being indefinite.

Claims 25 to 47 have been canceled without prejudice and claims 48 to 77 added. Support for the new claims is found in the original claims and at 0049 to 0057 and 0122 to 0126 for example.

Reconsideration of the application as amended is respectfully requested.

Rejections under 35 U.S.C. § 112

Claims 25 to 47 were rejected under 35 U.S.C. 112(b) as being indefinite.

Claims 25 to 47 have been canceled in favor of new claims that now recite ***a coated steel hot stamped product*** as described, support being found at 0049 to 0057 and 0122 to 0126 for example. These claims thus address the Examiner's concern regarding the layer structure not being in the precoated product. Claims directed to the precoating features have been removed without prejudice.

In view of the above, withdrawal of the rejection under 35 U.S.C. § 112 to claims 25 to 47 is respectfully requested.

New Claims

The new claims recite mean composition features finding support for example at 0049 to 0057 and 0122 to 0126. The new independent claims remove the claim limitation of "layer (a) has a thickness less than 15 micrometers" found at the specification at 0057, but add certain mean composition features, namely in claims 48 and 68 of "an intermetallic layer having a third mean iron composition different from the first and second mean iron compositions, the third mean iron concentration being higher than the second mean iron composition" and in claim 71 of "the second mean aluminum composition being greater than the third mean aluminum composition." These again find support for example at 0049 to 0057 and 0122 to 0126.

Applicants would like to note that during previous prosecution of related U.S. Patent No. 9,708,683, the claim limitation of the layer (a) having a thickness less than 15 micrometers was at issue in the issuance of those claims. While Applicant has now removed that limitation in the independent claims in the present application (though it remains in some dependent claims), it is

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noted that Takagi U.S. 2004/0009366 states at 0035 that: "Thickness of aluminum coating layer: 10˜20 μm." While this is the thickness of the aluminum coating before heat treatment in Takagi, there is simply no indication that the Takagi heat treatment process would increase this coating layer to meet the claim limitation of the present independent claims of claims 48, 68 and 71 of "wherein the coating has a thickness greater than 30 micrometers." Nor, if Takagi were so modified, is there any indication that the layer compositions as claimed in claims 48, 68 and 71 would be attained.

Applicant also notes that for the related U.S. 9,708,683 patent a petition for *inter partes* review has been filed and invites the Examiner to review the papers filed in that proceeding. The present claims are respectfully submitted as patentable over all of the prior art at issue.

CONCLUSION

It is respectfully submitted that the application is in condition for allowance and applicants respectfully request such action.

If any fees are deemed to be due at this time, the Assistant Commissioner is authorized to charge payment of the same to Deposit Account No. 50-0552.

Respectfully submitted,
DAVIDSON, DAVIDSON & KAPPEL, LLC

By:_____
William C. Gehris, Reg. No. 38,156

Davidson, Davidson & Kappel, LLC
589 Eighth Ave, 16th Floor
New York, New York 10018

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U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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PETITION FOR EXTENSION OF TIME UNDER 37 CFR 1.136(a)

Docket Number (Optional): 20631.1028CON5

Application Number: 16413799

Filed: 05/16/2019

For: Coated Steel Strips, Coated Stamped Products and Methods

Art Unit: 1784

Examiner: SCHLEIS, DANIEL J

This is a request under the provisions of 37 CFR 1.136(a) to extend the period for filing a reply in the above-identified application.

The requested extension and fee are as follows (check time period desired and enter the appropriate fee below):

		Fee	Small Entity Fee	Micro Entity Fee	
☑	One month (37 CFR 1.17(a)(1))	$200	$100	$50	$ 200
☐	Two months (37 CFR 1.17(a)(2))	$600	$300	$150	$
☐	Three months (37 CFR 1.17(a)(3))	$1,400	$700	$350	$
☐	Four months (37 CFR 1.17(a)(4))	$2,200	$1,100	$550	$
☐	Five months (37 CFR 1.17(a)(5))	$3,000	$1,500	$750	$

☐ Applicant asserts small entity status. See 37 CFR 1.27.

☐ Applicant certifies micro entity status. See 37 CFR 1.29.
Form PTO/SB/15A or B or equivalent must either be enclosed or have been submitted previously.

☐ A check in the amount of the fee is enclosed.

☐ Payment by credit card. Form PTO-2038 is attached.

☑ The Director has already been authorized to charge fees in this application to a Deposit Account.

☑ The Director is hereby authorized to charge any fees which may be required, or credit any overpayment, to Deposit Account Number 500552.

☑ Payment made via EFS-Web.

WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.

I am the

☐ applicant.

☑ attorney or agent of record. Registration number 38156.

☐ attorney or agent acting under 37 CFR 1.34. Registration number _____.

/williamcgehris/ — Signature

11/25/2019 — Date

William C. Gehris — Typed or printed name

2127361940 — Telephone Number

NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications. Submit multiple forms if more than one signature is required, see below*.

☐ * Total of _____ forms are submitted.

This collection of information is required by 37 CFR 1.136(a). The information is required to obtain or retain a benefit by the public, which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 6 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Mail Stop PCT, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

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The **Privacy Act of 1974 (P.L. 93-579)** requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (*i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Electronic Patent Application Fee Transmittal

Application Number:	16413799
Filing Date:	16-May-2019
Title of Invention:	Coated Steel Strips, Coated Stamped Products and Methods
First Named Inventor/Applicant Name:	Pascal DRILLET
Filer:	William C. Gehris/Simon Steiner
Attorney Docket Number:	20631.1028CON5

Filed as Large Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

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Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension - 1 month with $0 paid	1251	1	200	200
Miscellaneous:				
		Total in USD ($)		**200**

Electronic Acknowledgement Receipt

EFS ID:	37855584
Application Number:	16413799
International Application Number:	
Confirmation Number:	7637
Title of Invention:	Coated Steel Strips, Coated Stamped Products and Methods
First Named Inventor/Applicant Name:	Pascal DRILLET
Customer Number:	23280
Filer:	William C. Gehris/Simon Steiner
Filer Authorized By:	William C. Gehris
Attorney Docket Number:	20631.1028CON5
Receipt Date:	25-NOV-2019
Filing Date:	16-MAY-2019
Time Stamp:	18:27:46
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	DA
Payment was successfully received in RAM	$200
RAM confirmation Number	E2019AOI28031197
Deposit Account	500552
Authorized User	Simon Steiner

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

37 CFR 1.16 (National application filing, search, and examination fees)

37 CFR 1.17 (Patent application and reexamination processing fees)

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37 CFR 1.19 (Document supply fees)

37 CFR 1.20 (Post Issuance fees)

37 CFR 1.21 (Miscellaneous fees and charges)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		206311028con5DraftResOA_12nov19-WG.pdf	275127 0afa95c64c56ef9b7d0c23c93cbdccf321623008	yes	9
	Multipart Description/PDF files in .zip description				
	Document Description		**Start**	**End**	
	Amendment/Req. Reconsideration-After Non-Final Reject		1	1	
	Claims		2	7	
	Applicant Arguments/Remarks Made in an Amendment		8	9	
Warnings:					
Information:					
2	Extension of Time	extension.PDF	145664 eef024e7512727b6561d635943426bfe9cf45de7	no	2
Warnings:					
Information:					
3	Fee Worksheet (SB06)	fee-info.pdf	30725 f172b4f526ddf7960028c56c28b2af7aceee3d27	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	451516		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

PTO/SB/08a (03-15)
Approved for use through 07/31/2016. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	16413799
Filing Date	2019-05-16
First Named Inventor	Drillet
Art Unit	1784
Examiner Name	Schleis
Attorney Docket Number	20631.1028CON5

U.S.PATENTS Remove

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1					

If you wish to add additional U.S. Patent citation information please click the Add button. Add

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Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1					

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Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1							

If you wish to add additional Foreign Patent Document citation information please click the Add button Add

NON-PATENT LITERATURE DOCUMENTS Remove

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	16413799
	Filing Date	2019-05-16
	First Named Inventor	Drillet
	Art Unit	1784
	Examiner Name	Schleis
	Attorney Docket Number	20631.1028CON5

	1	"Continuously hot-dip coated strip and sheet of strucutral steels - Technical delivery conditions," European Standard EN 10326, July 2004, NON-EN 10326

If you wish to add additional non-patent literature document citation information please click the Add button Add

EXAMINER SIGNATURE

Examiner Signature		Date Considered	

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

ArcelorMittal Ex. 2001
Posco Co. LTD. v. ArcelorMittal
IPR2024-01376

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	16413799
	Filing Date	2019-05-16
	First Named Inventor	Drillet
	Art Unit	1784
	Examiner Name	Schleis
	Attorney Docket Number	20631.1028CON5

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

See attached certification statement.

☒ The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/williamcgehris/	Date (YYYY-MM-DD)	2020-01-06
Name/Print	William C. Gehris	Registration Number	38156

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

ArcelorMittal Ex. 2001
Posco Co. LTD. v. ArcelorMittal
IPR2024-01376

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these record s.

2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).

5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.

6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

ArcelorMittal Ex. 2001
Posco Co. LTD. v. ArcelorMittal
IPR2024-01376
Page 890 of 1430

Electronic Patent Application Fee Transmittal

Application Number:	16413799
Filing Date:	16-May-2019
Title of Invention:	Coated Steel Strips, Coated Stamped Products and Methods
First Named Inventor/Applicant Name:	Pascal DRILLET
Filer:	William C. Gehris/Simon Steiner
Attorney Docket Number:	20631.1028CON5

Filed as Large Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

ArcelorMittal Ex. 2001
Posco Co. LTD. v. ArcelorMittal
IPR2024-01376

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
SUBMISSION- INFORMATION DISCLOSURE STMT	1806	1	240	240
		Total in USD ($)		**240**

Electronic Acknowledgement Receipt

EFS ID:	38216106
Application Number:	16413799
International Application Number:	
Confirmation Number:	7637
Title of Invention:	Coated Steel Strips, Coated Stamped Products and Methods
First Named Inventor/Applicant Name:	Pascal DRILLET
Customer Number:	23280
Filer:	William C. Gehris/Simon Steiner
Filer Authorized By:	William C. Gehris
Attorney Docket Number:	20631.1028CON5
Receipt Date:	06-JAN-2020
Filing Date:	16-MAY-2019
Time Stamp:	17:26:42
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	DA
Payment was successfully received in RAM	$240
RAM confirmation Number	E202016H28254356
Deposit Account	500552
Authorized User	Simon Steiner

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

37 CFR 1.16 (National application filing, search, and examination fees)

37 CFR 1.17 (Patent application and reexamination processing fees)

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37 CFR 1.19 (Document supply fees)

37 CFR 1.20 (Post Issuance fees)

37 CFR 1.21 (Miscellaneous fees and charges)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Non Patent Literature	D82.PDF	1631436 839d121c824780631dfa1011f8cfe1aa30a04c1d	no	25
Warnings:					
Information:					
2	Information Disclosure Statement (IDS) Form (SB08)	IDSJan2020.PDF	1035293 324d04b63c1a1b8162227db0b46e679f95a2eae1	no	4
Warnings:					
Information:					
A U.S. Patent Number Citation or a U.S. Publication Number Citation is required in the Information Disclosure Statement (IDS) form for autoloading of data into USPTO systems. You may remove the form to add the required data in order to correct the Informational Message if you are citing U.S. References. If you chose not to include U.S. References, the image of the form will be processed and be made available within the Image File Wrapper (IFW) system. However, no data will be extracted from this form. Any additional data such as Foreign Patent Documents or Non Patent Literature will be manually reviewed and keyed into USPTO systems.					
3	Fee Worksheet (SB06)	fee-info.pdf	30685 466ece7855b87c09211353b78ab80d3c8f85895c	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	2697414		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

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National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/413,799	05/16/2019	Pascal DRILLET	20631.1028CON5	7637

23280 7590 03/02/2020

Davidson, Davidson & Kappel, LLC
589 8th Avenue
16th Floor
New York, NY 10018

EXAMINER
SCHLEIS, DANIEL J

ART UNIT	PAPER NUMBER
1784	

NOTIFICATION DATE	DELIVERY MODE
03/02/2020	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

ddk@ddkpatent.com

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DETAILED ACTION

4. (Continued)

The amendment filed on 25 November 2019 canceling all claims drawn to the elected invention and presenting only claims drawn to a non-elected invention is non-responsive (MPEP § 821.03) and has not been entered. The remaining claims are not readable on the elected invention.

The inventions are independent or distinct, each from the other because:

Newly submitted claims 48-77 directed to an invention that is independent or distinct from the invention originally claimed for the following reasons:

Restriction to one of the following inventions is required under 35 U.S.C. 121:

I. Original Claims 25-47, drawn to a precoated steel product, classified in B32B 15/012.

II. Amended Claims 48-77, drawn to a coated hot stamped product, classified in C21D 9/46.

Inventions I and II are related as mutually exclusive species in an intermediate-final product relationship. Distinctness is proven for claims in this relationship if the intermediate product is useful to make other than the final product, and the species are patentably distinct (MPEP § 806.05(j)). In the instant case, the intermediate product is deemed to be useful as a product that has not been stamped, for example as a sheet panel that is not stamped (e.g. simply a panel for a structure that is attached to the structure and is in sheet form) and the inventions are deemed patentably distinct because there is nothing of record to show them to be obvious variants.

Since applicant has received an action on the merits for the originally presented invention, this invention has been constructively elected by original presentation for prosecution

on the merits. Accordingly, claims 48-77 are withdrawn from consideration as being directed to a non-elected invention. See 37 CFR 1.142(b) and MPEP § 821.03.

Since the above-mentioned amendment appears to be a bona fide attempt to reply, applicant is given a TIME PERIOD of TWO MONTHS from the mailing date of this notice within which to supply the omission or correction in order to avoid abandonment. EXTENSIONS OF THIS TIME PERIOD UNDER 37 CFR 1.136(a) ARE AVAILABLE.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Daniel J Schleis whose telephone number is (571)270-5636. The examiner can normally be reached on 10 AM to 4 PM Monday through Friday.

Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an interview, applicant is encouraged to use the USPTO Automated Interview Request (AIR) at http://www.uspto.gov/interviewpractice.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Humera Sheikh can be reached on (571) 272-0604. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR

system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

Daniel J. Schleis
Primary Examiner
Art Unit 1784

/Daniel J. Schleis/
Primary Examiner, Art Unit 1784

Notice of Non-Compliant Amendment (37 CFR 1.121)	Application No. 16/413,799	Applicant(s) DRILLET et al.	
	Examiner Daniel J Schleis	Art Unit 1784	AIA (FITF) Status No

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

The amendment document filed on 11/25/2019 is considered non-compliant because it has failed to meet the requirements of 37 CFR 1.121 or 1.4. In order for the amendment document to be compliant, correction of the following item(s) is required.

THE FOLLOWING MARKED (X) ITEM(S) CAUSE THE AMENDMENT DOCUMENT TO BE NON-COMPLIANT:

- ☐ 1. Amendments to the specification:
  - ☐ A. Amended paragraph(s) do not include markings.
  - ☐ B. New paragraph(s) should not be underlined.
  - ☐ C. Other _____ .
- ☐ 2. Abstract:
  - ☐ A.Not presented on a separate sheet. 37 CFR 1.72.
  - ☐ B.Other _____ .
- ☐ 3. Amendments to the drawings:
  - ☐ A. The drawings are not properly identified in the top margin as "Replacement Sheet", "New Sheet", or "Annotated Sheet" as required by 37 CFR 1.121(d).
  - ☐ B. The practice of submitting proposed drawing correction has been eliminated. Replacement drawings showing amended figures, without markings, in compliance with 37 CFR 1.84 are required.
  - ☐ C. Other _____ .
- ☑ 4. Amendments to the claims:
  - ☐ A. A complete listing of all of the claims is not present.
  - ☐ B. The listing of claims does not include the text of all pending claims (including withdrawn claims)
  - ☐ C. Each claim has not been provided with the proper status identifier, and as such, the individual status of each claim cannot be identified. Note: the status of every claim must be indicated after its claim number by using one of the following status identifiers: (Original), (Currently amended), (Canceled), (Previously presented), (New), (Not entered), (Withdrawn) and (Withdrawn-currently amended).
  - ☐ D. The claims of this amendment paper have not been presented in ascending numerical order.
  - ☑ E. Other: See Continuation .
- ☐ 5. Other (e.g., the amendment is unsigned or not signed in accordance with 37 CFR 1.4):

  _____

For further explanation of the amendment format required by 37 CFR 1.121, see MPEP § 714.

TIME PERIODS FOR FILING A REPLY TO THIS NOTICE:

1. Applicant is given **no new time period if the non-compliant amendment is an** after-final amendment or an amendment filed after allowance. If applicant wishes to resubmit the non-compliant after-final amendment with corrections, the **entire corrected amendment** must be resubmitted.

2. Applicant is given **two months** from the mail date of this notice to supply the correction, if the non-compliant amendment is one of the following: a preliminary amendment, a non-final amendment (including a submission for a request for continued examination (RCE) under 37 CFR 1.114), a supplemental amendment filed within a suspension period under 37 CFR 1.103(a) or (c), and an amendment filed in response to a *Quayle* action. If any of above boxes 1. to 4. are checked, the correction required is only the **corrected section** of the non-compliant amendment in compliance with 37 CFR 1.121.

   Extensions of time are available under 37 CFR 1.136(a) only if the non-compliant amendment is a non-final amendment or an amendment filed in response to a *Quayle* action.

   Failure to timely respond to this notice will result in:
   Abandonment of the application if the non-compliant amendment is a non-final amendment or an amendment filed in response to a *Quayle* action; or
   Non-entry of the amendment if the non-compliant amendment is a preliminary amendment or supplemental amendment.

ArcelorMittal Ex. 2001
Posco Co. LTD. v. ArcelorMittal
IPR2024-01376

/Daniel J. Schleis/ Primary Examiner, Art Unit 1784	

ArcelorMittal Ex. 2001
Posco Co. LTD. v. ArcelorMittal
IPR2024-01376
Page 901 of 1430

PTO/SB/06 (09-11)
Approved for use through 1/31/2014. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 16/413,799	Filing Date 05/16/2019	☐ To be Mailed

ENTITY: ☑ LARGE ☐ SMALL ☐ MICRO

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA		RATE ($)	FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A		N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A		N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A		N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*		x $100 =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*		x $460 =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).				
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))					
* If the difference in column 1 is less than zero, enter "0" in column 2.				TOTAL	

APPLICATION AS AMENDED - PART II

		(Column 1)		(Column 2)	(Column 3)			
AMENDMENT	04/08/2020	CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA		RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	* 30	Minus	** 30	= 0		x $100 =	0
	Independent (37 CFR 1.16(h))	* 3	Minus	*** 3	= 0		x $460 =	0
	☐ Application Size Fee (37 CFR 1.16(s))							
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							
							TOTAL ADD'L FEE	0

		(Column 1)		(Column 2)	(Column 3)			
AMENDMENT		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA		RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	*	Minus	**	=		x $0 =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=		x $0 =	
	☐ Application Size Fee (37 CFR 1.16(s))							
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							
							TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.	SLIE
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".	/TONYA Q MCBRIDE/
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".	
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.	

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Electronic Acknowledgement Receipt

EFS ID:	39098953
Application Number:	16413799
International Application Number:	
Confirmation Number:	7637
Title of Invention:	Coated Steel Strips, Coated Stamped Products and Methods
First Named Inventor/Applicant Name:	Pascal DRILLET
Customer Number:	23280
Filer:	Cary S. Kappel
Filer Authorized By:	
Attorney Docket Number:	20631.1028CON5
Receipt Date:	08-APR-2020
Filing Date:	16-MAY-2019
Time Stamp:	14:22:11
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Response to Election / Restriction Filed	206311028con5DraftResOA_8apr20.pdf	96232 ba0d4d97e6223b03c50665effadbcf2cc0942a4f	no	9

Warnings:

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Information:	
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New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

IN THE UNITED STATES PATENT & TRADEMARK OFFICE

Application of:	ARCELORMITTAL
Inventor(s):	Drillet et al.
Application No.:	16/413,799
Filed:	May 16, 2019
Attorney Docket No.:	20631.1028CON5
Confirmation No.:	7637
Examiner:	Daniel J. Schleis
Title:	Coated Steel Strips, Coated Stamped Products and Methods

Submitted electronically via EFS-WEB April 8, 2020

RESPONSE TO OFFICE ACTION

Dear Sir or Madam:

In response to the Office Action dated March 2, 2020, please re-consider the above-identified patent application based on the following:

IN THE CLAIMS

This listing of claims will replace all prior versions, and listings, of claims in the application:

Listing of Claims:

Claims 1 to 47 (canceled).

Claim 48 (currently amended): A precoated steel ~~hot stamped~~ product comprising:

a strip of base steel having a first side and a second side; and

a coating on at least one of the first side of the strip of base steel and the second side of the strip of base steel, wherein the coating results from interdiffusion between the base steel, and an aluminum or aluminum alloy pre-coating, and wherein the coating includes, proceeding from the base steel outwards:

(a) an interdiffusion layer having a first mean iron composition,

(b) an intermediate layer having a second mean iron composition different from the first mean iron composition,

(c) an intermetallic layer having a third mean iron composition different from the first and second mean iron compositions, the third mean iron composition being higher than the second mean iron composition; and

(d) a superficial layer having a fourth mean iron composition different from the third mean iron composition,

wherein the coating has a thickness greater than 30 micrometers.

Claim 49 (currently amended): The precoated steel ~~hot stamped~~ product as recited in claim 48 wherein the layers (c) and (d) are quasi continuous by occupying at least 90% of a level corresponding to each of the layers (c) and (d) and wherein less than 10% of layer (c) is present at an extreme surface of the product.

Claim 50 (currently amended): The precoated steel ~~hot stamped~~ product as recited in claim 48 wherein the base steel includes the following components by weight based on total weight:

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0.15%<carbon<0.5%;

0.5%<manganese<3%;

0.1%<silicon<0.5%;

0.01%<chromium<1%;

titanium<0.2%;

aluminum<0.1%;

phosphorus<0.1%;

sulfur<0.05%;

0.0005%<boron<0.08%;

and further comprises iron and impurities inherent in processing.

Claim 51 (currently amended): The precoated steel ~~hot stamped~~ product as recited in claim 48 wherein the base steel comprises the following components by weight based on total weight:

0.20%<carbon<0.5%;

0.8%<manganese<1.5%;

0.1%<silicon<0.35%;

0.01%<chromium<1%;

titanium<0.1%;

aluminum<0.1%;

phosphorus<0.05%;

sulfur<0.03%;

0.0005%<boron<0.01%;

and further comprises iron and impurities inherent in processing.

Claim 52 (currently amended): The precoated steel ~~hot stamped~~ product as recited in claim 48 wherein the base steel comprises 20 ppm or less of sulfur.

Claim 53 (currently amended): The precoated steel ~~hot stamped~~ product as recited in claim 49 wherein the base steel comprises 20 ppm or less of sulfur.

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Claim 54 (currently amended): The precoated steel ~~hot stamped~~ product as recited in claim 48 wherein a ratio of titanium to nitrogen in the base steel in weight % is in excess of 3.42.

Claim 55 (currently amended): The precoated steel ~~hot stamped~~ product as recited in claim 49 wherein a ratio of titanium to nitrogen in the base steel in weight % is in excess of 3.42.

Claim 56 (currently amended): The precoated steel ~~hot stamped~~ product as recited in claim 48 wherein the layer (a) has a thickness less than 15 micrometers.

Claim 57 (currently amended): The precoated steel ~~hot stamped~~ product as recited in claim 48 wherein the layer (a) has a thickness less than 10 micrometers.

Claim 58 (currently amended): The precoated steel ~~hot stamped~~ product as recited in claim 48 wherein the interdiffusion layer comprises the following components by weight based on total weight: 86 to 95% Fe, 4 to10% Al, and 0 to 5% Si.

Claim 59 (currently amended): The precoated steel ~~hot stamped~~ product as recited in claim 48 wherein the intermediate layer comprises the following components by weight based on total weight: 39 to 47% Fe, 53 to 61% Al, and 0 to 2% Si.

Claim 60 (currently amended): The precoated steel ~~hot stamped~~ product as recited in claim 48 wherein the intermetallic layer comprises the following components by weight based on total weight: 62 to 67% Fe, 30 to 34% Al, and 2 to 6% Si.

Claim 61 (currently amended): The precoated steel ~~hot stamped~~ product as recited in claim 48 wherein the superficial layer comprises the following components by weight based on total weight: 39 to 47% Fe, 53 to 61% Al, and 0 to 2% Si.

Claim 62 (currently amended): The precoated steel ~~hot stamped~~ product as recited in claim 58 wherein the intermediate layer comprises the following components by weight based on total weight: 39 to 47% Fe, 53 to 61% Al, and 0 to 2% Si.

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Claim 63 (currently amended): The precoated steel ~~hot stamped~~ product as recited in claim 62 wherein the intermetallic layer comprises the following components by weight based on total weight: 62 to 67% Fe, 30 to 34% Al, and 2 to 6% Si.

Claim 64 (currently amended): The precoated steel ~~hot stamped~~ product as recited in claim 63 wherein the superficial layer comprises the following components by weight based on total weight: 39 to 47% Fe, 53 to 61% Al, and 0 to 2% Si.

Claim 65 (currently amended): The precoated steel ~~hot stamped~~ product as recited in claim 48 wherein the interdiffusion layer has a thickness of from 1 micron to 15 microns.

Claim 66 (currently amended): The precoated steel ~~hot stamped~~ product as recited in claim 48 wherein the first mean iron composition is 90 percent, the second mean iron composition is 43 percent, the third mean iron composition is 63 percent and the fourth mean iron composition is 45 percent.

Claim 67 (currently amended): The precoated steel ~~hot stamped~~ product as recited in claim 48 wherein the fourth mean iron composition is lower than the third mean iron composition.

Claim 68 (currently amended): A precoated steel ~~hot stamped~~ product comprising:

a strip of base steel having a first side and a second side; and

a coating on at least one of the first side of the strip of base steel and the second side of the strip of base steel, wherein the coating results from interdiffusion between the base steel, and an aluminum or aluminum alloy pre-coating, and wherein the coating includes, proceeding from the base steel outwards:

(a) an interdiffusion layer having a first mean iron composition,

(b) an intermediate layer having a second mean iron composition different from the first mean iron composition,

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(c) an intermetallic layer having a third mean iron composition different from the first and second mean iron compositions, the third mean iron concentration being higher than the second mean iron composition, and

(d) a superficial layer having a fourth mean iron composition different from the first, second and third mean iron compositions,

wherein the coating has a thickness greater than 30 micrometers.

Claim 69 (currently amended): The precoated steel ~~hot stamped~~ product as recited in claim 68 wherein the fourth mean iron composition is lower than the third mean iron composition.

Claim 70 (currently amended): The precoated steel ~~hot stamped~~ product as recited in claim 69 wherein the fourth mean iron composition is higher than the second mean iron composition.

Claim 71 (currently amended): A precoated steel ~~hot stamped~~ product comprising:

a strip of base steel having a first side and a second side; and

a coating on at least one of the first side of the strip of base steel and the second side of the strip of base steel, wherein the coating results from interdiffusion between the base steel, and an aluminum or aluminum alloy pre-coating, and wherein the coating includes, proceeding from the base steel outwards:

(a) an interdiffusion layer having a first mean aluminum composition,

(b) an intermediate layer having a second mean aluminum composition different from the first mean aluminum composition,

(c) an intermetallic layer having a third mean aluminum composition different from the first and second mean aluminum compositions, and

(d) a superficial layer having a fourth mean aluminum composition different from the first, second and third mean aluminum compositions, the second mean aluminum composition being greater than the third mean aluminum composition;

wherein the coating has a thickness greater than 30 micrometers.

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Claim 72 (currently amended): The precoated steel ~~hot stamped~~ product as recited in claim 71 wherein the fourth mean aluminum composition is less than the second mean aluminum composition.

Claim 73 (currently amended): The precoated steel ~~hot stamped~~ product as recited in claim 71 wherein the layer (a) has a thickness less than 15 micrometers.

Claim 74 (currently amended): The precoated steel ~~hot stamped~~ product as recited in claim 71 wherein the interdiffusion layer comprises the following components by weight based on total weight: 86 to 95% Fe, 4 to10% Al, and 0 to 5% Si.

Claim 75 (currently amended): The precoated steel ~~hot stamped~~ product as recited in claim 71 wherein the intermediate layer comprises the following components by weight based on total weight: 39 to 47% Fe, 53 to 61% Al, and 0 to 2% Si.

Claim 76 (currently amended): The precoated steel ~~hot stamped~~ product as recited in claim 71 wherein the intermetallic layer comprises the following components by weight based on total weight: 62 to 67% Fe, 30 to 34% Al, and 2 to 6% Si.

Claim 77 (currently amended): The precoated steel ~~hot stamped~~ product as recited in claim 71 wherein the superficial layer comprises the following components by weight based on total weight: 39 to 47% Fe, 53 to 61% Al, and 0 to 2% Si.

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REMARKS

Claims 48 to 77 are pending. In the Office Action dated March 3, 2020, the Examiner issued a restriction requirement alleging that claims 48-77 were directed to a non-elected invention. According to the Examiner, original claims 25-47 were directed to "a precoated steel product" (Group I), and previously submitted claims 48 to 77 were directed to "a coated hot stamped product" (Group II). Claims 48 to 77 have been amended to be directed to constructively elected invention (I) "a precoated steel product".

In the Office Action dated July 11, 2019, previously pending Claims 25 to 47 were rejected under 35 U.S.C. l 12(b) as being indefinite. These claims were canceled in favor of new claims 48-77 which were subject to the restriction requirement addressed above. Claims 48-77 are herein amended to recite "a precoated steel product". It is respectfully submitted that currently amended claims 48-77 address the Examiner's concern that, in prior claims 25-47, the layer structure was not positively claimed as part of the precoated steel product. It is respectfully submitted that claims 48-77 comply with 35 U.S.C. l 12.

Applicant further notes that claims 48-77 recite mean composition features finding support for example at 0049 to 0057 and 0122 to 0126. The independent claims remove the claim limitation of "layer (a) has a thickness less than 15 micrometers" found at the specification at 0057, but add certain mean composition features, namely in claims 48 and 68 of "an intermetallic layer having a third mean iron composition different from the first and second mean iron compositions, the third mean iron concentration being higher than the second mean iron composition" and in claim 71 of "the second mean aluminum composition being greater than the third mean aluminum composition." These again find support for example at 0049 to 0057 and 0122 to 0126. Applicants would like to note that during previous prosecution of related U.S. Patent No. 9,708,683, the claim limitation of the layer (a) having a thickness less than 15 micrometers was at issue in the issuance of those claims. While Applicant has now removed that limitation in the independent claims in the present application (though it remains in some dependent claims), it is noted that Takagi U.S. 2004/0009366 states at 0035 that: "Thickness of aluminum coating layer: 10~20 μm." While this is the thickness of the aluminum coating before heat treatment in Takagi, there is simply no indication that the Takagi heat treatment process

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would increase this coating layer to meet the claim limitation of the present independent claims of claims 48, 68 and 71 of "wherein the coating has a thickness greater than 30 micrometers." Nor, if Takagi were so modified, is there any indication that the layer compositions as claimed in claims 48, 68 and 71 would be attained.

Applicant also notes that for the related U.S. 9,708,683 patent a petition for inter partes review has been filed and invites the Examiner to review the papers filed in that proceeding.

The present claims are respectfully submitted as patentable over all of the prior art at issue.

It is respectfully submitted that the application is in condition for allowance and applicants respectfully request such action

If any fees are deemed to be due at this time, the Assistant Commissioner is authorized to charge payment of the same to Deposit Account No. 50-0552.

Respectfully submitted,
DAVIDSON, DAVIDSON & KAPPEL, LLC

By: /Cary Kappel/
Cary Kappel, Reg. No. 36,561

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/413,799	05/16/2019	Pascal DRILLET	20631.1028CON5	7637

23280 7590 07/10/2020

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EXAMINER
SCHLEIS, DANIEL J

ART UNIT	PAPER NUMBER
1784	

NOTIFICATION DATE	DELIVERY MODE
07/10/2020	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

ddk@ddkpatent.com

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Office Action Summary	Application No. 16/413,799	Applicant(s) DRILLET et al.	
	Examiner Daniel J Schleis	Art Unit 1784	AIA (FITF) Status No

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTHS FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☑ Responsive to communication(s) filed on 04/08/2020.

☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2a)☑ This action is **FINAL.** 2b) ☐ This action is non-final.

3)☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

5) ☑ Claim(s) 48-77 is/are pending in the application.

5a) Of the above claim(s) _____ is/are withdrawn from consideration.

6) ☐ Claim(s) _____ is/are allowed.

7) ☑ Claim(s) 48-77 is/are rejected.

8) ☐ Claim(s) _____ is/are objected to.

9) ☐ Claim(s) _____ are subject to restriction and/or election requirement

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to **PPHfeedback@uspto.gov.**

Application Papers

10)☐ The specification is objected to by the Examiner.

11)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

a)☐ All b)☐ Some** c)☐ None of the:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

** See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☑ Notice of References Cited (PTO-892)

2) ☑ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b) Paper No(s)/Mail Date 07/08/2019 and 01/06/2020.

3) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date _____.

4) ☐ Other: _____.

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DETAILED ACTION

Response to Amendment

In view of the amendments to the claims, the 35 U.S.C. 112 rejections directed to the claims are withdrawn. New rejections directed to the claims are set forth below and were necessitated by these amendments.

Information Disclosure Statement

The information disclosure statements (IDS) submitted on 8 July 2019 and 6 January 2020 were considered by the examiner.

Claim Rejections - 35 USC § 102 / § 103

In the event the determination of the status of the application as subject to AIA 35 U.S.C. 102 and 103 (or as subject to pre-AIA 35 U.S.C. 102 and 103) is incorrect, any correction of the statutory basis for the rejection will not be considered a new ground of rejection if the prior art relied upon, and the rationale supporting the rejection, would be the same under either status.

The following is a quotation of the appropriate paragraphs of pre-AIA 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

The following is a quotation of pre-AIA 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made

> to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

The factual inquiries set forth in *Graham v. John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under pre-AIA 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.

2. Ascertaining the differences between the prior art and the claims at issue.

3. Resolving the level of ordinary skill in the pertinent art.

4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

This application currently names joint inventors. In considering patentability of the claims under pre-AIA 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of pre-AIA 35 U.S.C. 103(c) and potential pre-AIA 35 U.S.C. 102(e), (f) or (g) prior art under pre-AIA 35 U.S.C. 103(a).

Claims 48-50 and 54-77 are rejected under 35 U.S.C. 102(b) as anticipated by or, in the alternative, under 35 U.S.C. 103(a) as obvious over U.S. Patent Number 6,296,805 (Laurent).

In regards to independent claims 48, 68, and 71 and dependent claims 49, 50, 54-67, 69-70, and 72-77, Laurent is directed to a coated, hot- and cold-rolled steel sheet comprising a very

high resistance after thermal treatment. (1:6-8) The sheet is provided with an aluminum-based coating, for example by dipping in a bath containing, in addition, from 8% to 11% silicon, from 2% to 4% iron, the sheet having a high mechanical resistance after thermal treatment and a high resistance to corrosion, as well as a good capacity for painting and gluing. (2:37-45) The aluminum-based layer is provided in a thickness of about 20 microns. (3:38-44)

Laurent teaches a composition for the steel that completely falls within or overlaps the teachings within the instant application and set forth within the claims. Laurent teaches:

	Claim 50	Claim 51	Laurent (1:47-64)
Carbon	0.15-0.5	0.2-0.5	0.15-0.5
Manganese	0.5-3	0.8-1.5	0.5-3
Silicon	0.1-0.5	0.1-0.35	0.1-0.5
Chromium	0.01-1	0.01-1	0.01-1
Titanium	<0.2	<0.1	<0.2
Aluminum	<0.1	<0.1	<0.1
Phosphorous	<0.1	<0.05	<0.1
Sulfur	<0.05	<0.03	<0.05
Boron	0.0005-0.08	0.0005-0.01	0.0005-0.08
Iron	Balance	Balance	Balance

Diffusion of the iron in the coating will be initiated at high temperature, thus there will be better cohesion between the coating and steel in the sheet. (3:26-37) After the shaping of a casting the coating is subjected to an increase in temperature to an excess of 5° C/second. (3:26-29)

Thermal treatment of the metal sheet consists in a heating at a temperature between Ac1, starting temperature of austenitic formation, for example 750° C and 1200° C, in a furnace, for a period which depends on the temperature to be reached and the thickness of the casting sheet. (3:61-65) For a completely martensitic structure, and for steel having the composition of the

example, the speed of cooling should be in excess of the critical speed of hardening, which is 27° C / second for an austenitizing at 900° C for five minutes, wherein the sheet has a thickness of approximately 1 mm. (4:4-9)

This process appears to be identical or substantially identical to the process set forth in the specification of the instant application, which produces the claimed product. The instant application sets forth that the aluminum hot-dip coating is precisely controlled to fall within a range equal to 20 and 33 microns. (¶46-47 of Specification) The favorable layer disposition is obtained when aluminum- or aluminum alloy pre-coated steel sheets, whose thickness range from, e.g. 07 to 3 mm, are heated for 3 to 13 minutes in a furnace heated to a temperature of 880 to 940° C. (¶58 of Specification) The heating rate is between 4 and 12° C/second for producing a favorable alloyed layer disposition. (¶59 of Specification)

The Instant Application sets forth that the Al-Si coating has 8 to 11% silicon, from 2 to 4% iron, and the remainder being aluminum or aluminum alloy. (¶67 of Specification) The Typical composition of Al-Si coating is Al-9.3% silicon-2.8%Fe. (¶67 of Specification) The inventive coatings, however, are not limited to these compositions. (¶67 of Specification)

It appears that the thickness of the aluminum hot-dip coating, the composition of the hot-dip aluminum coating, the thickness of the steel sheet, the time and temperature of the heating within the furnace, and the heating rates in Laurent are identical or substantially identical to those set forth in the specification of the instant application. Applicant teaches that the heating rate and temperature lead to the favorable layer disposition. (See ¶58 and ¶59 of Specification) Laurent further sets forth the composition of the steel that falls within the teachings of the instant application and result in the claimed structure.

Where the claimed and prior art products are identical or substantially identical, or are produced by identical or substantially identical processes, the Office can require an applicant to prove that the prior art products do not necessarily or inherently possess the characteristics of the claimed product. Whether the rejection is based on "inherency" under 35 USC 102, on "prima facie obviousness" under 35 USC 103, jointly or alternatively, the burden of proof is the same, and its fairness is evidenced by the Office's inability to manufacture products or to obtain and compare prior art products.

Consequently, absent a showing to the contrary, it appears that the properties of the product in the prior art necessarily or inherently possesses the characteristics of the claimed product, including the presence of the four claimed layers, the resulting thickness of the overall coating and its respective layers, and the quasi-continuous nature of the layers.

As to claims 54 and 55, Laurent teaches in the preferred embodiment that the titanium content with respect to the nitrogen content is in excess of 3.42. [2:11-14]

Claim Rejections - 35 USC § 103

Claims 51-53 is/are rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over Laurent

As to claim 51, Laurent sets forth compositional ranges that overlap the claimed compositional ranges.

	Claim 51	Laurent (1:47-64)
Carbon	0.2-0.5	0.15-0.5
Manganese	0.8-1.5	0.5-3

Silicon	0.1-0.35	0.1-0.5
Chromium	0.01-1	0.01-1
Titanium	<0.1	<0.2
Aluminum	<0.1	<0.1
Phosphorous	<0.05	<0.1
Sulfur	<0.03	<0.05
Boron	0.0005-0.01	0.0005-0.08
Iron	Balance	Balance

As to claims 52 and 53, Laurent teaches that the sulfur content of the preferred embodiment has a sulfur content of less than 0.03%. (1:65-2:10) This range taught by Laurent overlaps the claimed range.

Response to Arguments

Applicant's arguments with respect to the claims have been considered but are moot because the arguments do not apply to any of the references being used in the current rejection.

Conclusion

Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Daniel J Schleis whose telephone number is (571)270-5636. The examiner can normally be reached on 10 AM to 4 PM Monday through Friday.

Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an interview, applicant is encouraged to use the USPTO Automated Interview Request (AIR) at http://www.uspto.gov/interviewpractice.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Humera Sheikh can be reached on (571) 272-0604. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see https://ppair-my.uspto.gov/pair/PrivatePair.

Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

Daniel J. Schleis
Primary Examiner
Art Unit 1784

/Daniel J. Schleis/
Primary Examiner, Art Unit 1784

Notice of References Cited	Application/Control No. 16/413,799	Applicant(s)/Patent Under Reexamination DRILLET et al.	
	Examiner Daniel J Schleis	Art Unit 1784	Page 1 of 1

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*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	CPC Classification	US Classification
*	A	US-6296805-B1	10-2001	Laurent; Jean-Pierre	C21D8/0278	148/531
	B					
	C					
	D					
	E					
	F					
	G					
	H					
	I					
	J					
	K					
	L					
	M					

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	CPC Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

ArcelorMittal Ex. 2001
Posco Co. LTD. v. ArcelorMittal
IPR2024-01376
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Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/413,799	DRILLET et al.
	Examiner	Art Unit
	Daniel J Schleis	1784

CPC - Searched*		
Symbol	Date	Examiner

CPC Combination Sets - Searched*		
Symbol	Date	Examiner

US Classification - Searched*			
Class	Subclass	Date	Examiner

* See search history printout included with this form or the SEARCH NOTES box below to determine the scope of the search.

Search Notes		
Search Notes	Date	Examiner
Inventor Name Search	07/08/2019	Schleis
Assignee Name Search	07/08/2019	Schleis
Reviewed Global Dossier	07/08/2019	Schleis
Non-Patent Literature Search - Google Scholar	07/08/2019	Schleis
EAST Text Search - See Search History	07/08/2019	Schleis
Reviewed File Wrappers of Other Applications in Patent Family	07/08/2019	Schleis
Reviewed Global Dossier	07/06/2020	Schleis
Reviewed File Wrappers, including search histories- in Patent Family	07/06/2020	Schleis
Non-Patent Literature Search - Google Scholar	07/06/2020	Schleis
EAST Text Search - See Search History	07/06/2020	Schleis

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Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/413,799	DRILLET et al.
	Examiner	Art Unit
	Daniel J Schleis	1784

Interference Search			
US Class/CPC Symbol	US Subclass/CPC Group	Date	Examiner

ArcelorMittal Ex. 2001
Posco Co. LTD. v. ArcelorMittal
IPR2024-01376
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EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S1	13	((PASCAL) near2 (DRILLET)).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2013/02/26 09:51
S2	8	((DOMINIQUE) near2 (SPEHNER)).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2013/02/26 09:51
S3	11	((RONALD) near2 (KEFFERSTEIN)).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2013/02/26 09:51
S4	0	("2013/0029172").URPN.	USPAT	OR	ON	2013/02/26 09:51
S5	9	("20030152796" | "3240269" | "5023113" | "6296805" | "6815087" | "7137201" | "7217331" | "7503116").PN. OR ("8307680").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2013/02/26 09:51
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S8	4	("3214820" | "6197132" | "6296805").PN. OR ("7708843").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2013/02/26 10:40
S9	16	("20010042393" | "20070082214" | "20070163685" | "20090242086" | "20090308499" | "20110006491" | "20110165436" | "4546051" | "6017643" | "6093498" | "6296805" | "6298905" | "6564604" | "6815087" | "7137201" | "7867344").PN. OR ("8066829").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2013/02/26 10:40
S10	1	("2003/0152796").URPN.	USPAT	OR	ON	2013/02/26 10:43
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S13	195	(("5209860") or ("8066829") or ("8066829") or ("8307680") or ("20110006491") or ("20110165436") or ("20110214475") or ("20120064362") or ("20130029172") or ("6564604") or ("20010042393") or ("20120118437") or ("4846986") or ("20120085467") or ("20080261058") or ("4601766") or ("5248528") or ("5456953") or ("5568914") or ("5830290") or ("20040118482") or ("5287983") or ("4880481") or ("4344342") or ("4963400") or ("4999241") or ("5342672") or ("5792180") or ("6070444") or ("4353765") or ("5982073") or ("6129790") or ("6165595") or ("3798406") or ("4033918") or ("4311755") or ("4488862") or ("4508755") or ("4514264") or ("4525177") or ("4551085") or ("4554765") or ("4585519") or ("4842887") or ("4994517") or ("5273369") or ("5389452") or ("5538576") or ("5542978") or ("5639510") or ("5697715") or ("5729616") or ("5801128") or ("5837314") or ("5869160") or ("6020026") or ("6019923") or ("6251514") or ("6258425") or ("6262513") or ("6309748") or ("6340397") or ("6342108") or ("20020014181") or ("20090025836") or ("20090048127") or ("4374168") or ("4309951") or ("5810332") or ("5795661") or ("8349098") or ("20020160235") or ("20020166606") or ("20100294400") or ("20110056594") or ("20110056594") or ("20120085466") or ("5981089") or ("6197125") or ("4793867") or ("4941930") or ("4980241") or ("5238506") or ("5405427") or ("5939144") or ("6090873") or ("6241393") or ("3859239") or ("3850684") or ("3850647") or ("4316751") or ("4347085") or ("4401719") or ("4402994") or ("4533606") or ("4592958") or ("4867853") or ("5232619") or ("5242506") or ("5290362") or ("5332776") or ("5466280") or ("5608028") or ("5643474") or ("5700551") or ("5743536") or	US-PGPUB; USPAT; USOCR	OR	OFF	2013/02/26 10:54

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S15	0	("2012/0085467").URPN.	USPAT	OR	ON	2013/02/26 10:55

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S17	1	("2011/0165436").URPN.	USPAT	OR	ON	2013/02/26 10:56
S18	1	("2011/0006491").URPN.	USPAT	OR	ON	2013/02/26 10:56
S19	8,085	((428/601,600,602,653) or (420/104,120,121,126) or (148/531,535,534,537,635,653) or (72/364,342.1,47) or (280/1)).CCLS.	US-PGPUB; USPAT; USOCR	OR	OFF	2013/02/26 11:01
S20	2,517	S19 and (steel ferrous) same (aluminum aluminium al)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2013/02/26 11:02
S21	304	S20 and (interdiffusion intermediate intermetallic superficial) near3 layer	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2013/02/26 11:03
S22	14	("20020068189" | "20020104876" | "20030012977" | "20030207769" | "20040028939" | "3195991" | "4957822" | "4973523" | "5112416" | "5362574" | "5384205" | "5470666" | "7074496").PN. OR ("8053087").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2013/02/26 12:13
S23	8,085	((428/601,600,602,653) or (420/104,120,121,126) or (148/531,535,534,537,635,653) or (72/364,342.1,47) or (280/1)).CCLS.	US-PGPUB; USPAT; USOCR	OR	OFF	2013/02/26 12:33
S24	286	S23 and (carbon c) same (manganese Mn) same (Silicon si) same (Chromium Cr) same (titanium ti) same (aluminum al) same (Phosphorus P) same (Sulfur Sulphur S) same (Boron B)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2013/02/26 12:33
S25	59	S24 and (aluminum aluminium al) near5 (pre-coat$4 precoat$4 layer coat$5)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2013/02/26 12:35
S26	0	("2010/0294400").URPN.	USPAT	OR	ON	2013/02/26 12:36
S27	2	("2001/0001049").URPN.	USPAT	OR	ON	2013/02/26 12:40
S28	8,224	((428/601,600,602,653) or (420/104,120,121,126) or	US-PGPUB; USPAT; USOCR	OR	OFF	2013/09/19 16:58

		(148/531,535,534,537,635,653) or (72/364,342.1,47) or (280/1)).CCLS.				
S29	456	S28 and (interdiffusion intermediate intermetallic superficial) near3 layer	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2013/09/19 16:58
S30	4	S29 and (strain near3 ratio)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2013/09/19 16:59
S31	36	S28 and (strain near3 ratio)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2013/09/19 16:59
S32	16	("20060134451" | "20070113936" | "20070166565" | "20070246509" | "20090020276" | "20090165901" | "20100101688" | "20100112370" | "20100183897" | "20110014494" | "20110240280" | "20110287276" | "20110287277" | "5037707" | "6019939" | "7387844").PN. OR ("8247082").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2013/09/19 16:59
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S34	13	("4673551" | "4906534" | "5037707" | "5100048").PN. OR ("6019939").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2013/09/19 17:00
S35	4	("2010/0112370").URPN.	USPAT	OR	ON	2013/09/19 17:00
S36	0	("2009/0252641").URPN.	USPAT	OR	ON	2013/09/19 17:00
S37	4	("4985196" | "4990545" | "5139832" | "6084849").PN. OR ("7060140").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2013/09/19 17:00
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S39	9	("4601766" | "5019191" | "5871851").PN. OR ("6129992").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2013/09/19 17:01
S40	4	("3795971" | "4455352" | "4956025").PN. OR ("5529644").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2013/09/19 17:01

S45	40	(("20010042393") or ("8127449") or ("7137201") or ("7708843") or ("20070163683") or ("20070175040") or ("3240269") or ("7503116") or ("7217331")).PN.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	OR	OFF	2017/03/10 08:29
S46	10	(("20010042393") or ("8127449") or ("7137201") or ("7708843") or ("20070163683") or ("20070175040") or ("3240269") or ("7503116") or ("7217331")).PN.	US-PGPUB; USPAT; USOCR	OR	OFF	2017/03/10 08:43
S47	4	("3214820" | "6197132" | "6296805").PN. OR ("7708843").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2017/03/10 08:48
S48	8,872	((428/601,600,602,653) or (420/104,120,121,126) or (148/531,535,534,537,635,653) or (72/364,342.1,47) or (280/1)).CCLS.	US-PGPUB; USPAT; USOCR	OR	OFF	2019/07/08 10:56
S49	540	S48 and (interdiffusion intermediate intermetallic superficial) near3 layer	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2019/07/08 10:56
S50	13,610	(C21D9/46 or C23C2/12 or C23C2/40 or C23C2/26 or B32B15/012 or Y10T428/12389 or Y10T428/12396 or Y10T428/12757).cpc.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2019/07/08 10:58
S51	977	S50 and (interdiffusion intermediate intermetallic superficial) near3 layer	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2019/07/08 11:00
S52	2	S51 and (strain near3 ratio)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2019/07/08 11:02
S53	15,184	(C21D9/46 or C23C2/12 or C23C2/40 or C23C2/26 or B32B15/012 or Y10T428/12389 or Y10T428/12396 or Y10T428/12757).cpc.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2020/07/06 12:06
S54	1,089	S53 and (interdiffusion intermediate intermetallic superficial) near3 layer	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2020/07/06 12:06

EAST Search History (Interference)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S41	5,246	(C21D9/46 B32B15/012 C23C2/12 C23C2/26 C23C2/40 Y10T428/12389 Y10T428/12396 Y10T428/12757).cpc.	US-PGPUB; USPAT	OR	ON	2016/12/02 11:46
S42	1,776	S41 and (aluminum aluminium al) near5 (pre-coat$4 precoat$4 layer coat$5)	US-PGPUB; USPAT	OR	ON	2016/12/02 11:46
S43	888	S41 and ((aluminum aluminium al) near5 (pre-coat$4 precoat$4 layer coat$5)).clm.	US-PGPUB; USPAT	OR	ON	2016/12/02 11:46
S44	136	S43 and ((interdiffusion intermediate intermetallic superficial) near3 layer).clm.	US-PGPUB; USPAT	OR	ON	2016/12/02 11:47
S55	7,654	(C21D9/46 B32B15/012 C23C2/12 C23C2/26 C23C2/40 Y10T428/12389 Y10T428/12396 Y10T428/12757).cpc.	US-PGPUB; USPAT	OR	ON	2020/07/06 11:17
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S57	202	S56 and ((interdiffusion intermediate intermetallic superficial) near3 layer).clm.	US-PGPUB; USPAT	OR	ON	2020/07/06 11:17

7/6/2020 12:08:38 PM
C:\Users\dschleis\Documents\EAST\Workspaces\16413799.wsp

Doc code: IDS
Doc description: Information Disclosure Statement (IDS) Filed

PTO/SB/08a (03-15)
Approved for use through 07/31/2016. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	16413799
Filing Date	2019-05-16
First Named Inventor	Drillet
Art Unit	1784
Examiner Name	TBD
Attorney Docket Number	20631.1028CON5

U.S.PATENTS Remove

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	7867344	B2	2011-01-11	Kusumi et al.	
	2					

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Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	20040238080	A1	2004-12-02	Vandeputte et al.	

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Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1	2004106573	WO	A1	2004-12-09	SUMITOMO METAL IND	See English translation	
	2	2833504	FR	A1	2003-06-20	Laurent et al.	See English translation	

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /DJS/

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	16413799
	Filing Date	2019-05-16
	First Named Inventor	Drillet
	Art Unit	1784
	Examiner Name	TBD
	Attorney Docket Number	20631.1028CON5

	3	1013785	FR	B1	2006-10-25	Laurent	See English translation	
	4	2006051543	JP	A	2006-02-23	Kusumi et al.	See English machine translation, also e.g. US 7867344	

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NON-PATENT LITERATURE DOCUMENTS Remove

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T5
	1	Mahesh C. Somani, et al., "Dimensional Changes and Microstructural Evolution in a B-bearing Steel in the Simulated Forming and Quenching Process," ISIJ International, 2001, Volume 41, Issue 4, Pages 361-367 ("Somani")	
	2	Declaration of Mel Desart, dated April 16, 2019, relating to attached "High Strength Steels for Automotive Safety Parts," SAE Technical Paper 2001-01-0078. 2001, by Cornette, D., Hourman, T., Hudin, O., Laurent, J., and Reynaert, A."	
	3	Declaration Dr. Michael Miles, dated June 28, 2019 as filed in IPR2019-01275, US Patent No. 9,708,683	
	4	Declaration of Mel Desart, dated May 30, 2019, relating to attached "High Strength Steels for Automotive Safety Parts," SAE 2001 Transactions Journal of Materials & Manufacturing-V110-5, by Corneae, D., Hourman, T., Hudin, 0., Laurent, J., and Reynaert, A."	
	5	Declaration of Dr. Michael L. Knott dated April 22, 2019 realting to attached Somani (Mahesh C. Somani, et al., "Dimensional Changes and Microstructural Evolution in a B-bearing Steel in the Simulated Forming and Quenching Process," ISIJ International, 2001, Volume 41, Issue 4, Pages 361-367 ("Somani")) from University of Michigan's Art, Architecture, and Engineering Library's Technical Services Department	
	6	Publication History from SAE Mobilus, dated May 30, 2019 for Cornette et al., "High Strength Steels for Automotive Safety Parts" SAE Technical Paper Series 2001-01-0078, March 24 001, ISSN: 0148-7191	
	7	Fekete, J., Stibich, A., and Shi, M., "A Comparison of the Response of HSLA and Dual Phase Sheet Steel in Dynamic Crush," SAE Technical Paper 2001-01-3101, 2001	

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	16413799
	Filing Date	2019-05-16
	First Named Inventor	Drillet
	Art Unit	1784
	Examiner Name	TBD
	Attorney Docket Number	20631.1028CON5

	8	Robert R. Mayer, "Theoretical Effects of Hydroforming on Crashworthiness of Straight Sections," ASME International Mechanical Engineering Congress and Exposition, Applied Mechanics (2004):591-603	
	9	Publication History from ISIJ International for "Mahesh C. Somani, et al., "Dimensional Changes and Microstructural Evolution in a B-bearing Steel in the Simulated Forming and Quenching Process," ISIJ International, 2001, Volume 41, Issue 4, Pages 361-367 ("Somani")"	
	10	Webster's New Twentieth Century Dictionary (2nd ed. 1964), published by The World Publishing Company	
	11	Random House Webster's Unabridged Dictionary (2nd ed. 1998), Random House New York	
	12	ASM Materials Engineering Dictionary, ASM INternational, The Materials Information Society, 1992	
	13	Dictionary of Materials and Manufacturing, Nichols Publishing: New York, 1990	
	14	McGraw-Hill Dictionary of Scientific and Technical Terms, Sixth Edition, 2003	
	15	Certified Translation of "alliation" and "alliage"	
	16	Ahindra Ghosh, "Secondary Steelmaking, Principles and Applications" (2001), CRC Press	
	17	Åkerström, P. et al., "Material parameter estimation for boron steel from simultaneous cooling and compression experiments," Modelling and Simulation in Materials Science and Engineering. 2005, Vol.13, No.8, p.1291	
	18	ASTM Dictionaly of Engineering Science & Technology, ASTM International 2005	

EFS Web 2.1.17

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /DJS/

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	16413799
	Filing Date	2019-05-16
	First Named Inventor	Drillet
	Art Unit	1784
	Examiner Name	TBD
	Attorney Docket Number	20631.1028CON5

	19	Chambers Dictionary of Science and Technology, Tenth edition, 1999	
	20	Webster's Third New International Dictionary of the English Language Unabridged, 2003	
	21	Engels, H. et al., "Controlling and Monitoring of the Hot-Stamping Process of Boron-Alloyed Heat-Treated Steels." – p. 135-50 ("Engels"), published in Liewald, M. (Ed.). "New developments in sheet metal forming": Frankfurt a.M.: MATINFO, Werkstoff-Informationsges (2006)	
	22	Declaration of Marcel Thoms of University of Stuttgart dated June 7, 2019 relating to attached "Engels, H. et al., "Controlling and Monitoring of the Hot-Stamping Process of Boron-Alloyed Heat-Treated Steels." – p. 135-50 ("Engels"), published in Liewald, M. (Ed.). "New developments in sheet metal forming": Frankfurt a.M.: MATINFO, Werkstoff-Informationsges (2006)"	
	23	Certified translation of "Stahl"	
	24	Preliminary Opinion issued on June 19, 2019 in opposition proceedings of European Patent Application 06842403.5	

If you wish to add additional non-patent literature document citation information please click the Add button Add

EXAMINER SIGNATURE

Examiner Signature	/Daniel J. Schleis/	Date Considered	07/06/2020

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	16413799
Filing Date	2019-05-16
First Named Inventor	Drillet
Art Unit	1784
Examiner Name	TBD
Attorney Docket Number	20631.1028CON5

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

See attached certification statement.

The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Jennifer L. O'Connell/	Date (YYYY-MM-DD)	2019-07-08
Name/Print	Jennifer L. O'Connell	Registration Number	57392

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6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

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ArcelorMittal Ex. 2001
Posco Co. LTD. v. ArcelorMittal
IPR2024-01376

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Doc code: IDS
Doc description: Information Disclosure Statement (IDS) Filed

PTO/SB/08a (03-15)
Approved for use through 07/31/2016. OMB 0651-0031
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	16413799
Filing Date	2019-05-16
First Named Inventor	Drillet
Art Unit	1784
Examiner Name	Schleis
Attorney Docket Number	20631.1028CON5

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99)**	Application Number	16413799
	Filing Date	2019-05-16
	First Named Inventor	Drillet
	Art Unit	1784
	Examiner Name	Schleis
	Attorney Docket Number	20631.1028CON5

	1	"Continuously hot-dip coated strip and sheet of strucutral steels - Technical delivery conditions," European Standard EN 10326, July 2004, NON-EN 10326

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EXAMINER SIGNATURE

Examiner Signature	/Daniel J. Schleis/	Date Considered	04/27/2020

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

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ArcelorMittal Ex. 2001
Posco Co. LTD. v. ArcelorMittal
IPR2024-01376

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

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Application Number	16413799
Filing Date	2019-05-16
First Named Inventor	Drillet
Art Unit	1784
Examiner Name	Schleis
Attorney Docket Number	20631.1028CON5

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☒ A certification statement is not submitted herewith.

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Signature	/williamcgehris/	Date (YYYY-MM-DD)	2020-01-06
Name/Print	William C. Gehris	Registration Number	38156

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Posco Co. LTD. v. ArcelorMittal
IPR2024-01376

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PTO/SB/06 (09-11)
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PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 16/413,799	Filing Date 05/16/2019	☐ To be Mailed

ENTITY: ☑ LARGE ☐ SMALL ☐ MICRO

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA		RATE ($)	FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A		N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A		N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A		N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*		x $100 =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*		x $460 =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).				
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))					
* If the difference in column 1 is less than zero, enter "0" in column 2.				TOTAL	

APPLICATION AS AMENDED - PART II

		(Column 1)		(Column 2)	(Column 3)			
AMENDMENT	01/08/2021	CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA		RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	* 30	Minus	** 30	= 0		x $100 =	0
	Independent (37 CFR 1.16(h))	* 3	Minus	*** 3	= 0		x $480 =	0
	☐ Application Size Fee (37 CFR 1.16(s))							
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							
							TOTAL ADD'L FEE	0

		(Column 1)		(Column 2)	(Column 3)			
AMENDMENT		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA		RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	*	Minus	**	=		x $0 =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=		x $0 =	
	☐ Application Size Fee (37 CFR 1.16(s))							
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							
							TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.	LIE
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".	/NICOLE LOVE HENSLEY/
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".	
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Doc code: RCEX
Doc description: Request for Continued Examination (RCE)

PTO/SB/30EFS (02-18)
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REQUEST FOR CONTINUED EXAMINATION(RCE)TRANSMITTAL
(Submitted Only via EFS-Web)

Application Number	16413799	Filing Date	2019-05-16	Docket Number (if applicable)	20631.1028CON5	Art Unit	1784
First Named Inventor	Pascal DRILLET			Examiner Name	SCHLEIS, DANIEL J		

This is a Request for Continued Examination (RCE) under 37 CFR 1.114 of the above-identified application.
Request for Continued Examination (RCE) practice under 37 CFR 1.114 does not apply to any utility or plant application filed prior to June 8, 1995, or to any design application. The Instruction Sheet for this form is located at WWW.USPTO.GOV

SUBMISSION REQUIRED UNDER 37 CFR 1.114

Note: If the RCE is proper, any previously filed unentered amendments and amendments enclosed with the RCE will be entered in the order in which they were filed unless applicant instructs otherwise. If applicant does not wish to have any previously filed unentered amendment(s) entered, applicant must request non-entry of such amendment(s).

☐ Previously submitted. If a final Office action is outstanding, any amendments filed after the final Office action may be considered as a submission even if this box is not checked.

- ☐ Consider the arguments in the Appeal Brief or Reply Brief previously filed on _____
- ☐ Other _____

☒ Enclosed

- ☒ Amendment/Reply
- ☒ Information Disclosure Statement (IDS)
- ☐ Affidavit(s)/ Declaration(s)
- ☐ Other _____

MISCELLANEOUS

☐ Suspension of action on the above-identified application is requested under 37 CFR 1.103(c) for a period of months _____ (Period of suspension shall not exceed 3 months; Fee under 37 CFR 1.17(i) required)

☐ Other _____

FEES

☒ **The RCE fee under 37 CFR 1.17(e) is required by 37 CFR 1.114 when the RCE is filed.**
The Director is hereby authorized to charge any underpayment of fees, or credit any overpayments, to Deposit Account No 500552

SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT REQUIRED

☒ Patent Practitioner Signature

Applicant Signature

ArcelorMittal Ex. 2001
Posco Co. LTD. v. ArcelorMittal
IPR2024-01376

PTO/SB/30EFS (02-18)
Approved for use through 11/30/2020. OMB 0651-0031
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Signature of Registered U.S. Patent Practitioner			
Signature	/williamcgehris/	Date (YYYY-MM-DD)	2021-01-08
Name	William C. Gehris	Registration Number	38156

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3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).

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6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

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Electronic Patent Application Fee Transmittal

Application Number:	16413799
Filing Date:	16-May-2019
Title of Invention:	Coated Steel Strips, Coated Stamped Products and Methods
First Named Inventor/Applicant Name:	Pascal DRILLET
Filer:	William C. Gehris/Simon Steiner
Attorney Docket Number:	20631.1028CON5

Filed as Large Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

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Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension - 3 months with $0 paid	1253	1	1480	1480
Miscellaneous:				
RCE- 1ST REQUEST	1801	1	1360	1360
		Total in USD ($)		**2840**

Electronic Acknowledgement Receipt

EFS ID:	41581760
Application Number:	16413799
International Application Number:	
Confirmation Number:	7637
Title of Invention:	Coated Steel Strips, Coated Stamped Products and Methods
First Named Inventor/Applicant Name:	Pascal DRILLET
Customer Number:	23280
Filer:	William C. Gehris/Simon Steiner
Filer Authorized By:	William C. Gehris
Attorney Docket Number:	20631.1028CON5
Receipt Date:	08-JAN-2021
Filing Date:	16-MAY-2019
Time Stamp:	11:45:10
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	DA
Payment was successfully received in RAM	$2840
RAM confirmation Number	E202118B45414923
Deposit Account	500552
Authorized User	Simon Steiner

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37 CFR 1.16 (National application filing, search, and examination fees)

37 CFR 1.17 (Patent application and reexamination processing fees)

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37 CFR 1.19 (Document supply fees)

37 CFR 1.20 (Post Issuance fees)

37 CFR 1.21 (Miscellaneous fees and charges)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Foreign Reference	DE19749706wtranslation.pdf	435020 0acbd07871f1be79d37532de1e8fb46a401cdeac	no	10
Warnings:					
Information:					
2	Foreign Reference	EP919.PDF	590302 7956f475505af853e2d6c706b2c79ef10683b8da	no	9
Warnings:					
Information:					
3	Foreign Reference	CA2573226A1.pdf	3436169 2f414e0096772910ca709ef408ce81936f765885	no	23
Warnings:					
Information:					
4	Foreign Reference	EP549.PDF	1082648 4365fd2bd6295b95981831bf6a095b719d386638	no	21
Warnings:					
Information:					
5	Foreign Reference	EP314.PDF	691250 5c88138002e67ca3aca8d7d82ffdff64f6e62ee6	no	19
Warnings:					
Information:					
6	Foreign Reference	FR079FF.pdf	641254 66df71ce2f7c3ee1016e34d39985b7fe7d2f6d75	no	18
Warnings:					
Information:					

7	Foreign Reference	AU622697B2.pdf	4037030 69544783454ef9ea5c71e94e8225ca076e0df78e	no	25
Warnings:					
Information:					
8	Foreign Reference	JP037FF0001.PDF	926244 3f804da7a6170632e9878ac6fb89674ea33f3e2a	no	16
Warnings:					
Information:					
9	Non Patent Literature	StahlundEisen120.pdf	1958384 f61797214b2fbb05113ea5fc644bd2a95947aae1	no	7
Warnings:					
Information:					
10	Non Patent Literature	EmpiricalFormulaefortheCalculationofSomeTransformationTemperatures.pdf	1427555 97966ff782828aa64b59817987c34a4ff2cc0362	no	7
Warnings:					
Information:					
11	Non Patent Literature	16413825.pdf	146432 64f3e7e5265481a26f8adc60baa3bff8dbadf361	no	1
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13	Non Patent Literature	GokhaleReportonquantitative.pdf	619989 8d62118198d15455a716f7604fc99d665a74464f	no	6
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14	Non Patent Literature	Summons09701846.pdf	2977220 640452c08febc14075ee304f843167bd0ea908dc	no	21
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15	Non Patent Literature	BourougaReportibheating.pdf	1129784 81e7ff805aa75aba57452548930bb68dcb8c8264	no	11
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16	Non Patent Literature	MasayukiHeatingandCooling.pdf	4926491 6c640894dc1354731a1181c95fc05bc949b523d2	no	22
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17	Non Patent Literature	KolleckInvestigation.pdf	1093474 e826a85b15f33a6c265fa6483d0fe5cc0fb3a857	no	4
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19	Non Patent Literature	WEIFANFormation.pdf	1923468 57e4929d44e629bef5e34cec56c2ec41e29caf7e	no	6
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20	Foreign Reference	EP7004ff.pdf	6932 a8cf268dcc466ed594b43ef3e0d978f6b5d34088	no	2
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21	Information Disclosure Statement (IDS) Form (SB08)	IDSJan2021ff.PDF	1037121 2abbf215a93c7f7966ee13c52a864db0713745f5	no	6
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	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Response After Final Action	1	1
	Claims	2	7
	Applicant Arguments/Remarks Made in an Amendment	8	14

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Information:					
27	Request for Continued Examination (RCE)	RCE.PDF	1349952 9abc7f77d7a11efe0d32eaec2bcc244529e1c900	no	3
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Information:					
			Total Files Size (in bytes):	72064781	

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New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

Espacenet

Bibliographic data: DE19749706 (C1) — 1999-03-04

Producing hot rolled thin steel strip

Inventor(s): KIRCHER WERNER DIPL ING [DE] ± (KIRCHER, WERNER, DIPL.-ING., 40882 RATINGEN, DE)

Applicant(s): MANNESMANN AG [DE] ± (MANNESMANN AG, 40213 DUESSELDORF, DE)

Classification: - **international:** ***B21B1/24; B21B1/46;*** *B21B37/26;* (IPC1-7): B21B1/24; B21B1/46
- **cooperative:** **B21B1/24 (EP); B21B1/466 (EP);** B21B2201/02 (EP); B21B2201/04 (EP); B21B37/26 (EP)

Application number: DE19971049706 19971031

Priority number(s): DE19971049706 19971031

Abstract of DE19749706 (C1)

A first length of a strip to be coiled is rolled by a reduced number of roll stands to a thickness above 1 mm. By addition of further roll stands of the finish rolling section, a second and possibly further lengths of the coil are rolled at an increased speed to a strip with a final thickness less than 1 mm and down to as far as 0.8 mm. Subsequently, during a recoiling operation, the strip lengths with different thicknesses are separated.

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DESCRIPTION DE19749706C1

10 The invention relates to a method for the production of thin hot-rolled steel strip with a final thickness <1 mm from strip-shaped cast pre-material in successive steps, in which the solidified pre-material leaving the casting plant is divided into pre-strip lengths and heated to rolling temperature in a continuous furnace to convert it into a multi-stand Roll out the finishing train in a temperature-controlled manner and then wind it up into a coil.

15 Such a method is known from DE 195 40 978 A1.

16 Hot-rolled steel strip is produced, for example, in such a way that a cast semi-finished product, the weight of which is determined by the subsequent coil weight of the finished product, is reshaped to the desired geometric dimensions by one or more rolling processes. Usually these processes run one after the other and not simultaneously. It is only in the recent past that fully continuous or semicontinuous casting and rolling systems have increasingly been proposed. Although such systems were mentioned very early in the literature, it was always pointed out that these configurations can hardly be used in practice, since the parameters necessary for setting the desired strip properties could not be represented at that time.

24 In connection with single-strand systems, so-called semi-endless rolling has already been proposed, in which case long slabs are fed to a rolling mill via correspondingly long roller hearth furnaces. The slab is only divided into individual strips after the rolling mill. With this technology it is possible to roll several coils of very thin strips (0.8 mm) from relatively thick slabs at high speed (20 m / s). However, this high speed can only be achieved if the strip is clamped between the stands and the reel.

30 The introduction of the beginning of the strip into the last stands of the finishing line and the transport of the beginning of the strip over the outfeed roller table to the reel can only take place at a much lower speed, a maximum of 10 to 12 m / s. In particular, when very thin and slightly cooling strips are to be rolled at austenitic temperatures, there are problems with the high rolling speeds of the thin hot strips on the run-out roller table due to the continuous law and when the strips are threaded into the rolling stands.

36 The object of the present invention is to propose a method for the production of thin hot-rolled steel strip with which thin strips can be rolled austenitically at high speeds and then coiled into

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coils and in which the threading of these strips into the rolling stands and into the reel also occurs small tape thickness is made possible.

40 To solve the problem, based on the features specified in the preamble of claim 1, the invention proposes that a first strip length range of the coil to be wound is rolled into a strip with a thickness> 1 mm on a reduced number of stands of the finishing train, that by connecting additional stands the finishing train, a second and possibly further strip length areas of the coil is reduced at increased rolling speed to a strip with a final thickness <1 mm to 0.8 mm, and that in a later wrapping process of the coil, the strip length areas of different thicknesses are separated.

47 The proposed method enables the rolling of 0.8 mm thick finished strip in the austenitic temperature range by grading the strip thickness. Because the first strip length area is rolled with a greater thickness and correspondingly lower speed on a reduced number of roll stands, there are no problems with threading and winding the head area of this strip on the reel system. Threading the relatively thick strip into the last finishing stands and transporting it over the outfeed roller table is also not problematic, because the thicker strip is still sufficiently rigid. Only after a preselected strip length range has been reeled in is the strip reduced further by adding additional stands to the finishing train, which also increases the rolling speed. The now further reduced, preferably rolled out to 0.8 mm thick strip is coiled on the same reel as the previous strip length; a separation of the differently thick band length areas is only carried out during a later wrapping process of the coil.

58 According to the invention, it is thus easily possible to roll strips of different thickness graded strips from one and the same thin slab, which are later separated depending on the customer's request and / or the rolling program.

61 Preferably, in one embodiment of the invention, the first strip length range of the coil to be wound is rolled to a thickness of approx.1.5 mm in a maximum of six stands of the finishing train, the rest of the coil is graded after connecting additional stands or completely in any smaller thickness with the This thickness and the temperature of the rolled strip adjusted rolling speed rolled to the final thickness.

66 In order to specifically solve the problem of starting the tape, it is proposed in a further embodiment of the invention that the first tape length range of the coil to be wound is rolled at low speed and in such a length that the head of the tape is inserted into the reel and Strip tension is built up between the reel and the finishing train, that after increasing the speed and reducing the strip thickness, the remaining coil length is rolled, and that the thickened head piece is cut off when the strip is wrapped around. In this way, a lost starting piece is created that can be cut off on a separate rewinding system, but the method enables a very thin strip to be rolled out at very high speeds after the head of the strip has run into the reel.

74 According to a further feature of the invention, complete recrystallization of the material is achieved by a correspondingly large distance between the first and second finishing stands.

76 The process is suitable for two-stage rolling in the finishing train, with austenitic rolling in the first finishing stand and exclusively ferritic rolling in the further finishing stands, and targeted cooling of the strip between the first and second rolling stands.

79 If a long roller hearth furnace (up to 100 m) is used, high specific coil weights can be achieved.

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With the winding of the tape according to the invention, the output losses due to the severing of the head piece are avoided if a partial length of a thicker tape that can be sold is wound up at the beginning of the coil. Large coil weights reduce the frequency with which the beginning of the strip is cropped, so that cropping losses can be kept low even if a thicker length of strip is only produced for winding the strip onto the reel.

85 An embodiment of a casting and rolling plant according to the invention is shown in the drawing figures and is explained below:

87 1 shows a single-strand casting installation on which the method according to the invention can be carried out,

89 With the same system configuration, FIG. 2 shows a two-strand casting system with transverse slab transport.

91 In Fig. 1, 1 denotes the ladle turret, which supplies the casting machine numbered with 2 of a continuous sheet caster with melt. A length of approx. 100 m is cut from the pre-strip cast in the mold by means of the pendulum shears 3 after it has entered the roller hearth furnace 4. The pre-strip is then introduced into the first finishing stand 5 and rolled there austenitically before it is pierced into the other stands of the finishing train 7. The rolled strip leaves the finishing train 7 and runs over the run-out roller table with strip cooling to the reel 9, where it is wound into a coil. As proposed in the invention, a clear distance is provided between the first finishing stand 5 and the first stand of the finishing train 7, which makes a complete recrystallization of the material between these two stands possible. In addition, by installing a strip cooling system between these stands, ferritic rolling is also possible, with an austenitic structure then still being present in the first finishing stand 5 and a ferritic structure in the finishing stands of the finishing train 7.

102 The stands of the finishing train 7 can be switched on and off individually so that work can be carried out according to the proposal of the invention.

104 The system in Fig. 2 differs from that in Fig. 1 only in that the casting machine 2, the pendulum shear 3 and the furnace 4 are present twice, the only finishing line being served by lateral displacement of slabs cut to length via a slab transverse transport can.

107 The inventive method can be carried out on the system shown, for example, as follows: The pre-strip leaving the roller hearth furnace with a length of approx. 100 m becomes a strip with a thickness of in the first finishing stand 5 and at the same time in the following five stands of the finishing line 7 rolled out approx. 1.5 mm. As soon as the strip rolled in this way has reached the reel 9 via the run-out roller table 8 and has been wound up there, the strip is further reduced to 0.8 mm in thickness, for example, by connecting the last stand of the finishing train 7, thereby increasing the run-out speed of the strip The outfeed roller table is unproblematic because the strip is clamped between the finishing train 7 and the reel 9 and the very thin strip can therefore be rolled out at extremely high speeds. When the cooling device 6 is used between the first finishing stand and the finishing train 7, ferritic rolling can be carried out on the thin strip at high speeds and thus a two-stage rolling process can be carried out.

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CLAIMS DE19749706C1

1.

13 Process for the production of thin hot-rolled steel strip with a final thickness <1 mm from strip-shaped cast raw material in successive steps, in which the solidified raw material leaving the casting plant is divided into pre-strip lengths and heated to rolling temperature in a continuous furnace in order to roll it out in a temperature-controlled multi-stand finishing train and then wind it up to form a coil, characterized in that a first strip length range of the coil to be wound is rolled into a strip with a thickness> 1 mm on a reduced number of stands of the finishing train, that by connecting further stands of the finishing train, a second and possibly further strip length areas of the coil is reduced with increased rolling speed to a strip with a final thickness <1 mm to 0.8 mm and that in a later wrapping process of the coil, the strip length areas of different thicknesses are separated .

2.

26 Process for the production of thin hot-rolled steel strip according to claim 1, characterized in that the first strip length range of the coil to be wound is rolled to a thickness of approx. 1.5 mm in a maximum of six stands of the finishing train and the rest of the coil is graded or graded after additional stands are connected is completely rolled in any thickness with the respective thickness and the temperature of the rolled strip adjusted rolling speed to the final thickness.

3.

34 A method for producing thin hot-rolled steel strip according to claim 1 or 2, characterized in that the first strip length range of the coil to be wound is rolled at low speed and in such a length that the head of the strip is inserted into the reel and the strip is pulled between the reel and The finishing mill is constructed so that after increasing the speed and reducing the strip thickness

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the remaining coil length is rolled and that the thickened head piece is cut off when the strip is wrapped around.

4.

43 Process for the production of thin, hot-rolled steel strip according to one of Claims 1 to 3, characterized in that a complete recrystallization of the strip takes place with a corresponding distance between the first and the second roll stand.

5.

49 Process for the production of thin hot-rolled steel strip according to one of Claims 1 to 4, characterized in that rolling is carried out in two stages in the finishing train, with austenitic rolling in the first finishing stand and exclusively ferritic rolling in the further finishing stands and a targeted one between the first and second rolling stands The belt is cooled down.

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(12) **Patentschrift**

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Innerhalb von 3 Monaten nach Veröffentlichung der Erteilung kann Einspruch erhoben werden

(73) Patentinhaber:
Mannesmann AG, 40213 Düsseldorf, DE

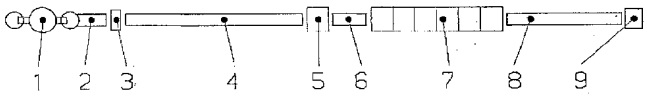
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(72) Erfinder:
Kircher, Werner, Dipl.-Ing., 40882 Ratingen, DE

(56) Für die Beurteilung der Patentfähigkeit in Betracht gezogene Druckschriften:
DE 1 95 40 978 A1

(54) Verfahren zur Herstellung von dünnem warmgewalztem Stahlband

(57) Die Erfindung betrifft ein Verfahren zur Herstellung von dünnem warmgewalzten Stahlband mit einer Enddicke < 1 mm aus bandförmig gegossenem Vormaterial in aufeinander folgenden Schritten, bei dem das die Gießanlage verlassende erstarrte Vormaterial in Vorbandlängen aufgeteilt und in einem Durchlaufofen auf Walztemperatur erwärmt wird, um es in einer mehrgerüstigen Fertigstraße temperaturgesteuert auszuwalzen und im Anschluß daran zu einem Coil aufzuwickeln. Dabei wird ein erster Bandlängenbereich des aufzuwickelnden Coil auf einer reduzierten Anzahl von Gerüste der Fertigstraße zu einem Band mit einer Dicke > 1 mm gewalzt, dann wird durch Zuschalten weiterer Gerüste der Fertigstraße ein zweiter und gegebenenfalls weitere Bandlängenbereiche des Coils mit erhöhter Walzgeschwindigkeit zu einem Band mit einer Dicke < 1 mm bis 0,8 mm reduziert und bei einem später erfolgenden Umwickelvorgang des Coils wird eine Auftrennung der Bandlängenbereiche unterschiedlicher Dicke vorgenommen.



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Beschreibung

Die Erfindung betrifft ein Verfahren zur Herstellung von dünnem warmgewalzten Stahlband mit einer Enddicke < 1 mm aus bandförmig gegossenem Vormaterial in aufeinanderfolgenden Schritten, bei dem das die Gießanlage verlassende erstarrte Vormaterial in Vorbandlängen aufgeteilt und in einem Durchlaufofen auf Walztemperatur erwärmt wird, um es in einer mehrgerüstigen Fertigstraße temperaturgesteuert auszuwalzen und im Anschluß daran zu einem Coil aufzuwickeln.

Ein derartiges Verfahren ist aus der DE 195 40 978 A1 bekannt.

Die Herstellung von warmgewalztem Stahlband erfolgt beispielsweise derart, daß ein gegossenes Halbzeug, dessen Gewicht durch das spätere Bundgewicht des Fertigproduktes bestimmt ist, durch einen oder mehrere Walzprozesse auf die gewünschten geometrischen Abmessungen umgeformt wird. Üblicherweise laufen diese Prozesse hintereinander und nicht simultan ab. Erst in der jüngeren Vergangenheit werden vermehrt vollkontinuierlich oder semikontinuierlich arbeitende Gieß-Walzanlagen vorgeschlagen. Zwar sind derartige Anlagen in der Literatur schon sehr früh erwähnt worden, es wurde jedoch stets darauf verwiesen, daß diese Konfigurationen praktisch kaum anwendbar sind, da die zur Einstellung der gewünschten Bandeigenschaften notwendigen Parameter zur damaligen Zeit nicht dargestellt werden konnten.

Im Zusammenhang mit Einstranganlagen ist bereits eine sogenannte Semi-Endloswalzung vorgeschlagen worden, dabei werden lange Brammen über entsprechend lange Rollenherdöfen einem Walzwerk zugeführt. Die Unterteilung der Bramme in einzelne Bänder erfolgt erst hinter dem Walzwerk. Bei dieser Technik besteht die Möglichkeit, aus relativ dicken Brammen mehrere Coils sehr dünner Bänder (0,8 mm) mit hoher Geschwindigkeit (20 m/s) zu walzen. Diese hohe Geschwindigkeit kann aber nur dann gefahren werden, wenn das Band zwischen Gerüsten und Haspel eingespannt ist.

Das Einführen des Bandanfanges in die letzten Gerüste der Fertigstraße sowie der Transport des Bandanfanges über den Auslaufrollgang zum Haspel kann nur mit wesentlich geringerer Geschwindigkeit, maximal 10 bis 12 m/s erfolgen. Insbesondere dann, wenn sehr dünne und leicht abkühlende Bänder bei austenitischen Temperaturen gewalzt werden sollen, gibt es Probleme bei den aufgrund des Konti-Gesetzes hohen Walzgeschwindigkeiten der dünnen Warmbänder auf dem Auslaufrollgang sowie beim Einfädeln der Bänder in die Walzgerüste.

Aufgabe der vorliegenden Erfindung ist es, ein Verfahren zur Herstellung von dünnem warmgewalzten Stahlband vorzuschlagen, mit dem dünne Bänder mit hohen Geschwindigkeiten austenitisch gewalzt und im Anschluß zu Bunden aufgecoilt werden können und bei dem das Einfädeln dieser Bänder in die Walzgerüste und in den Haspel auch bei geringer Banddicke ermöglicht wird.

Zur Lösung der Aufgabe wird ausgehend von den im Oberbegriff des Anspruchs 1 angegebenen Merkmalen erfindungsgemäß vorgeschlagen, daß ein erster Bandlängenbereich des aufzuwickelnden Coils auf einer reduzierten Anzahl von Gerüsten der Fertigstraße zu einem Band mit einer Dicke > 1 mm gewalzt wird, daß durch Zuschalten weiterer Gerüste der Fertigstraße ein zweiter und gegebenenfalls weitere Bandlängenbereiche des Coils mit erhöhter Walzgeschwindigkeit zu einem Band mit einer Enddicke < 1 mm bis 0,8 mm reduziert wird, und daß bei einem später erfolgenden Umwickelvorgang des Coils eine Auftrennung der Bandlängenbereiche unterschiedlicher Dicke vorgenommen wird.

Das vorgeschlagene Verfahren ermöglicht das Walzen von 0,8 mm dickem Fertigband in austenitischem Temperaturbereich durch Abstufung der Banddicke. Weil der erste Bandlängenbereich mit einer größeren Dicke und entsprechend geringerer Geschwindigkeit auf einer reduzierten Anzahl von Walzgerüsten angewalzt wird, bestehen keine Probleme beim Einfädeln und Anwickeln des Kopfbereiches dieses Bandes auf der Haspelanlage. Das Einfädeln des relativ dicken Bandes in die letzten Fertiggerüste und der Transport über den Auslaufrollgang ist ebenfalls nicht problematisch, weil das dickere Band noch genügende Steifigkeit aufweist. Erst nach Anhaspeln eines vorgewählten Bandlängenbereichs wird durch Zuschalten zusätzlicher Gerüste der Fertigstraße eine weitere Reduzierung des Bandes vorgenommen, wodurch auch die Walzgeschwindigkeit erhöht wird. Das nunmehr weiter reduzierte, vorzugsweise bis auf 0,8 mm dicke ausgewalzte Band wird auf dem gleichen Haspel wie die vorherige Bandlänge aufgecoilt; eine Trennung der unterschiedlich dicken Bandlängenbereiche wird erst bei einem späteren Umwickelvorgang des Coils vorgenommen. Nach der Erfindung ist es somit leicht möglich, auf ein und derselben Anlage aus ein und derselben Dünnbramme unterschiedlich in ihrer Dicke abgestufte Bänder zu walzen, die später je nach Kundenwunsch und/oder Walzprogramm getrennt werden.

Vorzugsweise wird in einer Ausgestaltung der Erfindung der erste Bandlängenbereich des aufzuwickelnden Coils in maximal sechs Gerüsten der Fertigstraße auf eine dicke von ca. 1,5 mm gewalzt, der Rest des Coils wird nach Zuschalten weiterer Gerüste abgestuft oder komplett in jeder beliebigen geringeren Dicke mit der dieser Dicke und der Temperatur des gewalzten Bandes angepaßter Walzgeschwindigkeit auf die Enddicke gewalzt.

Um speziell das Problem des Anwickelns des Bandes zu lösen, ist in einer weiteren Ausgestaltung der Erfindung vorgeschlagen, daß der ersten Bandlängenbereich des aufzuwickelnden Coils bei niedriger Geschwindigkeit so lange und in einer solchen Länge gewalzt wird, bis der Kopf des Bandes in den Haspel eingeführt und Bandzug zwischen Haspel und Fertigstraße aufgebaut ist, daß nach Erhöhung der Geschwindigkeit und Reduzierung der Banddicke die restliche Coillänge gewalzt wird, und daß bei einem Umwickelvorgang des Bandes das verdickte Kopfstück abgetrennt wird. Auf diese Weise entsteht zwar ein verlorenes Anfangsstück, das auf einer separaten Umwickelanlage abgetrennt werden kann, doch ermöglicht das Verfahren nachdem der Kopf des Bandes im Haspel eingelaufen ist das Auswalzen eines sehr dünnen Bandes mit sehr hohen Geschwindigkeiten,.

Durch einen entsprechend großen Abstand zwischen dem ersten und dem zweiten Fertiggerüst wird nach einem weiteren Merkmal der Erfindung eine vollständige Rekristallisation des Materials erreicht.

Das Verfahren eignet sich zur zweistufigen Walzung in der Fertigstraße, wobei im ersten Fertiggerüst austenitisch und in den weiteren Fertiggerüsten ausschließlich ferritisch gewalzt wird und zwischen dem ersten und zweiten Walzgerüst eine gezielte Abkühlung des Bandes vorgenommen wird.

Wenn ein langer Rollenherdofen (bis 100 m) eingesetzt wird, können hohe spezifische Coilgewichte erreicht werden. Mit dem erfindungsgemäßen Anwickeln des Bandes werden die Ausbringungsverluste durch Abtrennen des Kopfstückes vermieden, wenn eine Teillänge eines verkaufsfähigen dickeren Bandes am Anfang des Coils aufgewickelt wird. Große Coilgewichte reduzieren die Häufigkeit des Schopfens des Bandanfanges, so daß selbst dann, wenn

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eine dickere Bandlänge nur zum Anwickeln des Bandes auf dem Haspel hergestellt wird, die Schopfverluste gering zu halten sind.

Ein Ausführungsbeispiel einer erfindungsgemäßen Gieß- und Walzanlage ist in Zeichnungsfiguren dargestellt und wird nachfolgend erläutert:

Fig. 1 zeigt eine einsträngige Gießanlage, auf der das erfindungsgemäße Verfahren durchgeführt werden kann,

Fig. 2 zeigt bei gleicher Anlagenkonfiguration eine zweisträngige Gießanlage mit Brammenquertransport.

In **Fig.** 1 ist mit **1** der Pfannendrehturm bezeichnet, der die mit 2 bezifferte Gießmaschine einer Bogenstranggießanlage mit Schmelze versorgt. Von dem in der Kokille gegossenen Vorband wird eine Länge von ca. 100 m mittels der Pendelschere **3** abgetrennt, nachdem sie in den Rollenherdhofen **4** eingelaufen ist. Das Vorband wird sodann in das erste Fertiggerüst **5** eingeführt und dort austenitisch gewalzt, bevor es in die weiteren Gerüste der Fertigstraße **7** angestochen wird. Das gewalzte Band verläßt die Fertigstraße **7** und läuft über den Auslaufrollgang mit Bandkühlung zum Haspel **9**, wo es zu einem Coil aufgewickelt wird. Wie in der Erfindung vorgeschlagen, ist zwischen dem ersten Fertiggerüst **5** und dem ersten Gerüst der Fertigstraße **7** ein deutlicher Abstand vorgesehen, der eine vollständige Rekristallisierung des Materials zwischen diesen beiden Gerüsten möglich macht. Zusätzlich ist durch den Einbau einer Bandkühlung zwischen diesen Gerüsten auch ferritisches Walzen möglich, wobei dann im ersten Fertiggerüst **5** noch austenitisches und in den Fertiggerüsten der Fertigstraße **7** ferritisches Gefüge vorliegt. Die Gerüste der Fertigstraße **7** sind einzeln zu- und abschaltbar, so daß nach dem Vorschlag der Erfindung gearbeitet werden kann.

Die Anlage in **Fig.** 2 unterscheidet sich von der in **Fig.** 1 nur dadurch, daß die Gießmaschine **2**, die Pendelschere **3** und der Ofen **4** doppelt vorhanden sind, wobei durch seitliches Verschieben von in Länge geschnittenen Brammen über einen Brammenquertransport die einzige Fertigstraße bedient werden kann.

Das erfindungsgemäße Verfahren läßt sich auf der dargestellten Anlage beispielsweise wie folgt durchführen: Das den Rollenherdofen verlassende Vorband mit einer Länge von ca. 100 m wird in dem ersten Fertiggerüst **5** und gleichzeitig in den nachfolgenden fünf Gerüsten der Fertigstraße **7** zu einem Band mit einer Dicke von ca. 1,5 mm ausgewalzt. Sobald das so gewalzte Band über den Auslaufrollgang **8** den Haspel **9** erreicht und dort angewickelt worden ist, wird durch Zuschalten des letzten Gerüstes der Fertigstraße **7** eine weitere Reduzierung des Bandes auf beispielsweise 0,8 mm Dicke durchgeführt, dabei erhöht sich die Auslaufgeschwindigkeit des Bandes auf dem Auslaufrollgang unproblematisch, weil das Bandes zwischen der Fertigstraße **7** und dem Haspel **9** eingespannt ist und somit das sehr dünne Band mit extrem hohen Geschwindigkeiten ausgewalzt werden kann. Bei Einsatz der Kühlvorrichtung **6** zwischen dem ersten Fertigwalzgerüst und der Fertigstraße **7** läßt sich bei dem Dünnband ein ferritisches Walzen mit hohen Geschwindigkeiten durchführen und somit ein zweistufiger Walzprozeß ausführen.

Patentansprüche

1. Verfahren zur Herstellung von dünnem warmgewalzten Stahlband mit einer Enddicke < 1 mm aus bandförmig gegossenem Vormaterial in aufeinander folgenden Schritten, bei dem das die Gießanlage verlassende erstarrte Vormaterial in Vorbandlängen aufgeteilt und in einem Durchlaufofen auf Walztemperatur erwärmt wird, um es in einer mehrgerüstigen Fertigstraße temperaturgesteuert auszuwalzen und im Anschluß daran zu einem Coil aufzuwickeln, **dadurch gekennzeichnet**, daß ein erster Bandlängenbereich des aufzuwickelnden Coils auf einer reduzierten Anzahl von Gerüste der Fertigstraße zu einem Band mit einer Dicke > 1 mm gewalzt wird, daß durch Zuschalten weiterer Gerüste der Fertigstraße ein zweiter und gegebenenfalls weitere Bandlängenbereiche des Coils mit erhöhter Walzgeschwindigkeit zu einem Band mit einer Enddicke < 1 mm bis 0,8 mm reduziert wird und daß bei einem später erfolgenden Umwickelvorgang des Coils eine Auftrennung der Bandlängenbereiche unterschiedlicher Dicke vorgenommen wird.

2. Verfahren zur Herstellung von dünnem warmgewalzten Stahlband nach Anspruch 1, dadurch gekennzeichnet, daß der erste Bandlängenbereich des aufzuwickelnden Coils in maximal sechs Gerüsten der Fertigstraße auf eine Dicke von ca. 1,5 mm gewalzt wird und der Rest des Coils nach Zuschalten weiterer Gerüste abgestuft oder komplett in jeder beliebigen Dicke mit der jeweiligen Dicke und der Temperatur des gewalzten Bandes angepaßter Walzgeschwindigkeit auf die Enddicke gewalzt wird.

3. Verfahren zur Herstellung von dünnem warmgewalzten Stahlband nach Anspruch 1 oder 2, dadurch gekennzeichnet, daß der erste Bandlängenbereich des aufzuwickelnden Coils bei niedriger Geschwindigkeit so lange und in einer solchen Länge gewalzt wird, bis der Kopf des Bandes in den Haspel eingeführt und Bandzug zwischen Haspel und Fertigstraße aufgebaut ist, daß nach Erhöhung der Geschwindigkeit und Reduzierung der Banddicke die restliche Coillänge gewalzt wird und daß bei einem Umwickelvorgang des Bandes das verdickte Kopfstück abgetrennt wird.

4. Verfahren zur Herstellung von dünnem warmgewalzten Stahlband nach einem der Ansprüche 1 bis 3, dadurch gekennzeichnet, daß bei entsprechendem Abstand zwischen dem ersten und dem zweiten Walzgerüst eine vollständige Rekristallisierung des Bandes erfolgt.

5. Verfahren zur Herstellung von dünnem warmgewalzten Stahlband nach einem der Ansprüche 1 bis 4, dadurch gekennzeichnet, daß in der Fertigstraße zweistufig gewalzt wird, wobei im ersten Fertiggerüst austenitisch und in den weiteren Fertiggerüsten ausschließlich ferritisch gewalzt wird und zwischen dem ersten und dem zweiten Walzgerüst eine gezielte Abkühlung des Bandes vorgenommen wird.

Hierzu 1 Seite(n) Zeichnungen

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FIG. 1

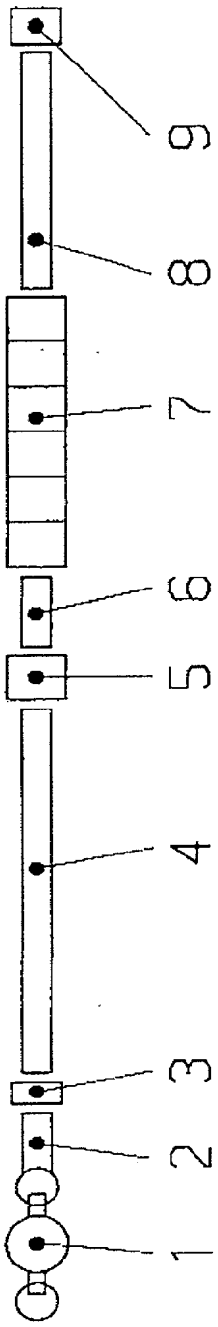
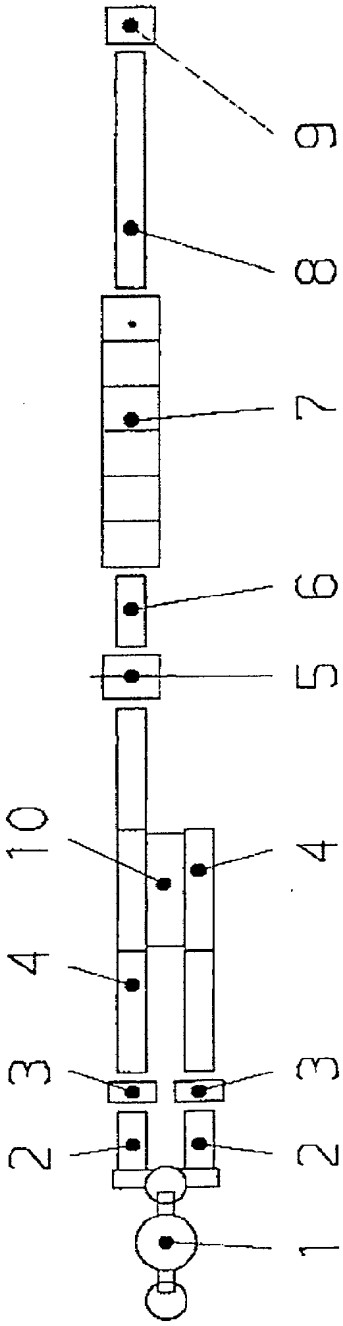


FIG. 2



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(54) **Method for descaling and cold rolling metal strip**

Verfahren zum Entzundern und Kaltwalzen von Metallband

Procédé pour le décalaminage et le laminage à froid de bandes métalliques

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Description

[0001] This invention relates to a method and apparatus for the descaling and subsequent cold-rolling of metal strip, particularly but not exclusively steel sheet in the form of strip.

[0002] In the making of steel strip, there is a descaling step for removing rust (or scale) from the surface of a hot coil and a cold rolling step for reducing the strip to a predetermined thickness. The descaling step has had its efficiency improved by combining a chemical method (e.g. pickling) and a mechanical method. On the other hand, the cold rolling step is exemplified by either a reversing mill for rolling multiple passes reversibly, or by a tandem mill system for rolling in one pass in one direction through a plurality of rolling machines.

[0003] Many existing general plants perform the descaling step and the cold rolling step discontinuously. Since the descaling step employs a continuous line passing hot coils sequentially, an expensive welder is arranged at the entrance side of the descaler. In order to prevent interruption of the line during the welding, moreover, a long accumulator (looper) and a long pickling tank are provided. Since, moreover, the pickled coil has to be fed to the cold rolling mill line, the pickled coil is divided again at the exit of the pickling equipment so that it may be sized suitably for the transfer and storage in the factory, until it is taken up for cold rolling. Between the pickling equipment and the cold rolling mill line, there may be a wide coil yard for absorbing the difference between the production schemes of the two equipments. This yard is equipped with facilities for transferring, storing and managing the coils.

[0004] An alternative approach has already been practiced using continuous pickling and cold rolling equipment, in which the pickling equipment and the tandem mill are directly connected.

[0005] With the aim of obtaining benefit from use of a single multi-pass reversing roll mill, it has been proposed to employ large size coils, composed of a strip having a length several times, e.g. five times, that of the normal transportable coil. JP-B-57-39844 (US-A-4 123 011) shows a welder for joining short coils, after which the strip is wound into a large size coil. The welding line stops when the large size coil is completed, and this coil is then unwound through a Sendzimir mill. Multi-pass rolling through this mill takes place, rewinding at each end being onto further drums. The final rolling pass leads to rewinding into the small coils, with shears subdividing the strip. The function of the large coil is to achieve a high yield and high production capacity of the reversing mill, by minimizing the periods of acceleration and deceleration of the mill and of threading the strip. Yield is also increased. However, this document does not concern itself with the combination of a descaler and a mill.

[0006] Another use of such large size coils, for a different purpose, is shown by JP-B-59-52710 (JP-A-54-58664). This discloses a line having a welder, an accumulator, a descaler, shears and large size coils on a pair of interchangeable drums. A single pass tandem mill is fed from the large coils alternatingly and delivers rolled strip to shears and drums for small coils. The size of the large coil is said to be five to ten times the standard small size. The reason given for the use of the large coil is to allow continued operation of the descaler even when the mill is stopped. There may be many reasons for stoppage of the mill such as roll changing. Thus, the formation of the large coils is apparently necessary only in order to deal with such a stoppage of the mill. Since there are no particular restrictions on the capacity of the descaler, the objective in this apparatus must be to maximize the capacity of the expensive tandem rolling mill. This means that the capacity of the descaler must be equal to the desired capacity of the rolling mill, and consequently the throughput speed of the descaler must be at least equal to that of the rolling mill. A large and expensive descaler is required. The capacity of a tandem mill is in principle much greater than that of a reversing mill.

[0007] A clear distinction in the prior art exists between the concept of using a tandem mill, where the aim is to achieve maximum use of the very high capacity of the expensive tandem mill, and on the other hand the concept of use of a reversing multi-pass cold rolling mill, whose capacity is much less than that of the tandem mill. The aim of this second concept is to arrange the plant to achieve, in an economical way, a maximum throughput through the reversing mill, together with if possible, high quality of product.

[0008] Figs. 3 and 4 illustrate this distinction by presenting data of the descaling equipment (i.e. the pickling equipment) and the cold rolling equipment prevailing at present in Japan.

[0009] Fig. 3 plots the correlation between the nominal production capacity (per month) of the pickling equipment and the line length of each line. These correlations naturally disperse depending upon the layout of the individual equipments and the product mixing ratios.

[0010] However, as a whole it can be seen that:

(1) a large line length is required for a high production capacity; and
(2) the line will not always become short in proportion to the capacity in an equipment having a low production capacity.

[0011] On the other hand, Fig. 4 presents the distribution of the nominal production capacity (per month) and the number of such cold rolling plants existing in Japan. For example, numeral 1 indicates a so-called "single-stand reversing mill", and numeral 5 indicates a so-called "five-stand tandem mill". For cold rolling plants, as a whole it can concluded that:

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(1) a higher production capacity can be achieved by a larger number of stands of the rolling mill; and
(2) a small production capacity can be realized by a single stand mill.

[0012] Thus, the situation for a descaling and cold rolling apparatus at present is as follows:

(1) a production capacity higher than 100,000 tons per month can be achieved by a large-scale pickling equipment having a line length of 200 to 300 m and a large-scale tandem mill having 5 to 6 stands; and
(2) a production capacity lower than 30,000 tons per month can be achieved by a pickling equipment having a line of length 100 m, which is rather long in relation to the production capacity and a single stand reversing mill of the smallest scale.

[0013] However, for a line having a medium production capacity of about 50,000 tons per month between the foregoing capacities (1) and (2):

(3) the pickling equipment requires a scale as large as that of 100,000 tons per month; and
(4) the cold rolling equipment has to adopt a multi-stand tandem mill having a scale as large as 100,000 tons per month because it is required to effect a predetermined thickness reduction in one pass, or a plurality of single stand reversing mills having a low production capacity have to be provided.

[0014] Thus, the equipment is so redundant relative to the desired production capacity that high and uneconomical investment is required.

[0015] On the other hand, the needs for the production and supply of steel sheet materials are not domestic but worldwide, and instead of the large-scale mills which have existed, medium-scale steel sheet production facilities are desired near the markets for the product.

[0016] In order to satisfy the above-specified needs, facilities are required for realizing a highly economical descaling and cold rolling method which is compact for the production scale but requires no excessive investment, and apparatus for realizing that method. However, these are hard to realize with the methods of the prior art.

[0017] With the existing plants of the prior art, the following problems are present.

(1) The continuous pickling line connects hot coils consecutively, so that an expensive welder is arranged at the entrance of the pickling equipment. In order to avoid interruption of the line during the welding, a long accumulator is arranged together with a long pickling tank, so that the line length is seriously enlarged as a whole.
(2) The pickled coils to be fed to the cold rolling equipment at a subsequent step are made by dividing the strip again so that their size may be suited for transfer and storage in the factory.
(3) It is also necessary to interpose between the pickling equipment and the cold rolling equipment a wide coil yard for absorbing the difference between the production schemes of the two equipments and plant facilities for transferring, storing and managing the coil in that region.

[0018] On the other hand, the above-specified items (2) and (3) are rationalized in the continuous pickling and cold rolling apparatus proposed in the prior art in which the pickling equipment and the tandem mill are directly connected. However, this apparatus naturally requires large-scale devices such as a large accumulator between the pickling equipment and the tandem mill so that it is effective for the very high production capacity of the tandem mill, but is of excessive size and cost for a plant having a medium production capacity.

[0019] Next, as to the cold rolling equipment, the tandem mills described above are suited for the large-scale plant having a large production capacity but not for a plant having a medium production ability.

[0020] On the other hand, the reversing mill has a scale suitable for the case in which a small production capacity is to be attained, but it has been thought that the number of such mills has to be increased for a medium-scale production capacity. A proposal is made in JP-A-57-64403 to combine a descaler and a reversing mill in a continuous line, but this results in a large, expensive and impractical plant, whose capacity is actually limited. JP-A-57-64403 describes a plant for continuous descaling and multi-pass reversing-mill rolling. A welder joins the strip, before entry to a descaler, from which the strip passes directly to the mill region. In the mill region, there are large strip accumulators whose intention is to allow the reversing mill to operate on the strip, portion by portion with multi-pass reverse rolling, while not interrupting the progress of the descaler. The strip is not sub-divided or coiled in the mill region. Fig. 3 of this document shows that the capacity becomes saturated, or nearly so, with a cycle length (i.e. the unit length of strip which is subjected to three-pass reversing rolling at one time) of 1,000 to 1,500 meters. Such a length is too short to obtain large benefits in the rolling operation. The apparatus also is impractical. Not only are the large accumulators expensive and bulky, but also it appears that their size limits the capacity of the machine. A large increase of accumulator capacity would result only in a small increase of productivity of the mill.

[0021] As mentioned above, JP-B-57-39844 proposes an improvement in the use of a reversing mill, but does not disclose a combined descaling and rolling line. Merely to provide a descaling line in front of the mill of JP-B-57-39844 would lead to an expensive plant, employing two welders and requiring space for storage of the coils, after descaling. The descaling apparatus, if

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placed after the welder shown in JP-B-57-39844, would be stopped when the welder stops, which is highly unsatisfactory for a descaler which should operate continuously to avoid over-pickling of parts of the strip. This stop time of the descaler would mean that the descaler has to be larger in nominal capacity than is required by the rolling mill capacity. Another disadvantage of the process of JP-B-57-39844 is the need to stop welding and winding a large coil on an entry drum during the first pass rolling, which reduces capacity. Yet another disadvantage is the need to stop the mill during its final pass at each time of coil division, which also reduces capacity.

[0022] The object of the present invention is to provide a solution to at least some of the problems identified above and to provide a descaling and cold rolling method for metal strip, which can be compact and have efficient and economical production capacity at a suitable scale.

[0023] The invention is based on the realization that, in a single apparatus line, the descaler and the reversing cold rolling mill can be operated simultaneously and at respective different strip entry speeds, by the interposition between them of means for forming large coils. This has the advantages, not appreciated in the prior art, that the descaler operating at a relatively low speed can be relatively short and therefore inexpensive, while the reversing mill is operated at appropriate speeds to give it a maximum production capacity. In this way, production capacities of both descaler and rolling mill can be maximized, without excessive investment cost, because each does not interfere in the operation of the other.

[0024] The production capacity of the relatively short descaler is matched to that of the reversing mill. Idle periods of the descaler and the mill in normal operation can be minimized or are eliminated. The descaler can operate continuously, with its output being divided to form the large coils, so avoiding over-pickling and other problems due to an idle period of the descaler, and avoiding the need for repeated threading of the descaler. Only one strip joining device such as a welder is required. The apparatus can operate almost as a fully continuous line, with interruption of continuity arising only on changing of the large coils fed into the reversing mill. The benefits of rolling long lengths in the reversing mill (i.e. reduction of number of reversals, reduction of threading time, improvement of yield due to reduction of strip end waste) are obtained.

[0025] In consequence, the welding, descaling, reversing rolling and re-division of the strip can be carried out high efficiently with a compact and economic apparatus, having a production capacity making a maximum use of the reversing mill.

[0026] The long strip length which is coiled to form the large coils is typically several times the length of the conventional transportable coil. In one example, this long strip length is at least 5000m, preferably more than 8000m, e.g. 8000-12000 m.

[0027] The invention provides a method of descaling and cold rolling metal strip as set out in claim 1.

[0028] In this specification and claims, the terms "long strip length" and "large coil" are not intended to define particular sizes, but merely to indicate that the strip lengths rolled in the invention are substantially longer than the coils from which they are formed, and than the coils which are finally produced.

[0029] Embodiments of the invention will be described below by way of non-limitative example with reference to the accompanying drawings, in which:-

Fig. 1 is a schematic diagram showing the construction of the descaling and cold rolling apparatus according to one embodiment of the present invention;

Fig. 2 is a schematic diagram of the construction of the descaling and cold rolling apparatus according to a second embodiment of the present invention;

Fig. 3 is a graph illustrating the relation between the nominal production capacity of pickling equipment existing in Japan and the equipment line length; and

Fig. 4 is a graph illustrating the number of cold rolling lines existing in Japan for respective nominal production capabilities, numerical values in bar graphs indicating the number of rolling mill stands in the individual lines.

[0030] In Fig. 1, the descaling and cold rolling apparatus embodying the present invention is a single line with a descaler 5 and a cold rolling mill 13 for reversible multi-pass cold rolling. At the entrance of the descaler 5, there is arranged a welder 4 for welding a plurality of hot-rolled coils 1 of regular transportable size to be fed to the descaler 5. Transport means 2 for the coils 1 is indicated. Between the descaler 5 and the reversible rolling mill 13, there is arranged an entrance side take-up and let-off device 7 for coiling the descaled strip to form a large coil 6 and simultaneously uncoiling the large coil 10A on the same line to feed it to the reversible rolling mill 13. At the exit of this reversible rolling mill 13, on the other hand, there is arranged a shearing machine 16 acting as re-dividing means for dividing again the cold-rolled large coil 15. Between the reversible rolling mill 13 and the shearing machine 16, there is arranged an exit side take-up and let-off device 11 for coiling the cold-rolled strips to form a large coil 10B and simultaneously uncoiling a large coil 14 on the same line to feed it to the shearing machine 16. A hot-rolled coil let-off reel 3 is arranged at the entrance side of the welder 4, and a cold-rolled coil take-up reel 18 is arranged at the exit side of the shearing machine 16.

[0031] Not shown in Fig. 1 are an accumulator (looper) between the welder 4 and the descaler 5, and a shears after the descaler for dividing the strip exiting from the descaler 5 for coiling.

[0032] The entrance take-up and let-off device 7 and the exit take-up and let-off device 11 are each of the well-

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known carousel reel type, in which two expandable reel drums 8 and 9, and 12 and 14 are rotatably borne on rotary discs 7a and 11a so that they each can rotate on their individual axes, and can rotate as a pair about a central axis of the disc 7a or 11a to exchange their positions mutually.

[0033] An advantage of the Carousel devices 7, 11 illustrated here is that a high power driving motor is required only for the drums 9, 12 coiling or uncoiling the material being rolled by the mill. Relatively small motors are required for the drums 8, 14. The carousels 7,11 can therefore be arranged so that the drums 8, 9 and 12, 14 are interchanged in rotation of the discs 7a, 11a, but the respective motors are not interchanged. This reduces overall the cost of the motors required.

[0034] The regular size hot-rolled coils 1 are delivered by a hot -rolled coil car 2 from outside of the line onto the hot-rolled coil let-off reel 3 so that they are consecutively let off and welded by the welder 4. The coils delivered may vary in width and are cold. Then, a large coil 6 is taken up after the descaler 5 onto the drum 8 of the entrance take-up and let-off device 7. On the other hand, simultaneously using the other drum 9 of the entrance take-up and let-off device 7 and the drum 12 of the exit take-up and let-off device 11 a previous long strip length of forming coils 10A and 10B is rolled a predetermined number of passes (e.g. three or five) by the reversible rolling mill 13. Simultaneously, also the large coil 15 on the other drum 14 of the exit take-up and let-off device 11 is uncoiled and divided again by the shearing machine 16 so that it is taken up as a plurality of regular size cold-rolled coils 17 by the take-up reel 18. The coils 17 are delivered to outside of the line by the cold-rolled coil car 19.

[0035] Between the coiling and uncoiling of the large coils 6 and 10A between the descaler 5 and the reversible rolling mill 13, the disc 7a is rotated to interchange the positions of the drums 8 and 9. Likewise, the coiling and uncoiling of the large coils 10B and 15 between the reversible rolling mill 13 and the shearing machine 16 are likewise carried out with interchange of the positions of the drums 12 and 14.

[0036] There will now be described typical specifications of the large coils 6 and 10A, and 10B and 15. The hot coil handled by a conventional reversing mill has a weight of 10 to 20 tons, a length of about 500 to 1,000 m and a diameter of about 1.5 to 2 m. In the present embodiment of the invention in contrast, the large coils 6 etc. having a very large weight need not be transported, e.g. by the crane of the plant. Thus, no difficulty arises even if several regular size hot-rolled coils are connected to form a long strip length having a weight of 100 tons or more and a length of about 10,000 m. The length of the large coil may be 10 times as large as that of the regular hot-rolled coil, but the diameter of the large coil is about 5 m at most so that it can be handled with adequate ease.

[0037] In the present embodiment thus far described, the descaled strip is once taken up as the large coil 6 by the entrance take-up and let-off device 7, and the large coil 10A is let off and fed to the reversible rolling mill 13 so that the descaling step and the rolling step are carried highly efficiently independently in parallel without any interference. On the other hand, the strip thus rolled to a predetermined thickness is divided again to form the regular size coils 17. By the exit take-up and let-off device 11, moreover, the cold-rolled strip is taken up again, and-the long coil 15 is let off and fed to the shearing machine 16. As a result, the rolling step and the redividing step are also carried highly efficiently independently without any interference.

[0038] At this time, the rolling step is usually carried out by the multi-pass reversible rolling and takes the longest time for one large coil. As a result, the descaling step and the re-dividing step have their internal line speed relatively reduced compared with the entry speed at each pass of the mill 13. Since, therefore, the descaler 5 is a chemical descaler, i.e., uses the pickling method, the pickling tank can be short. If a mechanical descaler is used in combination with the chemical descaler, the descaler 5 can have its line length shortened and made compact.

[0039] Moreover, the various operations can be accomplished under selected conditions without interfering with each other. For example, the redividing and final coiling steps can be carried out at a low line speed for inspecting the surfaces of the rolled product. Thus, a treating step can be added, if required, to the re-dividing step.

[0040] As a result, the welding step, descaling step, reversible rolling step and re-dividing step of the coil can be carried out highly efficiently without any mutual interference. The strip entry speed of the descaler 5 is different from the higher strip entry speeds in the rolling passes in the mill 13. There is no waste between the descaling step and the cold-rolling step and between the cold-rolling step and the re-dividing step, while a suitable production scale is maintained. Only one expensive welder 4 is required so that a highly compact and economical apparatus can be realized.

[0041] Since the coil length rolled is long, the frequency of changing pass direction, which can cause trouble, can be drastically reduced to elongate the rolling time period of one cycle, so that the operation can be run stably with high productivity and production yield.

[0042] The rolling step is reversible using a large coil so that the productivity and production yield can become better than in reversible rolling methods of the prior art. The rolling mill need not be interrupted even at the welding time or the re-dividing time to improve the quality of the surface, yield and productivity of the product.

[0043] Fig.2 shows another embodiment of the apparatus of the invention, in which the parts corresponding to those of Fig.1 are given the same reference numbers and will not be fully described again. From the reel 3, the uncoiling strip from the hot-rolled coil 1 passes

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through a straightener 3a and optional end shears 3b to the welder 4. After the welder 4 there is shown an accumulator (looper) 4a used to ensure that welding can take place without interruption of the descaler 5. The descaler 5 includes a scale breaker section 5a, an acid pickling tank 5b and a rinse tank 5c. A small accumulator 5d is located after the descaler 5, before an edge trimmer 5e (which prepares the descaled strip for coiling) and shears 5f, which divide the joined strip passing continuously through the descaler 5 into the successive long strip lengths for coiling as the large coils 6. The remainder of the line is substantially as shown in and described for Fig.1.

[0044] This embodiment of Fig. 2 has a production capacity of about 60,000 tons/month (or 700,000 tons/year). The pickling line (from the reel 3 to the carousel device 7) occupies a space about 100m in length.

[0045] It can be understood that the length of the long strip in each coil 6 does not correspond to an integral multiple of the length of the input coils 1. The length of the large coil 6 is chosen suitably for the cold rolling operation.

[0046] The descaling method and the descaler 5 are not limited to the chemical or mechanical types. These two types may be combined. It is also apparent that the type of the single stand reversing rolling mill is not especially limited. A six-high roll stand is indicated by way of example.

[0047] The take-up and let-off devices 7 and 11 may have carousel reel drums as solid drums which are not expandable nor contractible. In this case, the drum structures to be used need not be complex.

[0048] Furthermore, the present embodiment has been described with carousel reels in the take-up and let-off device 7 between the descaling step and the rolling step. However, the means for connecting those two steps as the same line can be exemplified devices such as a coil car, a coil conveyor or a coil hoist. The positional relation and distance between the two steps is not limited to those of the foregoing embodiments. Specifically, unlike the pickled coils of regular size of past practice in the art, the large coils formed at the descaling step are not extracted to be stored outside the line prior to rolling. Preferably the large coils are fed to the rolling step substantially in the order of preparation.

Claims

1. A method of descaling and cold rolling metal strip, comprising the following steps performed in a single apparatus line:-

   (a) joining a plurality of coils of said strip to form a plurality of long strip lengths,
   (b) sequentially passing said long strip lengths through a descaler (5),
   (c) winding said long strip lengths into large coils (6), and
   (d) sequentially cold rolling said long strip lengths in a cold rolling mill (13) from said large coils,

   characterized in that the descaler (5) and the cold rolling mill (13) operate simultaneously on two of the long strip lengths,

   in step (d) each said long strip length is rolled in a plurality of passes, with reversing, through a reversible multi-pass cold rolling mill (13) with unwinding of the long strip length and rewinding thereof between each two said passes through said mill,
   the speed of said strip in said descaler (5) being slower than the entry speed of the strip in each of said passes through said mill (13).

2. A method according to claim 1 wherein in step (c) the long strip length is coiled onto one of a first pair of coiling drums (8,9) to form said large coil, and thereafter said first pair of coiling drums (8,9) are mutually interchanged in position before unwinding of said large coil.

3. A method according to claim 1 or claim 2 wherein after the final one of said cold rolling passes said long strip length is recoiled onto a first one of a second pair of coiling drums (12,14), thereafter said second pair of coiling drums (12,14) are mutually interchanged in position, and then said long strip length is uncoiled from said first one of said second pair of coiling drums, subdivided and recoiled as a plurality of smaller coils.

Patentansprüche

1. Verfahren zum Entzundern und Kaltwalzen von Metallband mit den folgenden Schritten, die in einer einzigen Fertigungsstraße ausgeführt werden:

   (a) Verbinden einer Vielzahl von Coils des genannten Bands, um eine Vielzahl langer Bandabschnitte auszubilden,
   (b) aufeinanderfolgendes Hindurchführen der langen Bandabschnitte durch einen Entzunderer (5),
   (c) Aufwickeln der langen Bandabschnitte zu großen Coils (6), und
   (d) aufeinanderfolgendes Kaltwalzen der langen Bandabschnitte von den besagten großen Coils in einer Kaltwalzstraße (13),

   dadurch gekennzeichnet, daß der Entzunderer (5) und das Kaltwalzwerk (13) gleichzeitig zwei der langen Bandabschnitte bearbeiten,

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in Schritt (d) jeder der langen Bandabschnitte in einer Vielzahl von Durchgängen mit Umkehrung durch eine Vieldurchgangs-Umkehrkaltwalzstraße (13) gewalzt wird, wobei die langen Bandabschnitte abgewickelt und zwischen jeweils zwei der besagten Durchgänge durch die Straße wieder aufgewikkelt werden, und die Geschwindigkeit des Bands in dem Entzunderer (5) langsamer ist als die Eintrittsgeschwindigkeit des Bands in jedem der Durchgänge durch die Straße (13).

2. Verfahren nach Anspruch 1, wobei der lange Bandabschnitt in Schritt (c) von einem ersten Paar Wikkeltrommeln (8, 9) auf die eine davon gewickelt wird, um das besagte große Coil zu bilden, und anschließend die Wickeltrommeln (8, 9) dieses ersten Paars vor dem Abwickeln des großen Coils in ihren Positionen gegenseitig ausgetauscht werden.

3. Verfahren nach Anspruch 1 oder 2, wobei der lange Bandabschnitt nach dem letzten der Kaltwalzdurchgänge von einem zweiten Paar Wickeltrommeln (12, 14) auf eine davon gewickelt wird, anschließend die Wickeltrommeln (12, 14) dieses zweiten Paars in ihren Positionen gegenseitig vertauscht und dann der lange Bandabschnitt von der ersten des zweiten Paars Wickeltrommeln abgewickelt, unterteilt und als eine Vielzahl kleinerer Coils wieder aufgewickelt wird.

Revendications

1. Procédé de décalaminage et de laminage à froid de feuillard, comprenant les étapes suivantes, exécutées dans une seule ligne de machines :

(a) réunir une pluralité de bobines dudit feuillard pour former une pluralité de grandes longueurs de feuillard,
(b) faire successivement passer lesdites grandes longueurs de feuillard dans une décalamineuse (5),
(c) enrouler lesdites grandes longueurs de feuillard en grosses bobines (6), et
(d) successivement laminer à froid lesdites grandes longueurs de feuillard dans un laminoir à froid (13) à partir desdites grosses bobines,

caractérisé en ce que la décalamineuse (5) et le laminoir à froid (13) agissent simultanément sur deux des grandes longueurs de feuillard,

lors de l'étape (d), chaque dite grande longueur de feuillard est laminée en une pluralité de passes, en va-et-vient, dans un laminoir à froid réversible multipasse (13) avec déroulement de la grande longueur de feuillard et rembobinage de celle-ci entre deux dites passes dans ledit laminoir,
la vitesse dudit feuillard dans ladite décalamineuse (5) étant inférieure à la vitesse d'entrée du feuillard lors de chacune desdites passes dans ledit laminoir (13).

2. Procédé selon la revendication 1, dans lequel, lors de l'étape (c), la grande longueur de feuillard est enroulée sur un premier tambour parmi deux tambours d'enroulement (8, 9) pour former ladite grosse bobine, après quoi lesdits deux tambours d'enroulement (8, 9) prennent chacun la place de l'autre avant que ladite grosse bobine ne soit déroulée.

3. Procédé selon la revendication 1 ou la revendication 2, dans lequel, après la passe finale parmi lesdites passes de laminage à froid, ladite grande longueur de feuillard est réenroulée sur un premier tambour parmi deux tambours d'enroulement (12, 14), après quoi lesdits deux tambours d'enroulement (12, 14) prennent chacun la place de l'autre, puis ladite grande longueur de feuillard est déroulée dudit premier desdits deux tambours d'enroulement, est subdivisée et réenroulée sous la forme d'une pluralité de bobines plus petites.

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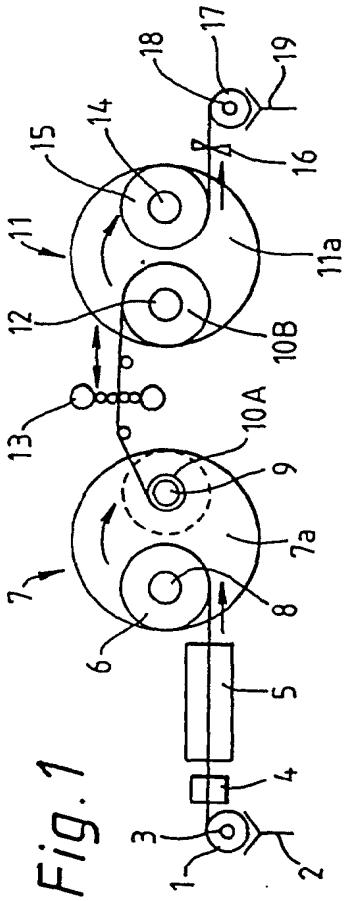


Fig. 1

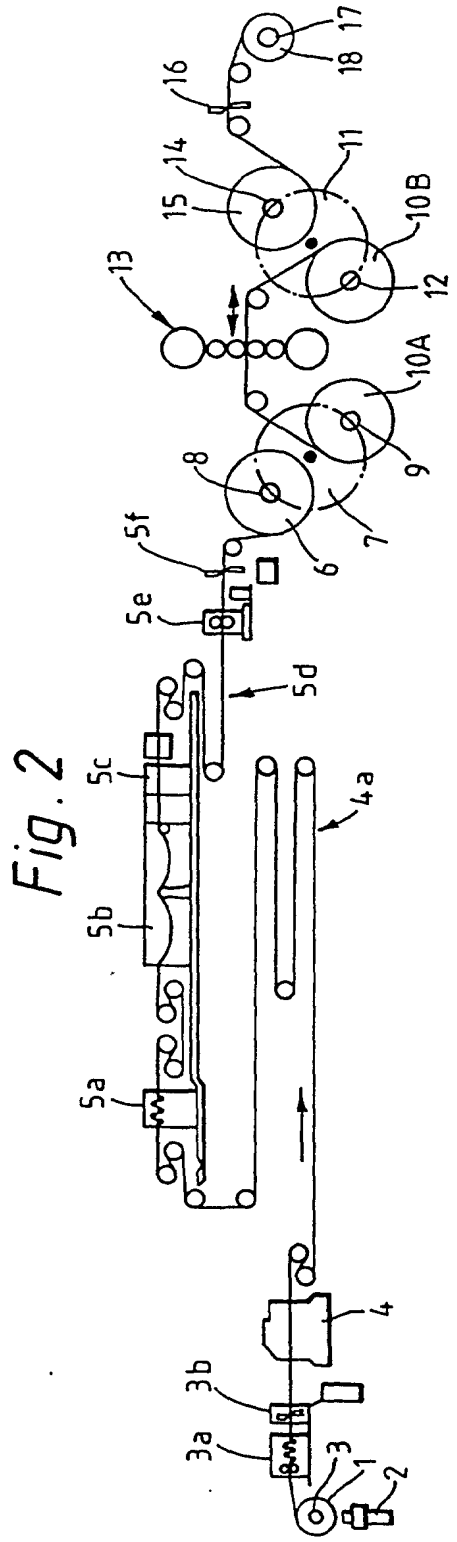


Fig. 2

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Fig. 3

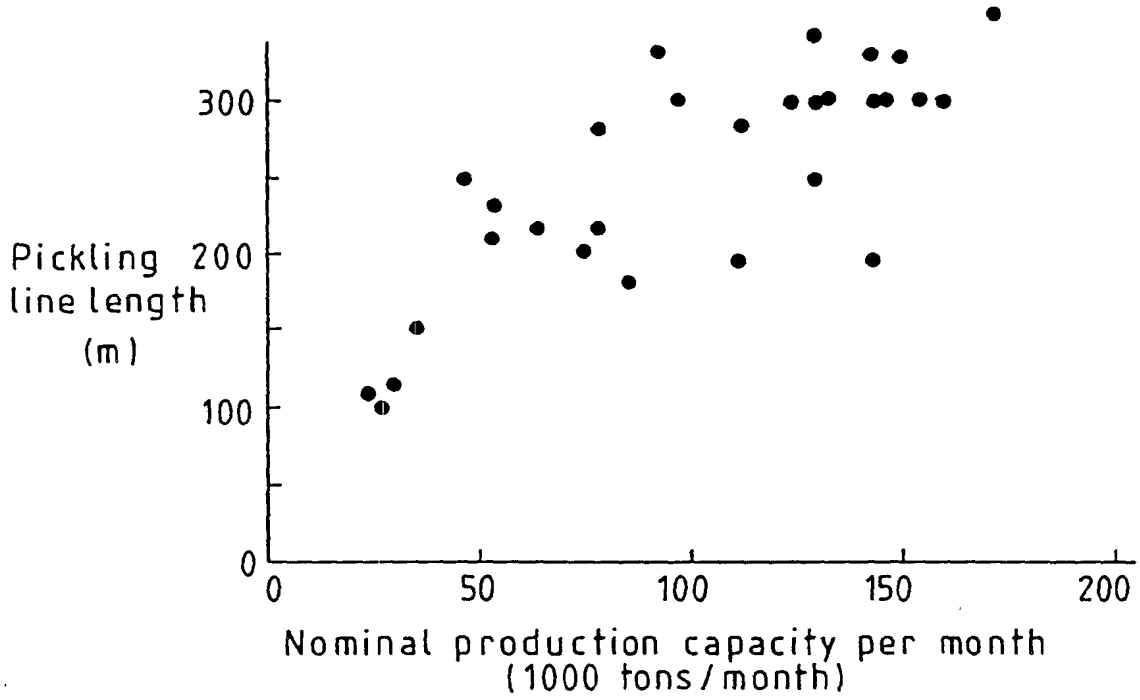
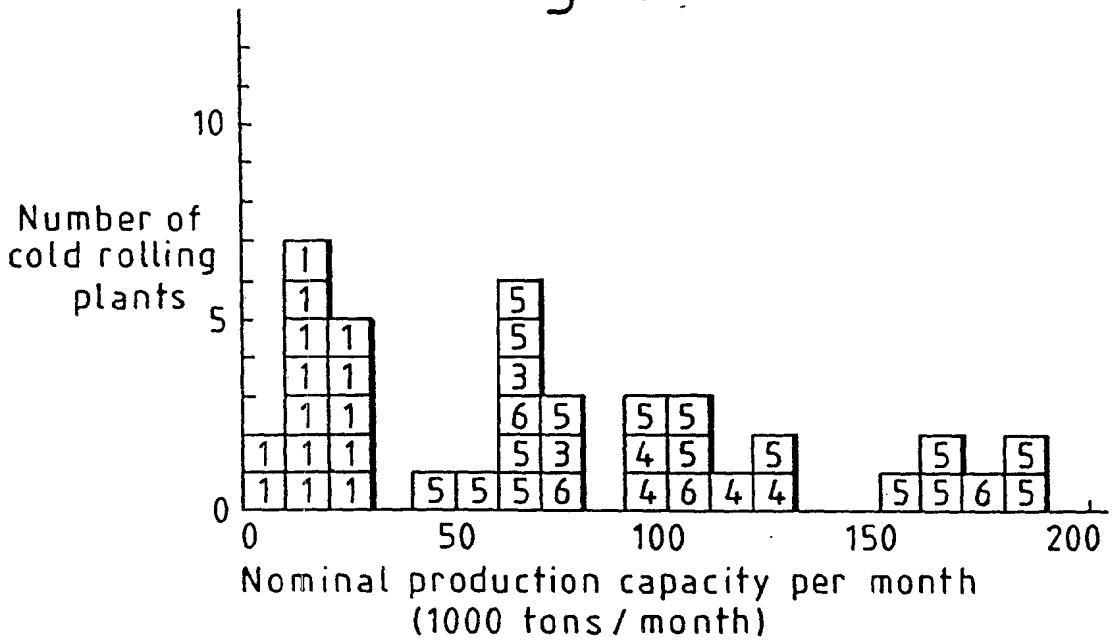


Fig. 4



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20060101ALI20050715BHJP C23C 2/12 20060101ALI20050715BHJP C23C 2/40
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(54) METHODE D'EMBOUTISSAGE A CHAUD POUR ELEMENT HAUTE RESISTANCE PARTANT DE TOLE D'ACIER ET DE PIECES EMBOUTIES A CHAUD

(54) METHOD OF HOT PRESSING HIGH STRENGTH MEMBER USING STEEL SHEET AND SUCH HOT PRESSED PARTS

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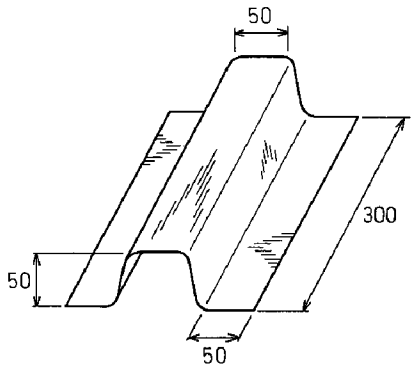
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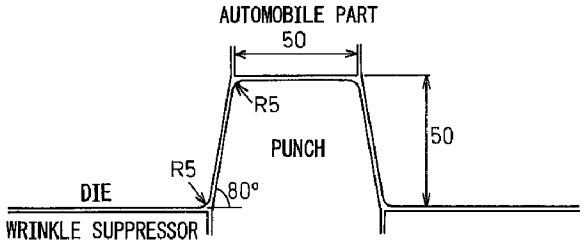
(54) Titre : METHODE D'EMBOUTISSAGE A CHAUD POUR ELEMENT HAUTE RESISTANCE PARTANT DE TOLE D'ACIER ET DE PIECES EMBOUTIES A CHAUD

(54) Title: HOT PRESSING METHOD FOR HIGH STRENGTH MEMBER USING STEEL SHEET AND HOT PRESSED PARTS

(a)



(b)



(57) Abrégé/Abstract:
A hot pressing method for a high strength automobile member wherein the member is produced by the use of, as a steel component, a steel sheet containing 0.05 to 0.5 mass % of C or a steel sheet plated with a metal material containing Al or Zn as a

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(57) Abrégé(suite)/Abstract(continued):
main component, and by the employment of a hot pressing method, characterized in that the heating temperature before pressing is Ac_3 or higher and 1100°C or lower, and the atmosphere during heating has a hydrogen concentration of 6 vol % or less and exhibits a dew point of 10°C or lower; and a hot pressed member manufactured by the above method. The above hot pressing method or hot pressed member uses a hot-rolled or cold-rolled steel sheet or an Al-based metal plated steel sheet or a Zn-based metal plated steel sheet, and can provide a member having a strength of 1200 MPa or higher after a forming at a high temperature and also being almost free from the fear of hydrogen embrittleness.

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ABSTRACT

The present invention provides a method of hot pressing using hot rolled and cold rolled steel sheet or Al-based plated steel sheet or Zn-based plated steel sheet enabling a strength of at least 1200 MPa to be obtained after high temperature forming and with extremely little possibility of hydrogen embrittlement and such hot pressed parts, that is, a method of hot pressing a high strength automobile parts comprising using steel sheet containing as steel compositions by wt% C:0.05 to 0.5% or steel sheet plated mainly with Al or Zn to produce automobile members by hot pressing during which making the heating temperature before pressing Ac_3 or more to 1100°C or less, making the hydrogen concentration in the heating atmosphere 6 vol% or less, and making the dew point 10°C or less and such hot pressed parts.

DESCRIPTION

METHOD OF HOT PRESSING HIGH STRENGTH MEMBER USING STEEL SHEET AND SUCH HOT PRESSED PARTS

TECHNICAL FIELD

The present invention relates to a method of hot pressing comprising using cold rolled or hot rolled steel sheet or Al-based or Zn-based plated steel sheet to hot press automobile pillars, door impact beams, bumper beams, or other strength parts and such hot pressed parts.

BACKGROUND ART

To lighten the weight of automobiles, an issue arising from the problem of global warming, it is necessary to make the steel sheet used for automobiles as high in strength as possible. In general, if making steel sheet high in strength, the elongation and r value decrease and the formability deteriorates. To solve this problem, technology for hot forming materials and using the heat at that time to raise the strength is disclosed in Japanese Patent Publication (A) No. 2000-234153. This technology aims at suitably controlling the steel compositions, heating the steel in the ferrite temperature region, and utilizing precipitation strengthening in this temperature region to raise the strength.

Further, Japanese Patent Publication (A) No. 2000-87183 proposes high strength steel sheet improved in press forming precision by reducing the yield strength at the formation temperature to much lower than the yield strength at ordinary temperature. However, these technologies may be limited in the obtained strength. On the other hand, technology for obtaining a higher strength by heating the material to the high temperature austenite single-phase region after formation and transforming it to a hard phase in the subsequent cooling

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process is proposed in Japanese Patent Publication (A) No. 2000-38640.

However, if heating and rapidly cooling a sheet after forming, problems may arise in the shape precision. As technology for overcoming this defect, technology for heating steel sheet to the austenite single-phase region, then cooling in the press formation process by a cooling rate of at least the critical cooling rate of martensite transformation determined by the steel compositions is disclosed in the Document (SAE, 2001-01-0078) and Japanese Patent Publication (A) No. 2001-181833. The former document discloses to suppress scaling of the surface at the time of heating by using Al-plated steel sheet. This type of pressing process is called "hot pressing" in the present invention.

As prior technology relating to hot pressing using such plated steel sheet, the following may be mentioned. Japanese Patent Publication (A) No. 2003-147499 discloses an example of using steel sheet covered by a plating layer comprised of an Fe-Zn alloy for hot pressing, while Japanese Patent Publication (A) No. 2003-41343 discloses an example of using Al-based plated steel sheet covered by a plating layer comprised of an Fe-Al alloy for hot pressing.

Further, Japanese Patent Publication (A) No. 2002-282951 discloses the example of a method of using a die and punch to press a heated metal sheet wherein the die clearance is defined from the viewpoint of the formability and hardenability.

DISCLOSURE OF THE INVENTION

In this way, the higher the strength, the more high strength steel sheet used for automobiles etc. has the above-mentioned problem of formability and the inherent problem, in particular in high strength materials of over 1000 MPa, of hydrogen embrittlement (also called aging cracks and delayed fracture), as is known from the past. Therefore, when using steel sheet as sheet for auto

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pressing, it is important to lower the amount of hydrogen of the material.

The present invention was made to solve this problem and provides a method of hot pressing using hot rolled or cold rolled steel sheet or an Al-based plated steel sheet or a Zn-based plated steel sheet able to give a strength of 1200 MPa or more after high temperature forming and with extremely little liability of hydrogen embrittlement and such pressed parts.

The inventors engaged in various studies to solve the above problem. As a result, they discovered that controlling the atmosphere and temperature at the time of heating to the austenite single-phase region before pressing is important for producing hot pressed parts superior in resistance to hydrogen embrittlement. That is, since the atmosphere at the time of heating includes hydrogen, this hydrogen invades the steel sheet. Even if moisture is included, similarly hydrogen may invade the steel sheet, so it is important to reduce hydrogen and moisture. Further, the inventors discovered that to prevent hydrogen embrittlement, it is important to suitably select the die clearance. The gist of the present invention based on this discovery is as follows:

(1) A method of hot pressing a high strength automobile parts comprising using steel sheet containing as a steel compositions, by wt%, C:0.05 to 0.5% or steel sheet plated mainly by Al or Zn to hot press an automobile member during which making the heating temperature before pressing at least the Ac_3 and not more than 1100°C, making the hydrogen concentration in the heating atmosphere not more than 6 vol%, and making the dew point not more than 10°C.

(2) A method of hot pressing a high strength automobile parts as set forth in (1), characterized in that a hydrogen concentration in the heating atmosphere is not more than 1 vol% and a dew point is not more than

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10°C.

(3) A method of hot pressing a high strength automobile parts as set forth in (1) or (2), characterized by introducing the steel sheet after heating into a press machine and making a clearance between a die and punch at the time of forming 1.0 to 1.8 times the thickness of the steel material used.

(4) A hot pressed part characterized by using a method of hot pressing as set forth in any one of (1) to (3).

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an external view of a hat shaped die used for a processing test of the examples.

BEST MODE FOR WORKING THE INVENTION

Next, the reasons for limitation of the present invention will be explained.

As explained above, the present invention comprises heating hot rolled or cold rolled steel sheet or Al-based or Zn-based plated steel sheet to 700°C or more, then hot forming it and immediately cooling and hardening it in a die to obtain the desired strength. The present invention defines the steel sheet before heating and press forming. The steel sheet compositions have to be superior in hardenability. Therefore, the amount of C must be 0.05% or more, preferably 0.1% or more. As other steel elements, Si, Mn, Ti, B, Cr, Mo, Al, P, S, N, or other elements are sometimes added. Si has an effect on the fatigue characteristics, so when included, 0.05 to 1% is preferable. Mn, B, Cr, and Mo contribute to the improvement of the hardenability, so when included, Mn: 0.5 to 3%, B: 0.05% or less, Cr: 2% or less, and Mo: 0.5% or less are preferable. Ti and Al improve the oxidation resistance of Al-based plated steel sheet, so when included, Ti: 0.5% or less and Al: 0.1% or less are preferable.

As to the type of plating, steel sheet given Al-based or Zn-based plating may be considered. If using

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these for hot pressing, formation of iron oxide at the surface is suppressed and corrosion resistance can be imparted.

First, the configuration of the Al-based plating layer will be explained. At the present time, Al-based plated steel sheets are being produced for various applications. The present invention may be used for these steel sheets. As the to configuration of the Al-based plating layer, there is steel sheet with plating mainly comprised of Al and, to suppress the formation of an alloy layer at the time of hot dip Al coating, preferably containing 3 to 15% of Si. In addition, as elements for improving more the corrosion resistance of the plating layer, there are Cr, Mg, Ti, Sn, etc. These may also be added. At this time, Cr: 0.1 to 1%, Mg: 0.5 to 10%, Ti: 0.1 to 1%, and Sn: 1 to 5% are desirably further included. Note that the Al-based plating layer contains Fe as an impurity. The amount is normally 0.05 to 0.5%.

Note that after heating, the surface may be formed with intermetallic compounds such as $FeAl_3$, Fe_2Al_5, Fe_3Al, and Fe_2Al_8Si. These phases tend typically to be composite layer structures of five layers, but no matter what these phase structures, the gist of the invention of the present invention is not affected. Further, the composition is mainly Al and Fe. When adding Si to the Al plating bath, Si is also included in an amount of about 5 to 10%. These elements form at least 90% of the total. Further, there may be some slight amount of residual Al not alloyed, but if a small amount, it does not have any particular effect on the performance. After heating, an Al-based oxide or nitride covers the surface, but these amounts are not particularly defined.

Next, the configuration of the Zn-plating layer will be explained. Zn-based plated steel sheets are currently being produced in various compositions. The present invention can be applied to these steel sheets. As typical configurations of Zn-based plating layers, the

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following may be mentioned: Zn-0.2%Al, Zn-5%Al-0.1%Mg, Zn-5%Al-0.1%Mg-mische metal, Zn-7%Al-3%Mg, Zn-11%Al-3%Mg-0.1%Si, Zn-55%Al-1.6%Si, etc. In addition, by plating in a Zn-0.1%Al bath, then heating, this may be changed to Zn-10%Fe. In addition, as elements for improving more the corrosion resistance of the plating layer, there are Cr, Mg, Ti, Sn, etc. These may also be added. At this time, Cr: 0.1 to 1%, Mg: 0.5 to 10%, Ti: 0.1 to 1%, and Sn: 1 to 5% are preferably contained.

Note that after heating, the surface may be formed with ζ, $\delta 1$, Γ, $\Gamma 1$ phases or other intermetallic compounds or a ferrite phase containing Zn in solid solution. These phases may be distributed in layers or distributed in the form of particles, but no matter what these phase structures, the gist of the invention of the present application is not affected. Further, if plating comprised including Al, formation of the above-mentioned Fe-Al-based compound is also possible. In the case of Zn-based plating, after the heating, a Zn-based or Al-based oxide film is formed, but even if these are formed, the gist of the present invention is not affected.

The amount of deposition of the Al-based or Zn-based plating, the treatment before plating, and the treatment after it are not particularly limited, but the plating deposition is preferably at least 50 g/m^2 on one side. This is because the greater the amount of plating deposition, the more improved the effect of suppression of oxidation at the time of heating and the corrosion resistance of the part after heating and forming. As such treatment after plating, chromate treatment, resin coating, etc. for primary rust prevention and lubrication are possible, but an organic resin is consumed upon heating, so is not preferred. For the chromate treatment as well, considering the recent restrictions on hexavalent chrome, electrolytic chromate or other trivalent coatings are preferred. Even not imparting a chromate coating and just coating with oil is possible in

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the case of Al-based plated steel sheet superior in corrosion resistance.

In the present invention, the temperature and atmosphere at the time of heating are defined. The temperature is made at least Ac_3 and not more than 1100°C. This is because for the steel sheet to completely transform to the austenite single-phase region, the Ac_3 temperature or more is necessary. On the other hand, if the heating temperature is too high, the surface oxidizes and hydrogen more actively invades the steel. If using a Zn-based plating, in addition to this, since the boiling point of Zn is about 910°C and, at a high temperature, Zn will completely evaporate away and the steel sheet will become seriously oxidized, 1000°C is preferably made the upper limit. More preferably, the upper limit temperature is 920°C. The lower limit temperature is preferably made 800°C. This is because even if heating to the Ac_3 temperature or more, in the interval after heating when the steel sheet is taken out from the furnace and transported to the press machine, the temperature drops and ferrite ends up being formed in some cases.

The heating atmosphere is made one with a hydrogen concentration of 6 vol% or less. This is because, as explained above, the invasion of hydrogen into the steel will increase the liability of hydrogen embrittlement. No lower limit is particularly set, but the lower the better. More preferably, the amount of hydrogen is 1% or less. Similarly, the inventors discovered in the present invention that the moisture in the atmosphere may also easily invade the steel as hydrogen. Therefore, the moisture in the atmosphere is also preferably low. In practice, the dew point is measured to measure the moisture content. The upper limit of the dew point is made 10°C. Note that the following equation is known for conversion of the dew point and moisture content. The moisture content at this time is 1.2 vol%. In particular,

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when using a Zn-based plated steel sheet, having the atmosphere contain oxygen causes the steel sheet surface to be formed with a Zn oxide and suppress the evaporation of Zn. Therefore, when using a Zn-based plated steel sheet, the atmosphere preferably contains oxygen in an amount of 1 to 21%. Further, not only plated steel sheet, but also not plated steel sheet (bare material) is invaded by hydrogen during heating, so the hydrogen concentration and moisture content of the heating atmosphere must be controlled.

Equation 1

$$pH_2O = \exp\left(-\frac{44016 - 118.774 * Tdp}{8.314 * Tdp}\right)$$

pH_2O: hydrogen concentration (vol%)

Tdp: dew point (absolute temperature)

The heating method is not particularly prescribed. It may be radiant heating by radiant tubes etc., induction heating, conduction heating, etc. The heating rate at this time is not limited. This naturally depends largely on the sheet thickness and the shape.

Hot pressing is characterized by cooling from an austenite phase to obtain a hardened microstructure. Naturally, the effect of the cooling rate after heating is great. In the present invention, it is necessary to cool by at least the critical cooling rate for obtaining a martensite structure as determined by the steel compositions, but as a general measure, the average cooling temperature from 700°C to 350°C is preferably at least 15°C/sec. This cooling rate depends on the steel ingredients. In a steel with a good hardenability, even with a cooling rate of about 20°C/sec, a desired structure mainly comprised of martensite can be obtained. Depending on the type of the steel, a cooling rate of about 30°C/sec

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may become necessary.

At the time of pressing, the clearance between the die and punch is an important factor. In the present invention, this clearance is preferably 1.0 to 1.8 times the sheet thickness. If the clearance is small, the sheet will have difficulty flowing resulting in ironing, so the surface of the steel sheet will suffer from galling which may form the starting point for hydrogen embrittlement. Further, if large, hardening tends to become difficult, the part will become uneven in strength, residual stress will remain in the part, and the possibility of hydrogen embrittlement will rise.

EXAMPLES

Next, examples will be used to explain the present invention in further detail.

(Example 1)

Cold rolled steel sheets having the steel compositions shown in Table 1 and having thicknesses of 1.4 mm were heated under various conditions, then formed by a hat shaped die as shown in FIG. 1. The clearance was made 1.1 times the sheet thickness. After this, in the flange of each part, 5 mmϕ holes were punched at 10 points with a clearance of 0.5 mm (two sides). After the elapse of seven days, a 20X power loupe was used to examine the punched out parts and judge the presence of microcracks. The samples were heated by insertion in an electric furnace controlled in atmosphere. The time for raising the temperature to 900°C was about 4 minutes, the time from the furnace to the press was about 10 seconds, and the press start temperature was about 750°C. The cooling was performed in the die. The average cooling rate from 700°C to 350°C was 40°C/sec. The heating conditions and the presence of any microcracks are shown in Table 2. Note that after forming, part was cut out and measured for Vicker's hardness at a load of 10 kgf, whereupon the Hv was in the range of 410 to 510 and a martensitic

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microstructure was exhibited at all levels. Further, after hot pressing, the surfaces of these steel sheets were formed with iron oxide.

No. 8 of Example 1 was high in dew point, so five or more microcracks occurred. No. 1 and No. 3 had amounts of hydrogen of over 1%, so small amounts of microcracks occurred.

Table 1

Sym-bol	C	Si	Mn	P	S	Al	N	Ti	Cr	Mo	B
A	0.15	0.1	2.1	0.01	0.004	0.03	0.004	0.02	0.4	0.01	0.003
B	0.21	0.2	0.9	0.02	0.005	0.015	0.005	0.01	0.9	0.4	0.004
C	0.27	0.15	0.88	0.01	0.002	0.02	0.004	0.02	0.23	0.5	0.003

Table 2

No.	Steel	Temp. (°C)	Holding temp. (min)	Heating atmosphere			Occur-rence of micro-cracks	
				Hydrogen (vol%)	Dew point (°C)	Oxygen (vol%)		
1	A	950	1	5	8	0.01	F	Inv. ex.
2	A	900	1	0.1	2	0.3	VG	Inv. ex.
3	B	800	2	2	-10	0.5	G	Inv. ex.
4	B	850	3	0.5	0	21	VG	Inv. ex.
5	C	1000	1	0.1	-30	21	VG	Inv. ex.
6	C	850	5	0.05	2	21	VG	Inv. ex.
7	A	900	10	0.07	6	21	VG	Inv. ex.
8	B	850	8	0.1	13	21	P	Comp. ex.
9	B	850	5	0.2	0	21	VG	Inv. ex.
10	C	850	2	0.1	-10	21	VG	Inv. ex.

Scoring of occurrence of microcracks:
Total number of microcracks at 10 points: VG (very good): 0, G (good): 1, F (fair): less than 5, P (poor): 5 or more

(Example 2)

Cold rolled steel sheets of the steel compositions shown in Table 3 after the ordinary hot rolling and cold rolling processes (sheet thickness 1.4 mm) were used as materials for hot dip Al coating. The hot dip Al coating was performed using a nonoxidizing furnace-reduction furnace type line. After plating, the gas wiping method was used to adjust the plating deposition to 80 g/m^2 per side, then the sheets were cooled. The plating appearance

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was good with no nonplated areas. The type of plating and the bath temperature are shown in Table 9. The plating bath composition at this time was Al-10%Si-2%Fe and the bath temperature was 660°C. The Fe in the bath was unavoidable Fe from the plating equipment or strip. The plating appearance was good with no nonplated areas. The thus hot dip Al coated steel sheets were heated under various conditions, then formed by a hat shaped die shown in FIG. 1. The clearance was made 1.1 times the sheet thickness. After this, in the flange of each part, 5 mmϕ holes were punched at 10 points with a clearance of 0.5 mm (two sides). After the elapse of seven days, a 20X power loupe was used to examine the punched out parts and judge the presence of microcracks. The samples were heated by insertion in an electric furnace controlled in atmosphere. The time for raising the temperature to 900°C was about 4 minutes, the time from the furnace to the press was about 10 seconds, and the press start temperature was about 750°C. The cooling was performed in the die. The average cooling rate from 700°C to 350°C was 40°C/sec. The heating conditions and the presence of any microcracks are shown in Table 4. Note that after forming into the hats, parts were cut out and measured for Vicker's hardness at a load of 10 kgf, whereupon the Hv's were in the range of 410 to 510 and a martensite structure was exhibited at all levels. Further, after hot pressing, the surfaces of these steel sheets were not formed with iron oxide.

Table 3

C	Si	Mn	P	S	Al	N	Ti	Cr	Mo	B
0.22	0.21	1.20	0.02	0.003	0.027	0.003	0.002	0.18	0.02	0.0018

Table 4

No.	Temp. (°C)	Holding temp. (min)	Heating atmosphere			Occurrence of microcracks	
			Hydrogen (vol%)	Dew point (°C)	Oxygen (vol%)		
1	800	5	0.01	2	0.3	VG	Inv. ex.
2	900	3	0.02	1	0.5	VG	Inv. ex.
3	1000	2	0.1	3	0.8	VG	Inv. ex.
4	1100	2	N.D.	1	1	VG	Inv. ex.
5	900	2	10	0	0.01	P	Comp. ex.
6	900	2	4	1	0.01	F	Inv. ex.
7	900	2	1	-1	0.01	VG	Inv. ex.
8	900	2	0.1	15	0.01	P	Comp. ex.
9	900	2	0.1	6	0.1	VG	Inv. ex.
10	900	2	0.05	2	0.1	VG	Inv. ex.
11	900	2	2	-20	0.5	G	Inv. ex.
12	900	2	0.01	7	21	VG	Inv. ex.
13	900	2	0.01	1	21	VG	Inv. ex.
14	980	8	0.01	1	21	VG	Inv. ex.
15	1050	5	0.01	1	21	VG	Inv. ex.
16	900	10	5	6	0.06	F	Inv. ex.

Scoring of occurrence of microcracks:
Total number of microcracks at 10 points: VG (very good): 0, G (good): 1, F (fair): less than 5, P (poor): 5 or more

As shown in Table 4, the amount of hydrogen invading the steel changes and the sensitivity to microcracks changes depending on the heating atmosphere and temperature. No. 5 with a hydrogen concentration of 10 vol% and No. 8 with a dew point of 15°C exhibited five or more cracks. As the hydrogen concentration and dew point are lowered, the formation of cracks is suppressed, but in the case of Nos. 6, 11, and 16, some cracks were formed.

(Example 3)

Cold rolled steel sheets having the steel compositions shown in Table 5 and having thicknesses of 1.4 mm were used for various types of Zn-based plating. The type of plating, bath compositions, and bath temperature at this time are shown in Table 6. These Zn-based plated steel sheets were used to form hats in the same way as in Example 1. The presence of any microcracks after punching was examined. The relationship between the

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heating conditions and the state of formation of cracks at this time is shown in Table 7. The cooling was performed in the die. The average cooling rate from 700°C to 350°C was 20°C/sec. The samples were measured for cross-sectional hardness after formation in the same way as in Example 1, whereupon all the samples had Hv's in the range of 410 to 510 and the structures were martensite microstructures. Further, after hot pressing, the surfaces of these steel sheets were not formed with iron oxide.

Table 5

Symbol	C	Si	Mn	P	S	Al	N	Ti	Cr	Mo	B
A	0.15	0.1	2.1	0.01	0.004	0.03	0.004	0.02	0.4	0.01	0.003
B	0.21	0.2	0.9	0.02	0.005	0.015	0.005	0.01	0.9	0.4	0.004
C	0.27	0.15	0.88	0.01	0.002	0.02	0.004	0.02	0.23	0.5	0.003

Table 6

Sym-bol	Composition of plating layer	Single side deposition (g/m^2)	Bath temp. (°C)
GI	Zn-0.2%Al	85	460
GA	Zn-10.5%Fe	70	460
GL	Zn-55%Al-1.6%Si	75	610
GAM	Zn-6%Al-3%Mg	65	420
GAMS	Zn-11%Al-3%Mg-0.1%Si	80	430

Table 7

No.	Steel	Plat-ing	Temp. (°C)	Holding time (min)	Heating atmosphere			Occur-rence of micro-cracks	
					Hydro-gen (vol%)	Dew point (°C)	Oxygen (vol%)		
1	A	GI	950	1	5	8	0.01	F	Inv. ex.
2	A	GA	900	1	0.1	2	0.3	VG	Inv. ex.
3	B	GL	800	2	2	-10	0.5	G	Inv. ex.
4	B	GAM	850	3	0.5	0	21	VG	Inv. ex.
5	C	GAMS	1000	1	0.1	-30	21	VG	Inv. ex.
6	C	GI	850	5	0.05	2	21	VG	Inv. ex.
7	A	GI	900	10	0.07	6	21	VG	Inv. ex.
8	B	GA	850	8	0.1	13	21	P	Comp. ex.
9	B	GA	850	5	0.2	0	21	VG	Inv. ex.
10	C	GL	850	2	0.1	-10	21	VG	Inv. ex.

Scoring of occurrence of microcracks:

Total number of microcracks at 10 points: VG (very good);

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0, G (good): 1, F (fair): less than 5, P (poor): 5 or more

In the same way as in Examples 1 and 2, No. 8 of Table 7 had a high dew point, so microcracks occurred. Nos. 1 and 3 had amounts of hydrogen larger than 1%, so some microcracks occurred. Further, Nos. 1 to 3 had low oxygen concentrations, so the furnace became dirty along with evaporation of the Zn in the furnace and deterioration of the surfaces of the steel sheets were observed.

(Example 4)

Cold rolled steel sheets of the steel compositions shown in Table 8 after the ordinary hot rolling and cold rolling processes (sheet thickness 1.4 mm) were used as materials. Parts were coated with Al by hot dipping or coated with Zn by hot dipping. The hot dipping was performed using a nonoxidizing furnace-reduction furnace type line. After plating, the gas wiping method was used to adjust the plating deposition, then the sheets were cooled. The plating appearance was good with no nonplated areas. The type of plating and the bath temperature are shown in Table 9.

Table 8

C	Si	Mn	P	S	Al	N	Ti	Cr	Mo	B
0.22	0.21	1.20	0.02	0.003	0.027	0.003	0.002	0.18	0.02	0.0018

Table 9

Sym-bol	Composition of plating layer	Single side deposition (g/m^2)	Bath temp. (°C)
AL	Al-10%Si-2%Fe	80	660
GI	Zn-0.2%Al	85	460
GA	Zn-10.5%Fe	70	460

The thus produced steel sheets were heated under various conditions and then formed by the hat shaped die shown in FIG. 1. The clearance at the time of hot pressing is shown in Table 10. After this, in the flange

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of each part, 5 mmϕ holes were punched at 10 points with a clearance of 0.5 mm (two sides). After the elapse of seven days, a 20X power loupe was used to examine the punched out parts and judge the presence of microcracks. The samples were heated by insertion in an electric furnace controlled in atmosphere. The time for raising the temperature to 900°C was about 4 minutes, the time from the furnace to the press was about 10 seconds, and the press start temperature was about 750°C. The cooling was performed in the die. The average cooling rate from 700°C to 350°C was 40°C/sec. The heating conditions and the presence of any microcracks are shown in Table 10. Note that after forming into the hat, part was cut out and measured for Vicker's hardness at a load of 10 kgf, whereupon the Hv was in the range of 410 to 510 and a martensite microstructure was exhibited at all levels.

Table 10

No.	Clearance at hot press (thickness ratio)	Type of plating	Temp. (°C)	Holding time (min)	Heating atmosphere			Occurrence of microcracks	Production of iron oxide	
					Hydrogen (vol%)	Dew point (°C)	Oxygen (vol%)			
1	0.8	CR	900	3	0.02	1	0.5	P	Yes	Comp. ex.
2	1.0	CR	900	3	0.02	1	0.5	VG	Yes	Inv. ex.
3	1.1	CR	900	3	0.02	1	0.5	VG	Yes	Inv. ex.
4	1.4	CR	900	3	0.02	1	0.5	VG	Yes	Inv. ex.
5	1.7	CR	900	3	0.02	1	0.5	G	Yes	Inv. ex.
6	1.9	CR	900	3	0.02	1	0.5	P	Yes	Comp. ex.
7	0.8	GI	900	10	0.07	6	21	P	No	Comp. ex.
8	1.0	GI	900	10	0.07	6	21	VG	No	Inv. ex.
9	1.1	GI	900	10	0.07	6	21	VG	No	Inv. ex.
10	1.4	GI	900	10	0.07	6	21	VG	No	Inv. ex.
11	1.7	GI	900	10	0.07	6	21	G	No	Inv. ex.
12	1.9	GI	900	10	0.07	6	21	P	No	Comp. ex.
13	0.8	GA	850	5	0.2	0	21	P	No	Comp. ex.
14	1.0	GA	850	5	0.2	0	21	VG	No	Inv. ex.
15	1.1	GA	850	5	0.2	0	21	VG	No	Inv. ex.
16	1.4	GA	850	5	0.2	0	21	VG	No	Inv. ex.
17	1.7	GA	850	5	0.2	0	21	G	No	Inv. ex.
18	1.9	GA	850	5	0.2	0	21	P	No	Comp. ex.

Scoring of occurrence of microcracks:

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Total number of microcracks at 10 points: VG (very good): 0, G (good): 1, F (fair): less than 5, P (poor): 5 or more

Nos. 1, 7, and 13 of Table 10 had clearances of the die at the time of hot pressing of less than the limit, so five or more microcracks were observed. Nos. 6, 12, and 18 of Table 10 had die clearances at the time of hot pressing of over the limit, so were uneven in strength and had residual stress remaining in the parts, so five or more microcracks were observed. Nos. 5, 11, and 17 had somewhat larger die clearances at the time of hot pressing, so were uneven in strength and tended to have residual stress remaining in the parts, so some microcracks occurred.

INDUSTRIAL APPLICABILITY

According to the present invention, it is possible to use hot rolled or cold rolled steel sheet or Al-based plated steel sheet or Zn-based plated steel sheet to produce high strength members by the hot pressing method and possible to use them without hydrogen embrittlement.

CLAIMS

1. A method of hot pressing a high strength automobile parts comprising using steel sheet containing as a steel compositions, by wt%, C:0.05 to 0.5% or steel sheet plated mainly by Al or Zn to form an automobile member by hot pressing during which making the heating temperature before pressing at least Ac_3 and not more than 1100°C, making the hydrogen concentration in the heating atmosphere not more than 6 vol%, and making the dew point not more than 10°C.

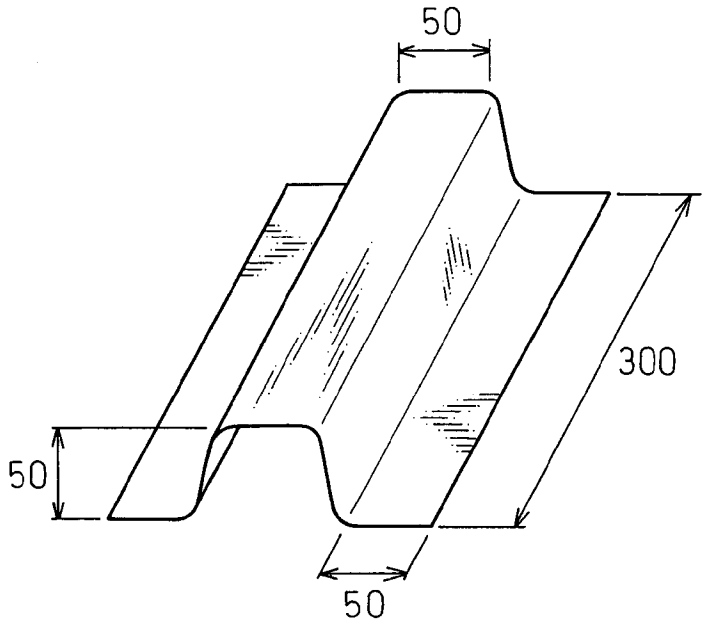
2. A method of hot pressing a high strength automobile parts as set forth in claim 1, characterized in that a hydrogen concentration in the heating atmosphere is not more than 1 vol% and a dew point is not more than 10°C.

3. A method of hot pressing a high strength automobile member as set forth in claim 1 or 2, characterized by introducing the steel sheet after heating into a press machine and making a clearance between a die and punch at the time of shaping 1.0 to 1.8 times the thickness of the steel material used.

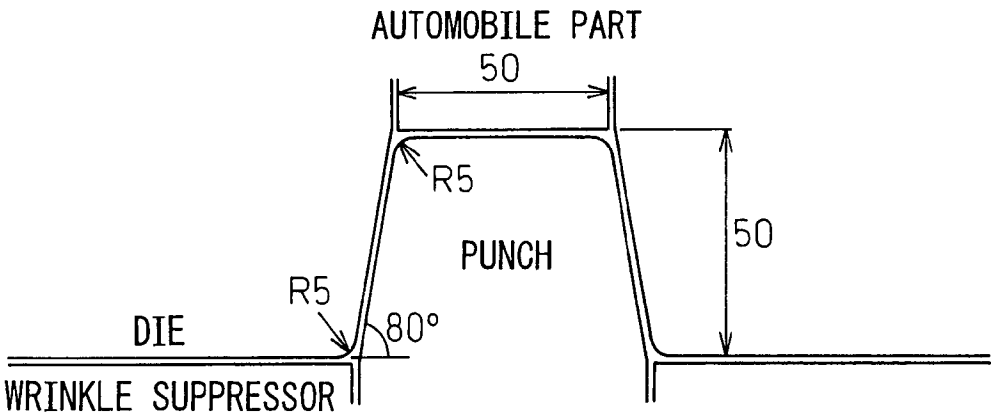
4. A hot pressed part characterized by using a method of hot pressing as set forth in any one of claim 1 to claim 3.

Fig. 1

(a)



(b)



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(54) Apparatus and method for control of metallic coating-weight by the use of gas knives

(57) A gas wiping die is provided with a predetermined arrangement of cams (41) which act against a flexible lip (21) either directly or through intermediate push rods (31) or the like to adjust the opening of the wiping die orifice (29). The invention may involve several cam shafts (43) which may be rotated by a so-called stepping motor or motors. The arrangement allows a smooth progression of changes in the opening and camber of the coating die gas orifice slot. Various contours of cam shaft may be provided to provide easily implemented programs of die adjustment, either smoothly or discretely, to adjust for variations in coating conditions or procedure.

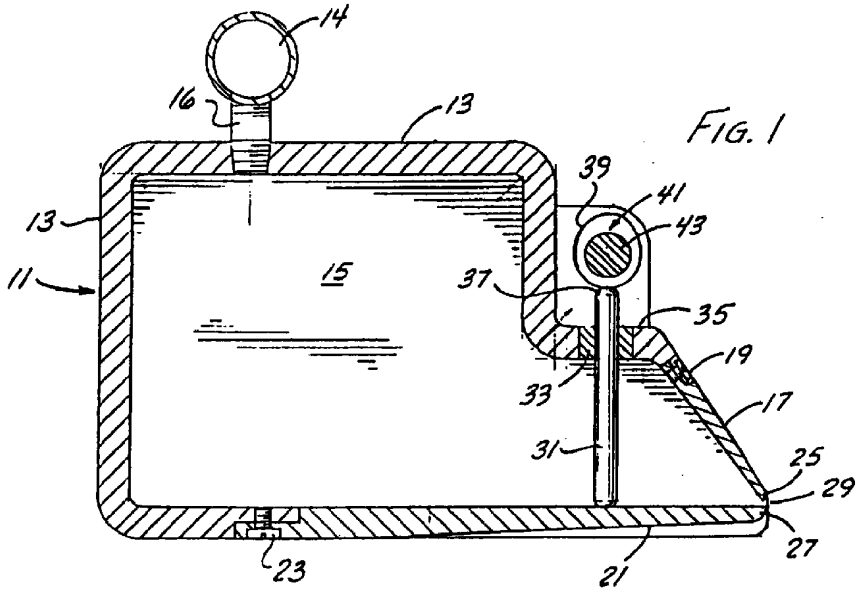


FIG. 1

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Description

Background of the Invention

(1) Field of the Invention.

This invention relates to the coating of metal strips with uniform coating weights and more particularly to the determination or control of the coating weight on hot-metal coated strips with so-called gas doctors or gas knives, and particularly to the use of adjustable orifice gas knives.

(2) Description of the Prior Art.

Various means have been used to control the coating weight of so-called hot dip coated strip and sheet material and particularly ferrous-base sheet and strip material which is passed through molten baths of tern, zinc, aluminum, aluminum-zinc and the like. In the coating of such material, the ferrous substrate material as it exits from the bath surface, draws up with it a quantity of at least temporarily adhering molten metal, which, as the ferrous material passes upwardly, solidifies on the surface of the base material. If the strip or sheet material is withdrawn from the bath sufficiently slowly, the excess molten metal will drain from the surface naturally establishing a coating thickness or weight dependent basically upon the temperature of the substrate as well as the coating plus the physical characteristics of the unsolidified coating material, particularly the weight or specific gravity. As coating lines have been accelerated, however, too much excess coating has been drawn up from the molten bath upon the surface of the substrate and has not had sufficient time to drain back into the molten bath causing overly thick as well as uneven coatings on the coated product.

Various expedients have been used to wipe this excess coating from the substrate surface including charcoal or the like floating upon the bath surface, stationary wipers between which the strip passes, so-called coating rolls between which the strip passes and in more modern practice blasts of gas which wipe the molten coating back into the bath leaving the desired residual surface layer which then solidifies, forming the ultimate coating upon the substrate.

The use of coating or doctor rolls between which the ferrous substrate passed as it exited from the molten bath was a very significant improvement in hot metal coating of sheet and strip material and over a period, the use of such rolls became very sophisticated in design and implementation. These coating rolls essentially limited the amount of metal drawn out of the metal bath with the substrate and then allowed the metal to be recoated with hot metal from the limited reservoir of metal between the rolls. The coating weight could be controlled by the pressure applied between the rolls and the depth the rolls were submerged in the molten bath. Almost all such sophisticated coating roll systems have now, however, been superseded by even more sophisticated gas or fluid wiping apparatus which is more flexible and longer lasting and, in general, does a better job at a lesser cost.

In the fluid or gas wiping process as used in the steel industry, a gas such as steam, air, nitrogen or other gaseous fluid is forced from a plenum chamber through a narrow slot or slit and directed against a molten metal coated steel strip or sheet as it passes upwardly from the molten coating bath past or by the slot. The narrow elongated blast of gas issuing from the slot wipes excess molten coating from the surface of the metal base and generally smooths the molten surface. Such gas wiping devices are generally referred to as fluid knives or wipers, or, if air is the wiping fluid, usually as air knives or wipers. They are also sometimes referred to as air doctors.

Fluid-wiping techniques have, in turn, developed into very sophisticated systems and a number of apparatus designs have been developed to wipe or smooth various molten coatings including zinc and aluminum and combinations of zinc and aluminum. One persistent problem has been that of so-called edge buildup in which the coating is thicker along the edges of the coated material due generally to less effective wiping at the edges as the result of interference between oppositely directed blasts of gas wiping the two opposite sides of the strip or sheet material. This has necessitated the use of increased slot diameters at the ends of the gas wiping orifices or slots near the sides of the strip or sheet material. However, since the ultimate coating weight is a function of a number of factors, including, primarily, strip or line speed, strip width and surface finish, strip temperature as well as the molten bath temperature, distance of the gas nozzle from the strip, gas flow through the nozzle and configuration of the nozzle, it is difficult to provide and, in fact, so far as it is known, impossible to provide a single nozzle or slot width and configuration that will be suitable for all coating conditions. Superimposed upon these enumerated factors in any particular coating bath is the further complication that each coating material has its own characteristics which inherently change the characteristics of the wiping operation. For example, molten zinc is inherently heavier than molten aluminum so that the effects of gravity tend to be more pronounced and a lesser blast of wiping gas will, in most cases, be effective to remove more molten zinc coating material than aluminum coating material. The amount of edge buildup, furthermore, is likely to be significantly less. Thus, in changing from one to another coating material, a new coating nozzle or wiping air die is usually necessary, requiring not only the changing of nozzles or wiping dies, a not inconsiderable job, but the maintenance of an inventory of different nozzles and dies which inventory is by no means inexpensive.

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Changes in line speed during operation of a coating bath, cooling of the strip, particularly if it has been heated in batch-type rather than in-line furnaces, changes in bath temperature and the like may also have considerable influence upon the wiping of the molten coated surface with a fluid wiper. For example, the molten bath and the strip or sheet being coated are seldom, if ever, of similar temperatures when they are brought together by the strip being immersed in the bath. Consequently, if the strip is cooler, the bath will tend to be cooled and, if the strip is hotter, the bath will tend to be heated as the strip is passed through the bath and the bath will tend to recover in the intervals between strips. This factor in itself causes the coating on the strip to vary progressively in a pattern from end to end. While small, such variation may assume importance for certain products and can be of relatively great economic significance in large scale operations, where any excess coating can assume considerable importance in cost of coating.

It has been recognized, therefore, that it would be desirable to have an infinitely adjustable slot width within normal operating limits which could, in particular, be adjusted while a coating line is operating to make adjustments for other variable factors of the coating operation as well as to make deliberate changes when such appear desirable. For example, it may at times be convenient to change the coating weight part way through the coating of a coil to accommodate a particular order and the like.

It would, in particular, be convenient if the width and configuration of the slot of a gas wiping die could be altered or varied easily, not only between orders or dependent upon coating conditions, but also as a coating operation progresses. Among prior attempts to provide variable orifices to conveniently make changes in the coating of a substrate may be mentioned the following:

U.S. Patent 2,415,644 issued February 11, 1947 to L.W. Leonhard et al. discloses an early form of doctor blade or air knife for smoothing and wiping the coating on a strip or web. Changes in the coating weight obtained by changing various parameters of the coating process, including the gas pressure, the width of the gas wiping orifice and other expedients are mentioned or discussed. Leonhard et al. discloses an air knife having two halves held together by adjusting and locking bolts. These bolts extending through the center of the enclosed chamber may in one embodiment be adjusted by a mechanical arrangement to adjust the opening of the gas orifice between the two halves of the die body in accordance with a control system. While the Leonhard et al. apparatus is designed especially for coating nonmetallic webs and the like and is arranged to operate on only one side of the web, it would probably be applicable also to the coating of metal strip and sheet material.

U.S. Patent 3,753,418 issued August 21, 1973 to R. Roncan discloses a wiping die arrangement for ferrous sheet and strip incorporating a nonadjustable upper lip opposed to an adjustable or flexible lip. The flexible lower lip may be adjusted by means of a mechanical screw arrangement which, through a series of rotating arms and intermediate intermeshing gears, forces the flexible lip up and down to adjust the distance between the lips. Differential adjustment along the length of the lip is said to be attainable.

U.S. Patent 3,841,557 issued October 15, 1974 to E.S. Atkinson discloses a gas wiping die in which the width of the slot from which the gas issues can be selectively adjusted by means of heating elements positioned at closely spaced intervals in one-half of the die. Atkinson, in his background discussion, discloses prior use of removable shims or inserts and the use of adjusting screws or bolts to warp the walls of the gas slot with respect to each other. These prior methods were slow and required an excessive amount of labor, however.

U.S. Patent 3,917,888 issued November 4, 1975 to D.J. Beam et al. discloses a gas wiping die in which the orifice width can be selectively changed by sliding into place on one lip, a variable insert member. The rate of taper of the opening can be adjusted by inserting different adjustment strips on the lip.

U.S. Patent 3,938,468 issued February 17, 1976 to J.B. Kirschner discloses a gas wiping die having a variable slot valve means mounted in or between the lips of the gas orifice of the die to change the effective cross section of the orifice. The valve means is in the form of a long, substantially round member or bar mounted in a circular opening within the die lips. The circular member is relieved in a certain pattern along one side to form a variable valve surface to allow the escape of gas past the rotatable valve member.

U.S. Patent 4,106,429 issued August 15, 1978 to I.J. Phillips discloses a gas wiping die in which the wiping orifice may be varied in size by moving the lips of the wiping orifice of the die longitudinally toward or away from the material being wiped. The lips are moved longitudinally with respect to the remainder of the wiping die. Such longitudinal movement is effected by a rotatable cam arrangement journaled within the lip structure itself. When a cam is rotated, it causes the separate lip structure to slide laterally with respect to the remaining structure of the wiping die, in effect, lengthening or shortening the lips.

U.S. Patent 4,524,716 issued June 25, 1985 to H.J. Mueller discloses a recent gas wiping die particularly for use in the paper coating arts. The Mueller die has converging lips and is provided with a flexible gas flow modification member in the form of a semi-stopper directly behind the opening of the lips. This stopper may be moved toward and away from the opening in the lips to relatively open or close the orifice and thereby control the flow of gas from the lips.

U.S. Patent 5,127,581 to Kuwano et al. discloses a fluid jetting pipe for use with powered chemical sprayers, blow cleaners and the like. The jetting pipe has an opening at the end and is provided with variable pivoted outlet members or throttling means projecting forward from the normal outlet of the jetting pipe. These pivoting outlet members are geared to each other by an intermediate intermeshing gearing which coordinates the opening or outward movement of

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one outlet member with the other. The intermeshing gears jointly serve as a linkage unit for simultaneously turning both the variable outlet members in opposite directions. While this U.S. Patent is directed toward a special type of nozzle, principally different from the inventional means, it does broadly disclose two variable position outlet members which are spring biased away from each other (by a separate spring) and which has a mechanical arrangement for overcoming the spring biasing, and describes interlocking gears to coordinate the movement of the two variable position outlet members. The toothed gear arrangement which is disclosed in this U.S. Patent shows gears one jaw or closure member of a pair of closure members together so they have equal movement. The actual movement of the jaw members is not effected by the gearing between them, however. If this U.S. Patent would be combined with e.g. U.S. 2,415,644 therefore, this would result in coordinating the opening of the two sets of outlet members together so that both operate equally or are opened or closed equally by being geared together. If the general arrangement of U.S. 5,127,581 would be changed to a presumably less preferred, merely once mentioned cam arrangement such cam arrangement would then also be used as a linkage unit for simultaneously turning both of the variable outlet members in opposite directions.

As can be seen from the above citations of prior patented gas wiping dies, there have been a fair number of attempts to produce a practical wiping die having a variable, and preferably, an infinitely variable die orifice. However, each has had certain disadvantages and no really satisfactory arrangement for varying the contour of the lips of the gas die to vary the flow of gas through various portions of the gas die to allow for varying conditions on a coating line have been either designed or developed. There is, consequently, a need for a practical gas wiping die or gas doctor, particularly for wiping and smoothing molten metal on the surface of ferrous strip and sheet material that may be conveniently varied in cross section to quickly vary the amount of gas issuing from the die at any given location across the face of the die to allow for variations in the operation of the coating line.

Objects of the Invention

It is an object of the present invention, therefore, to provide a gas wiping die in which the width of the wiping orifice may be varied from portion-to-portion or location-to-location across the face of the die to adjust for changes in the operating parameters of a coating line.

It is a further object of the invention to provide a gas wiping die in which the opening of the gas wiping orifice may be easily varied in a predetermined ratio across the face of the die with changes in the coating operation.

It is a still further object of the invention to provide a substantially infinitely adjustable orifice across the face of a gas wiping die to facilitate control of the wiping gas force upon various portions of a coated strip or sheet passing the coating die.

It is a still further object of the invention to provide an arrangement for differentially varying the width of the opening in a gas wiping die by means of a predetermined cam-shaft arrangement acting directly upon the lips of a wiping die.

It is a still further object of the invention to provide an arrangement for varying the opening of the orifice of a gas wiping die across the face of the die by means of a predetermined shape of a rotatable cam shaft controlling the position of the lips.

It is a still further object of this invention to provide an arrangement for varying the opening of a wiping die by means of an easily changeable cam shaft.

It is a still further object of the invention to provide a method of varying the wiping of a strip or sheet material with a gas wiping die during the coating of a single length of coil in a predetermined manner to allow for a progressive change in line or coating conditions during the coating of a single coil.

It is a still further object of the invention to provide a coating die apparatus that is effective to accurately and conveniently vary, in a predetermined manner, the opening of the wiping orifice of a gas wiping die by a single, foolproof mechanical arrangement.

It is a still further object of the invention to provide a convenient and effective arrangement for varying the opening across the face of a gas wiping die by means of a series of interconnected cams.

It is a still further object of the invention to provide a convenient and effective arrangement for varying the opening of a gas wiping die by means of a series of interconnected cams or a cam shaft extending more or less parallel to the opening of the die and acting upon a flexible lip of said die.

It is a still further object of the invention to provide an arrangement for varying the opening of a gas wiping die by use of more than one cam shaft.

Further objects and advantages of the invention will become evident from review of the following description and discussion together with the appended drawings.

The inventional solution is as defined in claims 1 and 12. Preferable features and embodiments are defined in the subclaims 2 to 11 and 13 to 15. The inventional apparatus is suitable for smoothing and wiping liquid material on a strip, liquid molten metal coated strips or liquid coating material on a flat base material.

The inventional method according to claims 16 to 19 can advantageously be performed with a cam arrangement as defined in the preceding device claims.

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Brief Description of the Invention

The present invention provides a gas wiping die for the wiping of molten coatings on flat material passing from a molten coating bath and particularly a molten metal coating bath. The wiping die is provided with at least one flexible or movable lip which is preferably permanently biased in one direction and urged in the opposite direction to tend to open or close the gas wiping die orifice by a multiple cam arrangement. The multiple cams are mounted upon or form an integral part of a cam shaft which is in mechanical contact either directly or indirectly with the flexible lip. Rotation of the cam shaft causes the multiple cams or the various sections of a differential cam or cams to exert more or less force against the movable or flexible lips to adjust them to open or close the die orifice at the effective location of the particular cam diameter in order to control the passage of wiping gas through this portion of the wiping die orifice. More than one cam shaft may be used to exert variable force against the flexible lip. Preferably an electrical stepping motor or motors is or are used to operate the cam shaft or shafts which control the opening between the lips of the die orifice at various positions along the orifice. The cam shafts may be used in conjunction with and/or replaced by differently contoured cam shaft assemblies to vary the adjustments possible. The cam shaft assemblies or equivalent functioning arrangements may be used to progressively vary the opening of wiping dies in a predetermined manner as a strip passes through a coating line to adjust for regularly recurring changes in coating distribution from one end of a coated strip to the other.

The Applicant has proved that if a differential cam arrangement is provided on a cam shaft with the cams in contact with a flexible lip pf the wiping die that a very practical and inexpensive method and means for adjusting the lips of the wiping die differentially both across the face of the strip and temporally along the strip as coating continues is attained. The arrangement of the invention is at once simple, practical and inexpensive.

In the inventional apparatus the cam shaft is preferably provided with a plurality of discreet cam patterns providing different contours to the lip openings in a predetermined time-related sequence when moved at a controlled rate by a motive means connected thereto.

Furthermore, the cam shaft may be advantageously provided with a plurality of smoothly changing cam surface patterns which effectively blend into each other to provide a sequence of preset time-related lip openings blending into each other as the cam patterns are moved at a controlled rate by a motive means connected thereto.

The time sequence essentially is dependent not upon an outside sequence of events, but directly upon a preset contour of a cam arrangement which may be designed to correspond with outside events such as liquid level speed, strip length, temperature or any of a number of other parameters, but is nevertheless preset once made.

Brief Description of the Drawings

Figure 1 is a transverse cross section through a preferred embodiment of the improved wiping die of the invention.

Figure 2 is a longitudinal view of the wiping die shown in Figure 1 viewed in the direction of, or facing the wiping orifice, but with the upper front lip of the die removed.

Figure 3 is a diagrammatic sketch showing the cam arrangement and drive arrangement from the front of the wiping die.

Figure 4 is an end view of a typical cam shaft of the invention showing various diameters and contours of the cams on such shaft.

Figure 5 is a diagrammatic sketch similar to Figure 3, but of an alternative embodiment of the invention incorporating two cam shafts.

Figure 6 is a diagrammatic sketch of a further alternative embodiment showing three cam shafts providing additional flexibility with respect to the corn action.

Figure 7 is a transverse cross section of an alternative embodiment of the invention in which the cam arrangement directly contacts the flexible lower lip section of the wiping die from outside the plenum chamber of the wiping die.

Figure 8 is a longitudinal view of the arrangement of Figure 7 viewed in the direction of the wiping gas orifice with the protective cover normally mounted over the cam arrangement removed.

Figure 9 is a transverse cross section of an alternative embodiment of the invention wherein the cam shaft directly contacts the flexible lower lips from inside the wiping die plenum chamber.

Figure 10 is a front view of the embodiment shown in Figure 9.

Figure 11 is a transverse cross section of an alternative embodiment of the invention wherein the cam shaft directly contacts the upper lip of the coating die from inside the plenum chamber.

Figure 12 is a front view of the embodiment shown in Figure 11.

Figure 13 is a diagrammatic sketch of a control system associated with a pair of wiping dies similar to those shown in Figures 1 and 2 mounted on a hot dip coating line.

Figure 14 is a view along the side in a longitudinal direction of a cam shaft made in accordance with one frequent arrangement or embodiment of the invention.

Figure 15 is a view along the side in a longitudinal direction of an integral cam shaft and cam arrangement in accordance with another embodiment of the invention.

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Figure 16 is a view along the side in a longitudinal direction of a further embodiment of the present invention.

Figure 17 is an end view of one contour of cam arrangement on a cam shaft in accordance with the present invention.

Figure 18 is an end view of an alternative cam contour on the cam shaft of an alternative embodiment of the present invention.

Figure 19 is a graphical presentation of the contour of the coating of a coated strip exhibiting a differential contour from end to end, said strip having been coated without using the present invention.

Figure 20 is a graphical presentation of the contour of the coating from one end to the other of a coated strip made using the present invention.

Description of the Preferred Embodiments

As indicated in the foregoing introductory remarks, the ultimate coating weight on a hot metal coated strip is a function of a number of factors, including (a) the line speed, (b) the width and surface finish of the strip, (c) strip temperature (d) molten bath temperature, (e) distance of the gas nozzle from the strip, (f) gas flow through the nozzle, and (g) the configuration of the nozzle which determines the configuration of the gas stream issuing from the gas knife and against the strip. One of the primary factors is the configuration of the gas stream issuing from the gas wiping orifice of the gas wiping die. Furthermore, conditions tend to change as the coating process proceeds. Consequently, it would be desirable to have a universally adjustable gas wiping orifice on a gas wiping die, which orifice could be adjusted not only with respect to the relative opening of said orifice, but also with respect to the contour or relative opening across the lateral extent of the gas orifice. In other words, it may be desirable in some operations, to have the gas wiping orifice relatively wide in the center and narrow toward the two edges so a heavier blast of gas issues from the center of said orifice. On the other hand, it is more frequently desirable to have the ends of the gas orifice relatively wider so that a heavier discharge of gas issues from the ends or extremities of the orifice providing more wiping action upon the edges of the strip where a heavy coating buildup tends to occur due primarily to interference between two oppositely moving gas streams or curtains from the two oppositely directed gas wiping orifices on opposite sides of the strip near the strip edges. This is the so-called edge-wiping or heavy edge phenomenon. If a sheet or strip with a uniformly heavy edge is coiled in the normal manner, the edges of the strip will be progressively turned upwardly as the coil is wound causing an unstable winding condition and in a long section of strip resulting in a coil having a severe camber when uncoiled. Such coils often require a separate flattening operation before being used. In addition, the excess coating on the edges is an economic loss, since, if the specification for the thickness of the coating is attained in the center of the coated strip, the sides of the strip will be too heavily coated with a resulting substantial loss in coating material, the cost of which cannot be recovered due to the fact that the coating weight meets a lesser specification overall.

Various arrangements and mechanisms have been proposed in the past for adjusting the width over all of the coating die orifice or, alternatively, adjusting the shape of the orifice. Such methods may comprise most basically the provision of a series of wiping dies having various configurations of orifice openings. Such arrangements may also comprise separate lip assemblies having differential or adjustable openings between them. A still further alternative which has been used to some extent, but not widely, has been in those arrangements in which the lips of the wiping die may be adjusted either mechanically, usually by rotating a threaded rod of some form to move the lips of the wiping die toward or away from each other, or, in at least one case, thermally, to differentially vary the shape and opening between the lips of the gas wiping die. While these various methods for adjusting the lips of a gas wiping die have had some success, they have, in general, not been satisfactory overall. A major detriment of such prior systems has been the multiple adjustments that must be effected in order to differentially adjust the lips of the coating die. This can require the use of multiple control and motor means. Consequently, there has been a need for a practical, easily operable and easily adjustable means for universally and differentially adjusting the opening between the lips of the wiping die or between various portions of the lips of a wiping die.

The present invention provides the practical arrangement, therefore, for varying the opening between the lips of a wiping die on a predetermined pattern basis as well as for making changes in the gauge of the wiping die in response to changing conditions on a coating line. Such changing conditions may involve changing from one order to a different order frequently requiring as a result different gauges of metal, different heating conditions or different coating materials. For example, one order may be for one gauge of strip or sheet material and the immediately following order may have a different gauge.

Since metal to be coated seldom, if ever, is entered into a coating pot at the same temperature as the molten metal within the coating pot, any new gauge strip entered into a coating pot will be either extracting heat from the coating pot at a greater or lesser rate or adding heat to the coating pot at a greater or lesser rate than the immediately preceding strip of a preceding order. In many cases, the material being coated will be heated to a higher temperature during pretreatment than the molten coating bath, depending, of course on the composition of the coating bath, and this additional heat is taken advantage of to maintain the temperature of the coating bath. However, a heavier gauge strip or sheet of the same temperature will add more heat to the molten bath displacing, over a period, the temperature of the bath upwardly and resulting in different wiping properties of the molten metal. Since the heated metal strip enters the

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bath at a very high rate of speed, it may cause relatively significant temperature changes in a very short time. Meanwhile, although adjustments of the heating of the coating pot by its principal heating means may be made to counteract changes in the heating of the strip, such changes can only be made relatively slowly. If relatively quick adjustments of the wiping gas can be made, however, these other changes can be often compensated for.

While the pressure of the gas and thereto, the volume of wiping gas have previously been adjustable relatively quickly, differential adjustment of the wiping gas orifices has not been conveniently attainable on an accelerated basis. The differences which differential heating may make in the relative coating weight across the width of a strip may, by the use of the present invention, be immediately compensated for by changing the relative opening of the slot of the coating die. This is done by adjusting the cam arrangement of the invention to bias one of the lips of the coating die more or less from the opposing lip to open or close that particular portion of the coating die orifice as may be appropriate to maintain uniform conditions of coating of the strip.

The coating characteristics of various coating materials such as, for example, zinc, aluminum and aluminum-zinc combinations are also different and the gauge of the coating across the face of the strip varies particularly dependent upon the weight or density of the coating, since different densities cause more or less of the coating to drain downwardly upon the strip surface back into the molten bath merely through the action of gravitational force. Normally upon the changing of the coating material within the pot, it will be necessary to also change the wiping dies in order to have a wiping die with an orifice contour appropriate to that particular coating material. Obviously, however, changing the coating dies adds an extra cost factor, and even if accomplished during the changing of other elements of the coating bath arrangement, still requires additional personnel, not to say the danger of working above or in the vicinity of a hot metal coating material. By the use of the present invention, however, that is with the use of a cam arrangement for varying the width of the slot orifice in the coating die, rapid changes from one coating material to another may be easily adjusted for merely by providing a cam having sections about its diameter appropriate for several alternative coating materials. This still allows a certain amount of specialized variation on the cam which will enable the process to be adjusted for the particular specialized changes which may be encountered with any particular coating material. Alternatively, a different cam rod with a different cam ratio may be easily substituted for a previous cam rod to alter the available adjustments to the orifice opening available during operation.

The following description in conjunction with the appended drawings is designed to make clear the full advantages as well as the operation of the process of the invention and the construction of the necessary equipment for implementing the process of the invention.

In Figure 1 there is shown a typical gas wiping coating die 11 comprising a chamber having more or less angular side walls 13 which enclose an open plenum chamber 15. It will be recognized that the plenum chamber 15 extends outwardly and inwardly from the plane of the drawing to form a fairly extensive open space for the receipt of a wiping gas such as air, steam, nitrogen or other suitable gas to be used for providing an elongated gas blast from the orifice of the wiping die to wipe the surface of a metal strip passing the orifice of the wiping die. Such wiping gas may be supplied to the plenum chamber 15 via headers 14 from which a suitable gas is fed via conduits 16 to the plenum chamber 15. The wiping die 11 is provided also with an upper lip 17 secured to the side walls 13 by fastenings 19, usually large industrial or machine screws. Likewise, the lower lip 21 is also secured to the side walls 13 through machine screws 23. It will be understood that the machine screws 19 and 23 extend more or less in a row along the face of the coating die as shown in various of the figures such as, for example, Figures 3, 5, 6 and 8 which show the upper lip fastenings 19. The lower end of the upper lip 17 is designated as 25 while the outer end of the lower lip 21 is designated as 27. These ends 25 and 27 are contiguous with each other and define between their surfaces a narrow gas slot 29 through which the gas wiping jet or sheet of gas extends. This slot orifice 29 may have an operating width of perhaps three (3) one hundreds to 4.5 one hundreds inches and is preferably adjustable in accordance with the invention within a range of .025 to .050 inches. As may be seen from Figure 2, this adjustment is fairly critical and may be accomplished across the extent of the lip through the action of a continuous series of push or adjustment rods 31 as shown in Figure 3, only one of which is shown in Figure 1. Such rods 31 are arranged to press downwardly upon the lower lip 21 to bias it away from the upper lip 17. It will be understood that there are a series of adjustment rods 31 as shown in Figures 2 and 3 spaced at intervals along the wiping die in a position to exert downward force against the lower lip at various positions along the length of the wiping die. The lower lip 21 is meanwhile arranged to have a natural resilient action which will tend to bring it back or flex it toward the upper lip 17. In this manner, the resilience of the metal in the lower lip is arranged to tend to close the slot orifice 29 while the adjustment rods 31 are arranged to resist this closure and maintain the slot orifice sufficiently open for the exit of the amount of wiping gas which it is desired to have pass through that particular portion of the slot.

The upper portions of the adjustment rods 31 pass through a series of bushings 33 in the upper surface of the side walls 13 of the coating die 11. As shown in Figure 11, the bushings are arranged in a step 35 in the upper portion of the side walls 13 of the coating die 11. However, it will be understood, that the bushings 33 could be positioned in any convenient location within the upper portions of the coating die 11. The upper bearing end 37 of each of the push rods 31 are arranged to contact various cam surfaces 39 of cams 41 spaced at intervals along a cam shaft 43. The cam shaft 43 extends longitudinally along the step 35 of the wiping die and is journaled in conventional fashion in suitable bearings,

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not shown, at the ends or positioned at strategic intervals along the step 35, or, in other words, along the longitudinal extent of the coating die 11. As shown diagrammatically in Figure 2, the cam shaft 43 may be turned either by manual adjustment from a suitable crank or other manual means, not shown, for applying torque to the cam shaft 43, or more preferably, by a remote drive means such as an electrical stepping motor or the like controlled from a remote location away from the coating line, or at least away from the immediate vicinity of the hot metal bath. Motor control of the position of the cam shaft may be either controlled by manually operated controls or by computer means as shown, for example, in Figure 13.

Figure 3 shows the end of the cam shaft driven by a chain drive 47 from a stepping motor 49 through the action of sprockets 51 and 53 mounted respectively upon the end of the cam shaft and the stepping motor shaft. The stepping motor 49 is in turn shown supported from an overhang on the end of the coating die. Such overhang 55 comprises the end of a structural member or bracket 57 which passes over the top of the coating die 11 and is secured to the upper portion of the side walls 13 of the coating die in any suitable manner. It will be understood that the bracket 57 may be replaced by any other suitable arrangement for supporting the coating die and/or the stepping motor 49.

Figure 4 shows an enlarged end view of the cam shaft 43 with the series of separate cams of varying sizes and configurations 41 spaced at various locations along the extent of the cam shaft 43. Normally the cams 41 located at or toward the ends of the cam shaft 43 will be larger in general diameter or "higher" at their largest portion than the cams 41 towards the center of the cam shaft 43. The smaller diameter portion of the cams 41 may be substantially the same height as the surface of the cam shaft 43 or may will be mere extensions of the surface of the cam shaft. Alternatively, they may comprise discrete cam sections on a separate shaft as shown in Figures 1 to 3.

As may be seen by reference to Figures 1 and 2, when the cam shaft 43 is rotated by the stepping motor 49 shown in Figure 3, the cams 41 will be rotated into various positions, depending on how much the stepping motor 49 is turned. If the cam shaft 43 is turned from an initial position in which all the cam surfaces are the same elevation or distance from the center 59 of the cam shaft 43, as shown at the upper left in Figure 4, to a position 180 degrees from the initial position, the cams will be brought into a position in which the distance of the cam surfaces 39 of each cam will be at a maximum distance from the center 59 of the cam shaft 43. This will bias the push rods or adjustment rods 31, as shown in Figures 1, 2, 3 and 4, downwardly to a degree dependent upon which diameter of the cam is bearing on its top bearing surface 37. Since the cams 41 designated A, B, C and D in Figure 3 from the ends of the coating die have the greatest maximum diameters in decreasing order, the push rods 31 at the ends of the die will bias the lower lip 21 of the die downwardly farther at the ends of the coating die than toward the center of the coating die. The minimum biasing is at the center of the coating die where the cam surface 39 of the various cams designated in Figure 3, for example, as L, M and N, in increasing order from the center cam L, has the minimum diameter or the minimum distance from the center 59 of the cam shaft 43 to the outer cam surface 39.

It will be seen from the above, therefore, that when the cam shaft is in the minimum position, i.e. wherein the cam surface 39 is the minimum distance from the center 59 of the center of the cam shaft 43, the camber of the slot opening 29, or, in other words, the differential between the opening on the ends of the coating die orifice and the opening of the center of the coating die orifice, will be a minimum. In the case where the cam surfaces are all of equal height at this point, the coating die will be arranged with the orifice having the same diameter along the entire extent of the orifice. When such cam shaft, however, is rotated 180 degrees, the distance from the center of the cam shaft 59 and the individual cam surfaces will be maximized and the orifice will be opened a maximum extent in all areas. Since the end cams are normally arranged to have the maximum distance at this point between the center of the cam shaft and the cam surface, the outer portions of the wiping die will be opened up a maximum amount when the cam shaft is at this 180° position. Rotation of the cam shaft an intermediate amount or degree between the minimum and maximum will provide various intermediate openings of the slot of the wiping die. Thus by machining a cam shaft in various configurations and then moving or rotating such cam shaft to a series of predetermined positions to take advantage of these configurations, a regular sequence of adjustments of the die can be made. Such adjustments may be made for various operating conditions. For example, if it is desired to operate the line with a relatively great differential between the opening of the coating die orifice in the center and the opening of the coating die orifice at the sides of the die or the extremities of the die in order to maximize the suppression of edge buildup, the cam may be rotated to the maximum differential position. However, if for some reason coating buildup is significantly less in another operation, the cam may be rotated to a less extreme position.

Alternatively, if the coating conditions tend to change as the operation of the line continues, the stepping motor may be operated progressively to turn or rotate the cam shaft and apply different openings to the coating die orifices to adjust for continuously varying conditions. While for illustration the use of a cam shaft arrangement has been shown in which the contour of the die opening slot is relatively or differentially opened more at the ends of the die as the overall die slot is increased in opening width particularly to compensate for increasing edge buildup, it will be understood that the cam shaft arrangement of the invention can be made with a relative contour which will compensate for various other changes in coating conditions and changes depending upon the operation.

In Figure 3, the arrangement shown in Figures 1 and 2 is shown from the outside of the die facing towards the die orifice. A series of increasing cam diameters across the face of the wiping die from the center may be seen and it will

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be noted that the opening of the slot orifice 29 at the bottom of the die is greater at the ends. The lower ends of the push rods or adjustment rods 31 may be seen through the slot opening or slot orifice 29 as viewed in Figure 3. The push rods or adjustment rods 31, although visible in Figure 3, have a very limited diameter in an actual installation so that they do not seriously interfere with the flow of gas from the slot orifice of the wiping die. In order to minimize any interference with such flow, it is desirable that the adjustment rods 31 be positioned back as far as possible from the opening in the slot orifice as shown in Figure 1. Other designs may bring the push rods even farther away from the slot opening.

Figure 5 is similar to Figure 3, but shows an alternative embodiment of the invention in which there are two separate cam shafts each provided with separate stepping motors 49a and 49b. It is frequently found that the coating operation has become unequal in that one edge of the coated strip or sheet has a heavier coating than the other edge. In such case, it may be desirable to differentially adjust the coating die openings on opposite edges of the strip. The arrangement shown in Figure 5 allows such independent adjustment of the die openings adjacent the two edges. In this manner, if there is a heavier edge buildup on one adjacent edge of the strip for one reason or another, the coating die can be opened more adjacent that edge to allow more for adjustment of the coating on that side by applying a heavier or more vigorous blast of coating wiping gas on that side. It will be understood that in the apparatus of Figure 5, a series of cams on each cam shaft will have different maximum diameters, usually based largely upon having a lesser/maximum on that portion of the cam which is to be used in the center of the die and a greater/maximum diameter on that portion of the cam shaft which is to be mounted near the edges of the coating die. Rather than having a generally curved configuration, therefore, which will provide first a maximum opening, decreasing to a minimum opening near the center of the die and then back to a maximum opening near the other end of the die, each individual cam shaft will have merely a series of diameters which will provide a minimum opening of the die orifices at one end of the cam shaft and a maximum opening at the other end when the cam shaft is turned to its maximum differential extent. As indicated above, this particular sequence is merely illustrative of a frequently used contour for the die opening and various changeable contours can be provided for. As in the arrangement shown in Figures 1, 2, 3 and 4, the cam shafts in Figure 5 may be adjusted either manually by crank means or preferably by stepping motors as shown. Where an automatic control system is used to control the operation of the stepping motors, it will obviously be necessary to incorporate a somewhat more sophisticated control means for maintaining the relative rotation of the cam shafts at a desired proportion. When there are two contiguous cam shafts, it will usually be found desirable to have the minimum height of the cams uniform completely around the two closest adjacent cams so that when these two ends are placed next to each other, the adjustment of the adjacent portions of the lips of the die will be the same regardless of what relative position the adjustment of the two cam shafts take. For convenience in illustration, the camber of the slot opening 29 is shown in Figure 5 uniform across its width.

Figure 6 shows a still further alternative arrangement of the invention which provides not just two (2) separate cam shafts, but three (3) separate cam shafts, 43a, 43b and 43c, each operated by a separate stepping motor 49a, 49b and 49c. As will be understood, this arrangement provides certain advantages of flexibility of the coating line, but also has increased complexity and may be worthwhile only in certain specific lines where complete flexibility is particularly important. The cams and slot opening are again for convenience shown uniform and, in fact, the variations in an actual installation may be so small as to be scarcely detectable with the naked eye.

While the arrangement shown in Figures 1, 2, 3 and 4 and their variations shown in Figures 5 and 6 are very effective and easily implemented, the adjustment rods extending through the plenum chamber of the coating die do introduce a minimum of turbulence and possible variations in the gas wiping jet issuing from the slot in the gas wiping die.

Fig. 7 shows an alternative arrangement for a wiping die in which the cam shaft 43 and cams 41 are journaled in bearings, not shown, on structural brackets 63 attached to or constituting extensions of the side walls 13 of the coating die, see, for example, Fig. 8. The cam shaft 43 and structural brackets 63 are mounted below the wiping die in a position such that the cam surfaces bear against the underside of the lower lip 21 of the wiping die. The stiff structural brackets 63 hold the cam surfaces 39 tightly against the bottom portion of the flexible lower lip 21 of the wiping die so that as the relative elevation of the cam surfaces changes with respect to each other as the cam shaft rotates, the flexible lip may be pressed more or less inwardly to partially close the gap of the slot orifice 29. In the embodiment shown in Figure 7, it will be understood that the flexible lower lip 21 is arranged to have its normal flexing in an outward direction so that such flexing will be opposed by the surfaces 39 of the cams 41. The upper lip 17 is arranged essentially in the same position as in the other die shown in the Figures 1 to 4. It is preferable to have a cover 65 mounted over the cam shaft 43 and cams 41 to prevent them from being splashed by hot metal from the molten coating bath located under the wiping dies. Obviously, if molten metal splashed upon the cam surfaces, it would change, at least temporarily, the critical machining of such surfaces and interfere with accurate operation and biasing of the lower lip 21 of the wiping die 11.

Figure 8 is a longitudinal view of the wiping die shown in Figure 7 viewed in the direction of the orifice slot 29 and showing the cam shaft 43 and the various cams 41 arranged under the main structure of the wiping die. In Figure 8, the cover 65 for the cam shaft arrangement has been removed in order to better show the cam arrangement. It will be noted that, since the cam shaft is positioned beneath the lower lip, there is absolutely no impediment within the plenum chamber 15 which might interfere with even egress of the wiping gas originally derived from the manifolds 14 from plenum chamber 15 through the slot orifice 29. The arrangement of a stepping motor 49 at the end of the wiping die is shown in Figure 8 in a position to operate the cam shaft 43. An outwardly increasing camber of the die opening 29 is shown in Figure 8.

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Figure 9 shows a still further embodiment of the invention in which the cam shaft 43 and cams 41 are positioned directly against the flexible lower lip in a somewhat similar manner to that shown in Figure 7 except that the position of the cams is above the lip 21 rather than below the lip 21. It will be understood that the permanent biasing of the lip 21 will, in the case of Figure 9, be toward the upper lip 17 rather than away from it as in Figure 7. Preferably, a smoothly contoured cover 67 is provided within the interior of the plenum chamber 15 of the wiping die shown in Figure 9. Such smoothly contoured cover prevents the inevitable hump occasioned by the presence of the fairly sturdy and substantial cam shaft 43 and cams 41 mounted thereupon from interfering with smooth flow of gas from the plenum chamber 15 through the slot orifice 29. Since the cam shaft 43 and cams 41 are maintained completely within the interior of the wiping die structure, they are in a fairly clean, non-contaminated atmosphere and it is, therefore, not necessary that a tight fit be maintained between the cover and the flexible lower lip 21. This allows the lip 21 to be easily flexed without interference from the cover. Such cover 67 is, as indicated above, present not so much as a protective cover to shield the cams 41 and cam shaft 43, but to attain a smooth flow of gas across the cover which gas might otherwise be forced into turbulence by passage past the uneven surfaces of the cams. It will be understood that both the size of the cam shaft shift and the height of the cover 67 has been exagerated in Figure 9.

Figure 10 shows a longitudinal outside view of the wiping die shown in Figure 9. It will be noted in Figure 10 that the slot orifice does not appear constricted by the presence of adjustment rods or other extraneous mechanical devices which might interfere with the smooth flow of wiping gas from the orifice.

Figure 11 shows a still further alternative embodiment of the invention in which the flexible lip is the upper lip 17, and such lip is biased from the inside by means of a rotatable cam arrangement. As in Figures 7 and 9, the cam shaft 43 and cams 41 supported upon such shaft are supported in turn upon a structural bracket 69 which is attached securely to the end of the upper side wall 13. In Figure 11, the flexible lip 17 will be permanently biased inwardly toward the plenum chamber and the cams 41 will serve to press such lip 17 outwardly away from the plenum chamber and also away from the slot orifice 29 so that said slot orifice is maintained open to allow wiping gas to pass therethrough in a thin sheet which serves to wipe the surface of the strip or sheet passing up from a coating bath past the end of the wiping die 11. Both the structural bracket 69 and the cam shaft 43, as well as the cams 41 attached thereto, are preferably protected by cover 71 which, as seen in Figure 11, is securely attached to the inside of the sidewall 13 of the coating die and extends downwardly over the cam assembly to generally protect the cam assembly from the contents of the plenum chamber 15. A space or clearance 73 is provided, however, between the end of the cover 71 and the inside surface of the flexible upper lip 17 to allow clearance for movement of the flexible lip 17. As in the previous embodiments, flexible lip 17 is biased so that it normally flexes itself in a direction opposite to the direction in which it is forced outwardly by the cam surfaces. While some of the wiping gas will get into the cam chamber behind the cover 71, no harm will be done since the gas, even in the case of steam, is clean and unpolluted. As in the previous embodiments in Figures 7 and 9, it will be seen in Figure 11 that the cam arrangement is substantially out of line with the slot orifice so that neither the cams nor the cover over the cams interferes in any way with the gas exiting from the slot orifice 29. Figure 12 is a front view of the coating die of Figure 11 showing the unobstructed die orifice 29 and clean appearance similar to Figure 10.

It will be understood in Figures 7, 9 and 11 that while the cam means are shown in the form of a single cam, usually rotated by a stepping motor mounted at one end of the die, that double or multiple cams can be used such as shown in Figures 5 and 6.

Figure 13 shows a diagrammatic sketch of a coating apparatus making use of the preferred wiping dies of the invention as shown in Figures 1 through 4. In Figure 13, a coating pot 81 for a hot-dip-coating-type metal such as aluminum, zinc or aluminum-zinc, shown as a pool of molten coating metal 83 in the pot 81, is arranged with a sinker roll 85 held at a predetermined depth within the molten metal 83 and a stabilizer roll 86 just below the surface of the molten metal. A metal strip such as a steel strip 87 passes into the hot metal through the surface after having passed over guide rolls 89, 91 and 93. The guide rolls 89 and 91 are contained within a muffle furnace 95 where the strip is heated, usually in a reducing atmosphere, prior to passing into the molten metal 83. A pair of gas wiping dies 97 and 99, which as indicated above, are substantially identical to those shown diagrammatically in Figures 1 through 4 are supported upon structural support members 101 and 103 upon which they are pivoted at 102 and 104 at a predetermined height above the hot metal bath. The steel strip 87 passes upwardly from the sinker roll 85 past the stabilizer roll 86 and between the gas wiping dies 97 and 99 in a position such that each side of the strip will be wiped by a preheated pressurized gas curtain issuing from the slot orifice of each wiping die. The wiping dies 97 and 99 are both provided with cam means 107 and 109 acting through push rod means 111 and 113 to bias the lower lips of the wiping dies 97 and 99 to provide a differential thickness curtain of gas to wipe the surface of the strip 87 in order to establish a desired thickness of coating upon such surface. The wiping dies 97 and 99 are shown partially broken away to reveal the push rod means 111 and 113 extending vertically inside.

The gas curtain issuing from the slot orifices of the gas wiping dies serves to wipe back excess coating into the coating bath 83. The gas for the wiping dies 97 and 99 is provided through headers 115 and 117 which are supplied with the gas through any suitable source. An electrical stepping motor is provided in conjunction with each coating die 97 and 99 to control the rotation of the cam means 107 and 109. Meanwhile, a main computer control means 121 is

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supplied to control the wiping of the strip or sheet automatically. The computer control means 121 is, in itself, controlled from a console 123 which may provide, through manual manipulation, input data indicating what thickness of coating is to be applied to the surface of the strip or sheet. The main computer control is provided with a number of sensors 125, 127 and 129 to detect respectively, the temperature of the strip issuing from the muffle furnace 95 and passing through the snout or hood 96, the temperature of the hot metal bath 83, the thickness of coating on the strip issuing from the bath on both sides of the strip, the temperature detector on the one side of the strip being denoted as detector 129A and the detector on the other side of the strip being denoted as detector 129B. A further detector, again with one detector on each side of the strip, is a coating thickness detector pair 131A and 131B provided above the wiping dies. The two detectors 131A and 131B detect the final coating thickness after the strip has passed through the coating detectors and preferably after the coating has solidified upon the surface of the strip, although this is not strictly necessary. Each one of these detectors is connected to the main computer control by a suitable signal line.

A control line passes also from the computer control 121, to each of the headers 115 and 117 feeding gas to the coating dies as well as to the stepping motors 119 which control each of the cam means. These control lines serve to automatically position the cam means to open or close the slot orifice or wiping orifices of each wiping die to the best differential opening across the face of the die for the particular coating conditions. They also control the amount of gas passing to the coating dies through the headers by means usually of a butterfly valve in the headers. These additional control features are not shown, as they are conventional in the art.

Figures 14, 15 amd 16 show for comparison longitudinal views of forms of cam shafts 43 having either integral cams or separate cams 41 rigidly secured to its surface similar to those shown in the previous views. In Figure 14 the cam shaft is shown by itself with a series of differentially proportioned cams equally spaced along the shaft. The overall camber is shown generally convex rather than concave as shown in the other illustrations to illustrate that various contours of the cam shaft may be used for various control functions. It can be seen in Figure 14 that the top of the cams upon the cam shaft has a substantially parallel series of cam surfaces whereas the bottom of the cam shaft, i.e. 180° from the parallel series of cam surfaces, has a generally convex arrangement of cooperating cam surfaces which define, as shown, a convex shape, which, it will be understood, could also be concave and might more usually be concave in outline. The cam arrangement shown in Figure 14 is designed especially for use with the dies shown in the previous figures where only either a push or adjustment rod bears directly upon the flexible lip which is ultimately moved by the cams or, alternatively, the cam surfaces bear directly upon the surface of the flexible lip of the coating die. It will be understood that various configurations and combinations of cams may be used together to obtain various arrangements of the cam surfaces and contours of the ultimate flexible die surfaces.

Figure 15 shows a modified type of cam in which the cam shaft itself provides essentially the surface of the various cams of the various sections. This is a substantially solid cam arrangement which, it will be noticed, has essentially the same overall outline of cam surfaces as in Figure 14.

One disadvantage of the arrangement shown in Figure 15 is that surfaces of the cams are inclined at the same angle as the overall change between the cam positions This is a disadvantage because of the inclined point of contact with other mechanical means which may tend to be detrimentally displaced to the side, particularly in the operation of adjustment rods such as shown in Figures 1 through 4. However, this disadvantage can be obviated by providing a cam shaft such as shown in Figure 16. In the cam shaft shown in Figure 16, each of the cam locations for operation of a push rod is provided with a uniform surface parallel to the central axis of the cam shaft so that there are, in fact, "flat," although upwardly curved, cam surfaces 61 for the push rods to bear against. It will be seen that Figures 14 and 16 are substantially equivalent to each other with the exception that the excess metal between the cam sections has been removed in Figure 14 to make a lighter, but not necessarily stronger or cheaper structure.

Various cam outlines may also be used. For example, a normal cam outline having a progressively increasing distance between the center of the cam shaft and the edge of the cam surface from one portion to another is shown in Figure 4. Another possible arrangement is shown in Figure 17 in which instead of the maximum distance between the center of the cam shaft and the surface of the cam, i.e. the highest uniform section, being located at 180° from the portion having the lowest uniform section, the distance of the cam surface from the center of the cam shaft instead increases from the minimum distance steadily as the cam turns until the maximum distance between the two points is found at a location of about 300 or more degrees about the cam shaft progressing in one direction. The distance of the cam surface from the center of the cam shaft then decreases precipitiously to bring it back to the minimum or lowest uniform section. The arrangement shown in Figure 17 provides a wider range of attainable adjustments over a cam shaft having the same diameter as the cam shaft arrangement shown in Figure 4. In other words, in Figure 4, the increase in size of the cam shaft occurs over one-half of the distance about the cam shaft, while in Figure 17 the same increase in distance occurs over more than three-quarters of the circumference of the cam or cam shaft allowing basically a more gradual increase which will give finer control with a less precise movement of the cam shaft. The lowest cam portion in Figure 17 is at 61A while the maximum cam diameter is at 61B fairly close by.

Other arrangements are also possible such as, for example, that shown in Figure 18 where the cam surface progresses in a series of steps from lesser to greater distances between the center of the cam shaft and the surface of the cams. As seen in Figure 18, the series of steps 133 provide longer areas, for example 133A and 133B, of more or

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less uniform cam action elevation and push rod action. This arrangement also has advantages in obtaining increased preciseness of movement with a less precise prime mover. In other words, a stepping motor or other movement providing means does not have to be as precise in operation to arrive at a given elevation on the cam surface. Instead, certain predetermined, desirable surface elevations are provided already machined on the surface, which the stepping motor or other motive unit need merely reach fairly imprecisely and which will then be held for a significant distance on the cam as the cam shaft turns so that there is less danger that an imprecise opening of the die lips may be attained by an anomaly in the operation of the motive means. Other possible variations of the cam surfaces to operate the cam of the invention will occur to those skilled in the art.

Figure 19 is a plot showing schematically the coating gauge or thickness of a lengthy strip or sheet passing through a coating bath where the strip or sheet is cooler than the bath temperature. Plot A is for thickness of the coating on one edge of the sheet and plot C is for the thickness of the coating on the other edge of the sheet, while plot B is the thickness of the coating in the center of the sheet. The gauge of the coating thickness are plotted on the abscissa of the graph in relative terms, i.e. an increase in coating thickness is shown by increase in the position of the graph for each coating, such positions being plotable according to the index marks on the abscissa at the left and the right of the graph. The index marks, however, do not have any absolute values other than that the marks are 1000th of an inch apart. Consequently, if the strip coating increases by 1000th of an inch, or one mil, the elevation of the plot will rise from one index mark to the next. The three plots, A, B and C, for different portions of the strip, consequently do not indicate that the coating is thicker on A than on C, but only show the relative increase in the coating from one end of the strip at the left of the plot to the other end of the strip at the right of the plot.

It may be seen in Figure 19 that the center of the strip tended to become more thickly coated, but only to a relatively minor extent, while the edges of the strip A and C were more subject to an increase in coating thickness due to heavy edge coating effect which became relatively more pronounced as the temperature of the bath decreased due to the cooling of the strip entering into the bath causing more material to adhere to the strip surface, basically because the molten coating material becomes slightly more viscous with decreasing temperature.

Figure 20 shows the same type of plot as in Figure 19. In the case of Figure 20, plots X and Z plot the relative thickness of coating on the edges of a strip or on the surface of the strip near the edges, while the plot X indicates the thickness of the coating in the center of the strip. The coating line in operation, plotted in Figure 20, is an illustration of typical results to be expected from a line such as shown in Figure 13 when equipped with a means such as the cam arrangement shown in the drawings to gradually increase the opening of the gas orifice and the gas wiping dies, particularly near the edges of the dies as the coating process proceeds from one end to the other strip being coated. It will be seen that the predetermined camber of the cam surfaces has effectively counteracted the progressively increasing viscosity of the coating by opening the gas wiping die's orifices sufficiently to counteract such increasing viscosity by wiping additional coating from the surface of the strip. The control system 121, shown in Figure 13, through detection of the temperature of the strip and of the bath material operates the stepping motors which turn the cam surfaces at a rate which will maintain both the temperature of the bath material more constant and at the same time, compensates for the increasing viscosity of the molten bath material by increasing the gas blast issuing from the slot orifices of the wiping dies. Since essentially the same series of increases tend to occur in each coating bath subjected to this phenomenon, a cam which will correct for this type of changes can be fairly easily designed.

As will be recognized, if the relative increase in the cam surfaces of the cam rod shown in either Figures 14, 15 or 16, are carefully calculated beforehand, and the rapidity of change of the stepping motor is also carefully orchestrated by a computer means or even, alternatively, by manual means, the continuous compensation demonstrated by Figure 20 for a slow and undesirable increase in the amount of coating on a strip can be easily compensated for. It will be recognized that if manual turning of the cams are provided, that the compensation will be somewhat stepwise, since very fine adjustments will not be practical. However, three to four adjustments of the cam rotation during the run through of a strip will successfully even out the coating to a considerable extent. Naturally, however, it is very desirable to have a computer run the stepping motors. Alternatively, the motors can be run manually, again, however, with the somewhat stepwise adjustment which this provides. A more uniformly coated strip on the average, however, will still result.

It will also be recognized, that a coating line making use of the cam rod adjustments of the present invention will normally have available a series of cam rods which may be easily substituted for each other, depending upon the operation of the line. For example, a given line may well have a master cam rod which will take care of most changes on a line and allow the line operators to compensate particularly over a period for heavy edge buildup and the like. However, at the same time, other specialized cam rods may be produced and kept available at the site to compensate for specialized conditions or to provide specialized adjustment for the openings in the coating knives.

While the present invention has been described at some length and with some particularlity with regard to several embodiments, it is not intended that the invention be limited to any such particulars or embodiments, but it is to be construed broadly with reference to the appended claims so as to provide the broadest possible interpretation of such claims in view of the prior art and thereby to effectively encompass the intended scope of the invention.

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Claims

1. An adjustable die for smoothing and wiping liquid coating material on flat elongated material moving past said die using a fluid wiping medium issuing from said die comprising:

   (a) a die body (11) encompassing a plenum chamber (15) and an elongated orifice along one side for egress of said fluid wiping medium,
   (b) means for supplying pressurized fluid wiping medium to said plenum chamber,
   (c) a pair of fluid confining members (17, 21) on each side of the elongated orifice (29) for defining the opening between said fluid confining members and therefore the conformation and/or dimensions of any stream of fluid wiping medium passing through the orifice,
   (d) at least one of said fluid confining members being resiliently biasable toward or away from the other of said pair of fluid confining members,
   (e) said resiliently biasable confining member being in at least indirect physical contact with at least two different contour variable position cam surfaces (39) arranged and constructed to bias the resilient fluid confining member at two different points in line with the elongated orifice in directions which will redefine the conformation and/or dimensions of the elongated orifice and therefore the stream of any fluid wiping medium passing through the orifice, and
   (f) said variable position cam surface being adjustable with respect to its position by means of a movement engendering means.

2. An adjustable wiping die in accordance with claim 1 wherein the pair of fluid confining members comprise integrally relisient lip means (17, 21) on the wiping die.

3. An adjustable wiping die in accordance with claim 2 wherein there are a plurality of differentially contoured variable position cam surfaces (39) in at least indirect contact with the resilient lip means (17, 21).

4. An adjustable wiping die in accordance with claim 3 wherein the plurality of variable position cam surfaces (39) are provided upon a rotatable cam shaft (43) rotatable by the movement engendering means.

5. An adjustable wiping die in accordance with claim 4 wherein the variable position cam surfaces (39) are in indirect contact with said resilient lip means (17, 21) through a plurality of independent intermediate biasing members (31).

6. An adjustable wiping die in accordance with claim 5 wherein the plurality of independent intermediate biasing members comprise independently movable push rod means (31) extending between the variable position cam surfaces and the resilient lip means.

7. An adjustable wiping die in accordance with claim 4 wherein the variable position cam surfaces (39) are in direct contact with the resilient lip means to bias said lip means.

8. An adjustable wiping die in accordance with claim 7 wherein the variable position cam surfaces (39) are defined by substantially adjacent cams (41) mounted on a cam shaft (43) or wherein the variable position cam surfaces are defined by a substantially continuous variable conformation cam surface on a rotatable cam menber.

9. An adjustable wiping die in accordance with claim 3 wherein the variable position cam surfaces (39) are defined by a variable conformation cam surface positioned along a rotatable cam member which is rotatable by a stepping motor (49), wherein operation of the stepping motor to rotate the rotatable cam member is controlled by a control system in accordance with a predetermined pattern based upon coating operation data provided to the control system.

10. An adjustable wiping die in accordance with claims 8 and 9 wherein there are at least two separate cam shafts (43) for adjusting separate sections of the resilient lip means.

11. An adjustable wiping die in accordance with claim 2 wherein the resilient lip means is permanently biased in a direction opposite to which the variable position cam surface will physically urge the lip means.

12. An apparatus for smoothing and wiping liquid material on a strip by gas wiping comprising:

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(a) an elongated plenum chamber (15) connected to manifold means (14, 16) for supplying a wiping gas to said plenum chamber,
(b) a pair of oppositely disposed lips (17, 21) associated with said plenum chamber and defining an elongated gas ejection and wiping orifice (29) on said plenum chamber,
(c) at least one of said oppositely disposed lips having a resilient construction enabling the outer end of said lip to be adjustably positioned with respect to the outer lip to thereby vary the orifice width between the lips,
(d) a plurality of differential cam sufaces (39) provided about a transverse shaft (43) mounted substantially parallel to the orifice between the lips such that the cam surfaces are in at least in direct contact with a surface of said lip having a resilient construction such that rotation of said shaft will differentially alter the contour of said lip and the elongated gas ejection and wiping orifice in a predetermined ratio.

13. An apparatus in accordance with claim 12 wherein natural flexure of the lip is toward the opposite lip and the shaft and the associated cam surfaces are journaled within the plenum chamber adjacent and in effective contact with one side of the flexible lip or, alternatively, wherein natural flexure of the lip is away from the opposite lip and the shaft and associated cam surfaces are located outside of the plenum chamber in at least indirect contact with said lip.

14. An apparatus in accordance with claim 13 additionally incorporating a shield means separating the cam means in contact with said lip from the main portion of the plenum chamber.

15. An apparatus in accordance with claims 13 and 14 wherein the transverse shaft is rotatable by a stepping motor.

16. A method for wiping a coated sheet or strip material with a gas wiping die comprising:

(a) passing the coated material past the wiping die,
(b) adjusting the wiping gas flow through the gas orifice in the die differentially along the extent of the orifice in a predetermined pattern by variying the distance between the lips at differential locations along the lips by a means having a predetermined contour pattern of differential adjustment modes operable in discreet time periods during operation of the coating line for providing predetermined contour openings between the lips.

17. A method in accordance with claim 16 wherein the means having predetermined differential adjustment modes is a rotatable cam arrangement.

18. A method in accordance with claim 16 or 17 wherein a series of predetermined contour openings between the lips is provided by a cam shaft having a plurality of differential cam surfaces associated with it and with a plurality of discreet cam patterns providing different contours to the lip openings in a time-related sequence.

19. A method in accordance with claim 16 or 17 wherein the cam shaft is provided with a plurality of smoothly changing cam patterns which effectively blend into each other to provide a sequence of time-related lip openings blending into each other.

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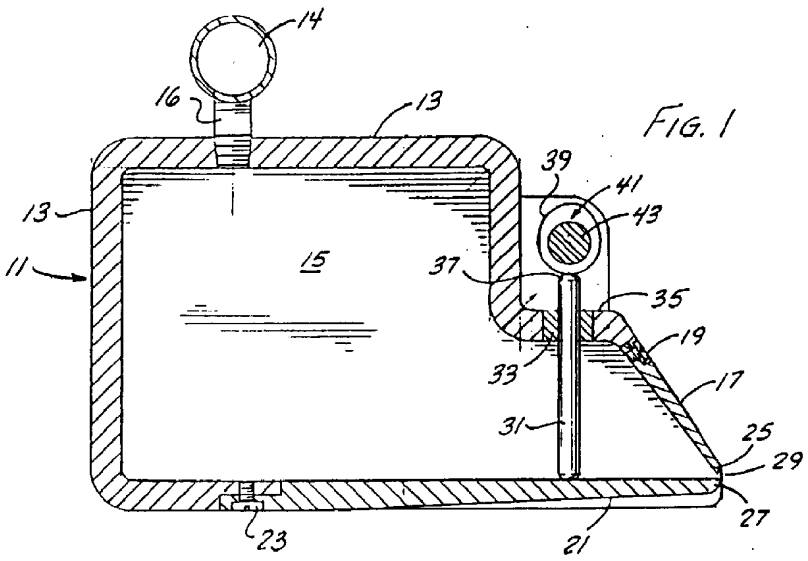
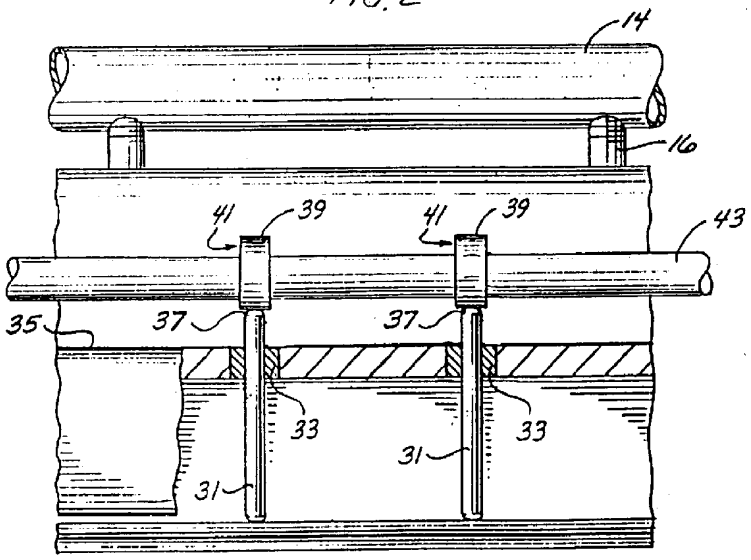


FIG. 1

FIG. 2



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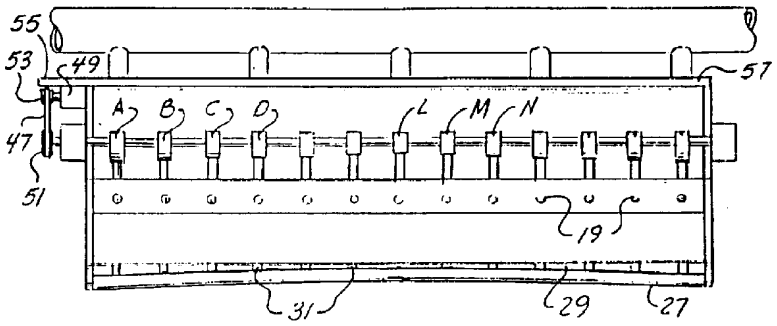


FIG. 3

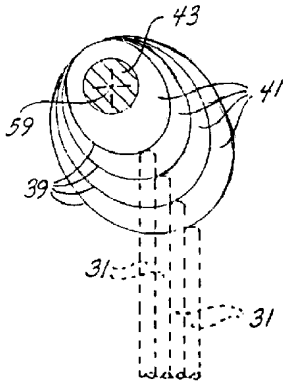


FIG. 4

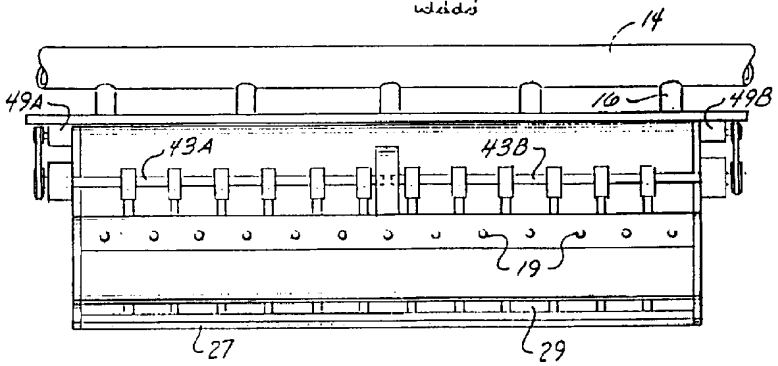


FIG. 5

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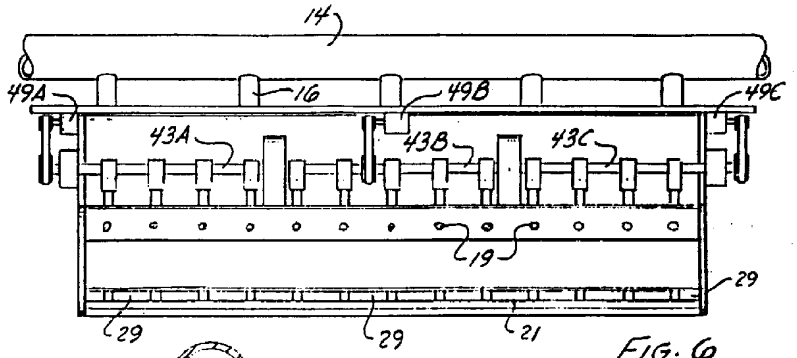


FIG. 6

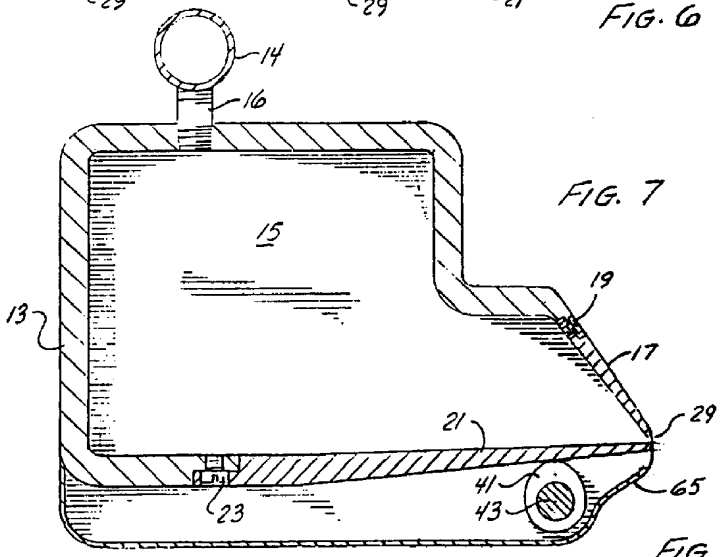
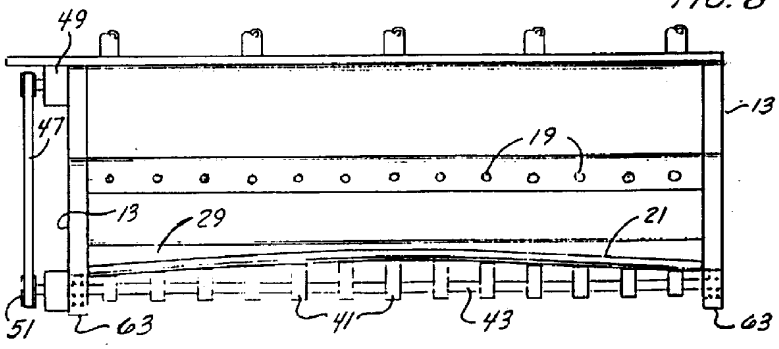


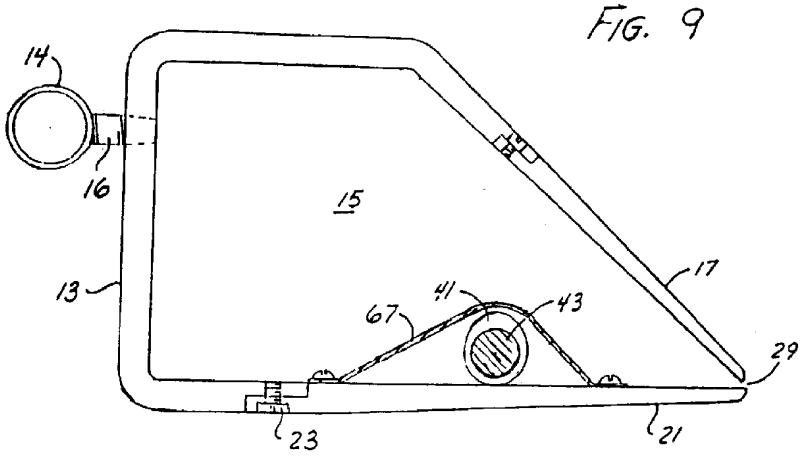
FIG. 7

FIG. 8



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FIG. 9



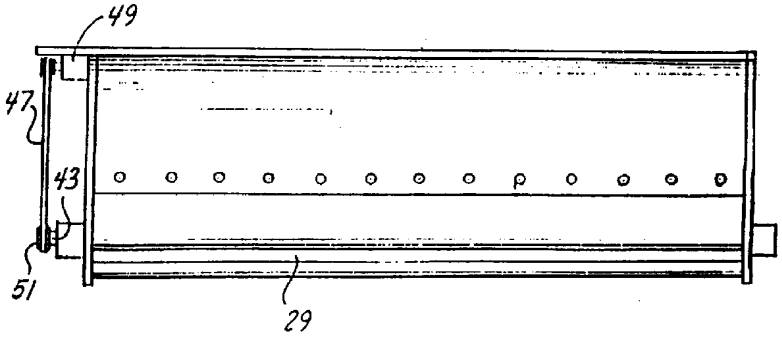


FIG. 10

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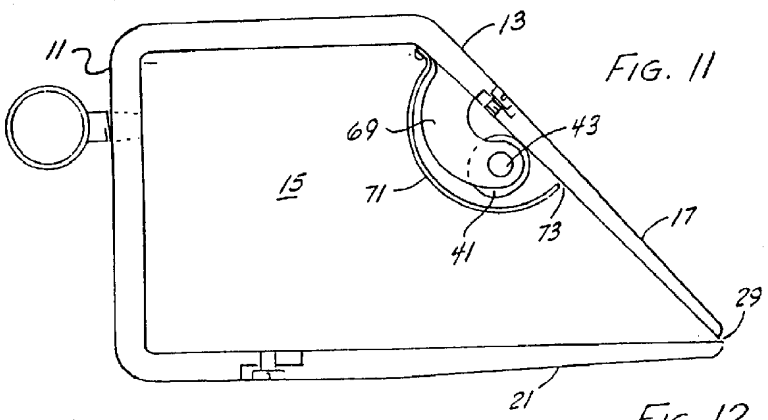


FIG. 11

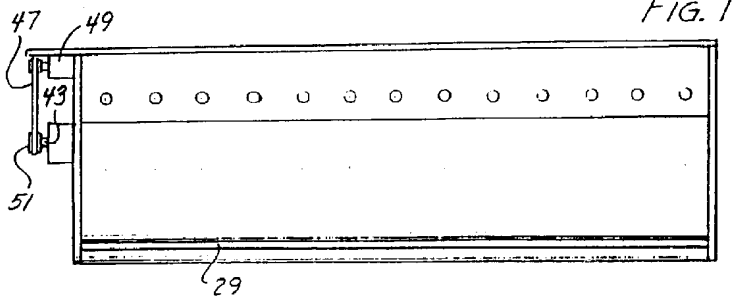


FIG. 12

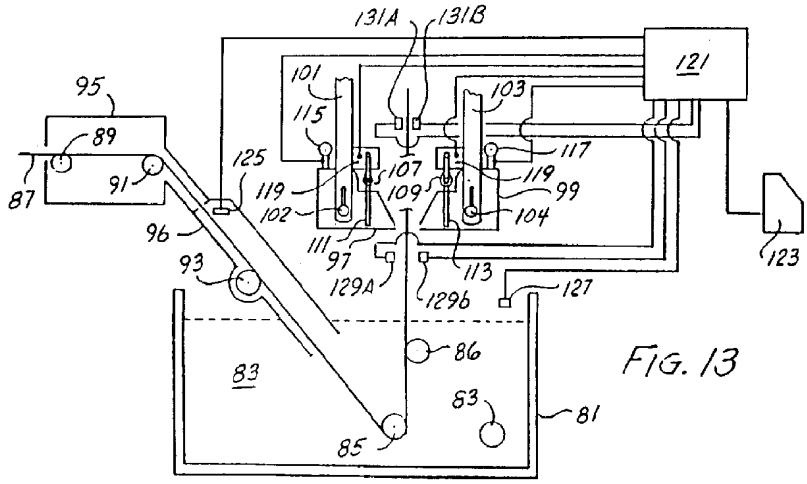


FIG. 13

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FIG. 14

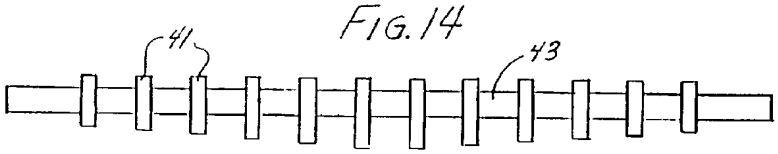


FIG. 15

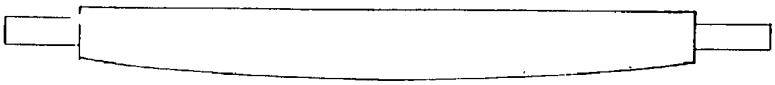


FIG. 16

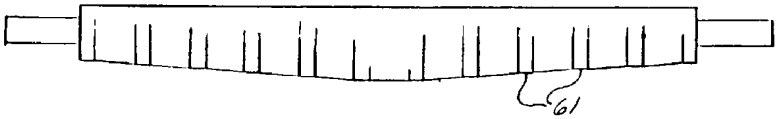


FIG. 17

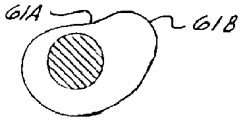


FIG. 18

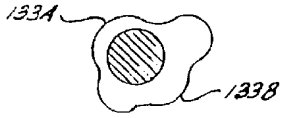


FIG. 19

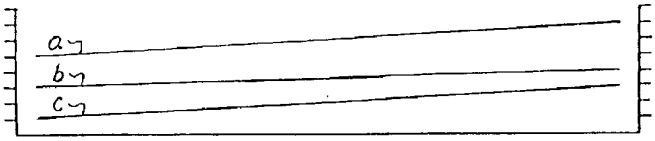
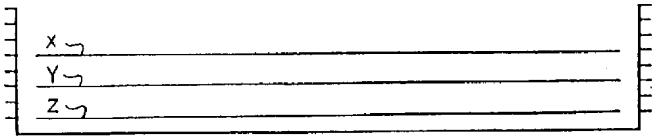


FIG. 20



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European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 94 11 0948

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	PATENT ABSTRACTS OF JAPAN vol. 17, no. 373 (C-1083) 14 July 1993 & JP-A-05 059 514 (NISSHIN STEEL) 9 March 1993 * abstract *	1-6, 11-13, 16,17	C23C2/20
X	EP-A-0 566 497 (CLECIM) * page 4, column 6, line 59 - page 5, column 7, line 11; claims 1-15; figures 2-4 *	16	
A	* page 5, column 8, line 24 - line 30 *	1-6, 9-13, 17-19	
A	PATENT ABSTRACTS OF JAPAN vol. 16, no. 180 (C-0935) 30 April 1992 & JP-A-04 021 752 (KAWASAKI STEEL CORP) 24 January 1992 * abstract *	1,16	
A	FR-A-2 136 041 (DEMAG) * claims 1-9; figures 1-4 *	16	TECHNICAL FIELDS SEARCHED (Int.Cl.6)
A,D	FR-A-2 090 313 (ITALSIDER) * claims; figures 1,2 *	16	C23C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	28 November 1994	Elsen, D

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

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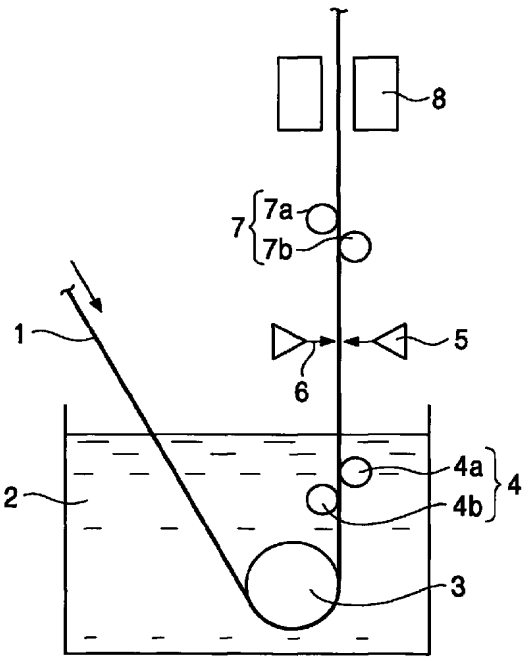
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(54) Method of manufacturing hot dip coated metal strip

(57) A method of manufacturing a hot dip coated metal strip includes the steps of depositing a molten metal coating solution on the surfaces of the metal strip by continuously dipping the metal strip in a coating bath, lifting the metal strip at a constant speed while supporting it with a pair of upper and lower support rolls for clamping the surfaces of the metal strip in the coating bath, adjusting the coating weights of the molten metal deposited on the surfaces of the metal strip by wiping the molten metal with gases from gas wiping nozzles disposed above the surface of the coating bath, and advancing the metal strip while supporting it with a pair of upper and lower touch rolls for clamping the surfaces thereof, wherein the metal strip is advanced by setting the distance L between the upper support roll disposed in the coating bath and the lower touch roll disposed outside the coating bath within the range determined by a formula $L \leq 80 \times T \times W^2/V$, where L: distance between the upper support roll in the coating bath and the lower touch roll outside the coating bath (mm), V: line speed of the metal strip (m/min),
T: tension imposed on the metal strip (kgf/mm^2), and W: target coating weight per one side of the metal strip (g/m^2). According to the invention, the stable quality of the metal strip can be obtained by reducing the variation of the coasting weights of the molten metal deposited on the surfaces of the metal strip by reducing the variation of the coating weights of the molten metal deposited on the surfaces of the metal strip at all times regardless of the change of the operating conditions under which continuous hot dip galvanizing operation is carried out. Further, a coating cost can be greatly reduced by preventing the excessive deposition of the molten metal.

FIG. 2



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Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to a method of manufacturing a hot dip coated metal strip. More particularly, the present invention relates to a method of manufacturing a hot dip coated metal strip having a coating layer of a uniform thickness by reducing the vibration of the metal strip which is lifted from a hot dip coating bath and travels vertically at an approximately constant speed.

2. Description of the Related Art

[0002] In general, hot dip galvanizing is applied to the surfaces of a steel strip using a continuous hot dip galvanizing apparatus (also referred to as a line) as described below.

[0003] First, as shown in Fig. 2, a steel strip 1 as a material to be coated is introduced into a hot dip galvanizing bath 2, the direction of travel of the steel strip 1 is diverted upward by a sink roll 3 disposed in the galvanizing bath 2, the crossbow of the steel strip 1 is corrected by a pair of upper and lower support rolls 4 disposed in the galvanizing bath 2 so as to clamp both the surfaces of the steel strip 1, and then the steel strip 1 is lifted vertically from the galvanizing bath 2. During that time, molten zinc is deposited on the surfaces of the steel strip 1. A gas 6 (referred to as a wiping gas) is blown onto the surfaces of the steel strip 1, on which the molten zinc has been deposited and which travels upward, through nozzles 5 (referred to as wiping nozzles because they wipe off the coated metal) so that the amount of the molten metal deposited on the steel strip 1 is adjusted to a desired amount (so that the molten metal can be uniformly deposited on the entire surface of the steel strip 1). A pair of touch rolls 7, which clamp the surfaces of the steel strip 1 similarly to the support rolls 4, are disposed above the wiping nozzles 5 to stabilize the travel of the steel strip 1. The steel strip 1, which has passed through the touch rolls 7, may be subjected to an alloying treatment by travelling through an alloying furnace 8 disposed above the touch rolls 7 so that the coating layer thereof is alloyed when necessary.

[0004] By the way, recently, it has become very important to stably manufacture at high speed a hot dip galvanized steel strip which has a low coating weight (referred to as light coating). In accordance with the reduced coating weight, there has been required a technology for manufacturing a hot dip galvanized steel strip while preventing the vibration thereof due to an increase in the pressure of the wiping gas 6, and the like. This is because the coating weight of the molten zinc deposited on the surfaces of the steel strip is greatly varied by an increase in the vibration of the steel strip and the quality of a product is thereby deteriorated.

[0005] Ordinarily, when the hot dip coated steel strip 1, which has a particularly low coating weight (coating weight per one side is 45 g/m^2 or less), is manufactured at a high speed, the steel strip 1 is vibrated at the position where the wiping nozzles 5 are disposed in a direction vertical to the surfaces thereof in a total amplitude of vibration of 1 - 2 mm at all times.

[0006] Since wiping cannot be smoothly carried out when this vibration occurs, at present, the standard deviation of the variation of the coating weights on the surfaces of a steel strip σ is set to a large value of 2 - 4 g/m^2 (σ = 2 - 4 g/m^2) with respect to the coating weight per one side of 45 g/m^2. However, since it is generally required by customers to guarantee the lower limit of the coating weight, when the guarantee for the lower limit is kept, molten zinc is excessively deposited. This means that a large amount of zinc is wastefully consumed from the view point of manufacturers.

[0007] When a hot dip galvannealed steel strip is manufactured, the large variation of the coating weight directly leads to the variation of the coating weight of hot dip galvannealing. Thus, when the steel strip 1 is manufactured, the coating is often undesirably exfoliated in a powder state (referred to as powdering) from a portion of the steel strip 1 where zinc is thickly deposited; moreover,a defect such as uneven alloying, and the like is liable to occur in the manufacture of the steel strip 1.

[0008] Technologies for preventing the vibration have been vigorously developed and many of them have been published. For example, Japanese Unexamined Patent Application Publications Nos. 5-320847 and 5-078806 disclose technologies for disposing a static pressure pad to maintain the pressure of a gas which is blown to wiping nozzles at a constant pressure. Further, Japanese Unexamined Patent Application Publication No. 6-322503 discloses a technology for separately disposing nozzles for blowing a shield gas above wiping nozzles and disposing gas shield plates between the shield gas blowing nozzles and the wiping nozzles.

[0009] However, the technologies for preventing the vibration of a steel strip by means of the static pressure pad or by blowing another gas are not in practical use because high power must be specially provided to generate a desired pressure and flow rate of gas as well as the effect of the technologies is lowered when the steel strip has a relatively large thickness.

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[0010] Further, Japanese Unexamined Patent Application Publications Nos. 52-113330, 6-179956 and 6-287736 disclose technologies for preventing the vibration of a steel strip using magnetic force or electromagnetic force. However, these technologies are not yet in practical use because not only do they separately require an expensive magnetic force generator and operation is made complex but also the effect of the technologies is lowered in a steel strip having a relatively large thickness.

SUMMARY OF THE INVENTION

[0011] In view of the above circumstances, an object of the present invention is to provide a method of manufacturing a hot dip coated metal strip which can provide the metal strip with stable quality by reducing the variation of the coating weight of molten metal to be deposited on the surfaces of the metal strip even if operating conditions of hot dip coating are changed as well as which can greatly lower a coating cost by preventing the excessive deposition of the molten metal.

[0012] To achieve the above object, the inventors examined the influences of tension of a traveling metal strip, target coating weight, linear speed of the metal strip, pressure of a wiping gas, distance between a touch roll disposed above wiping nozzles and a support roll disposed in a bath, and the like on the vibration of the metal strip at a gas wiping position in many test operations. Then, the inventors have completed the present invention based on a knowledge discovered from the analysis of data obtained in the examination that the vibration of a metal strip can be greatly reduced when operation is carried out by setting the distance between the touch roll and the support roll disposed in the bath within a certain range.

[0013] That is, according to the present invention, there is provided a method of manufacturing a hot dip coated metal strip which includes the steps of depositing molten metal on the surfaces of the metal strip by continuously dipping the metal strip in a hot dip coating bath, lifting the metal strip at a constant speed while supporting it with a pair of upper and lower support rolls for clamping the surfaces of the metal strip in the coating bath, adjusting the coating weights of the molten metal deposited on the surfaces of the metal strip by wiping the molten metal with gases from gas wiping nozzles disposed above the surface of the coating bath, and advancing the metal strip while supporting it with a pair of upper and lower touch rolls disposed outside the coating bath for clamping the surfaces thereof, wherein the metal strip is advanced by setting the distance L between the upper support roll disposed in the coating bath and the lower touch roll disposed outside the coating bath within the range determined by the following formula:

$$L \leq 80 \times T \times W^2/V$$

in which,

L: distance between the upper support roll in the coating bath and the lower touch roll outside the coating bath (mm);
V: linear speed of the metal strip (m/min);
T: tension imposed on the metal strip (kgf/mm^2); and
W: target coating weight per one side of the metal strip (g/m^2)

[0014] Furthermore, according to the present invention, it is preferable that the metal strip be composed of a steel strip and that the molten metal coating solution in the hot dip coating bath be molten zinc. Still further, it is preferable that the metal strip be subjected to an alloying treatment downstream of the upper touch roll.

[0015] According to the present invention, the total amplitude of vibration of the metal strip having the molten metal deposited on the surfaces thereof is greatly reduced at gas wiping positions as compared with a conventional total amplitude of vibration, and coating weights can be smoothly and ideally adjusted. As a result, a metal strip having molten metal deposited on all surfaces thereof can be stably manufactured with a uniform coating weight.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016]

Fig. 1 is a view showing how support rolls and touch rolls are disposed within and outside a bath, respectively, and how a steel strip is vibrated;
Fig. 2 is a view showing an ordinary continuous hot dip galvanizing apparatus;
Fig. 3 is a graph showing the relationship between a distance L between an upper support roll in the bath and a lower touch roll outside the bath and a total amplitude of vibration of a steel strip;
Fig. 4 is a graph showing the relationship between a pressure of a gas ejected from gas wiping nozzles and a total

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amplitude of vibration of a steel strip;

Fig. 5 is a graph showing the relationship between tension of a steel strip and a total amplitude of vibration thereof;

Fig. 6 is a graph showing the relationship between a pressure of a gas ejected from the gas wiping nozzles and a coating weight per one side of a steel strip;

Fig. 7 is a graph showing the relationship between the linear speed of a steel strip and a coating weight per one side thereof;

Fig. 8 is a graph showing the relationship between a total amplitude of vibration of a steel strip and variation of a coating weight per one side thereof;

Fig. 9 is a graph comparing variation of a coating weight in a conventional coating method and that in the method of the present invention;

Fig. 10 is a graph comparing an amount of consumption of metal in the conventional coating method and that in the method of the present invention; and

Fig. 11 is a graph comparing a ratio of occurrence of a defective product due to powdering in the conventional coating method and that in the method of the present invention.

DESCRIPTION OF PREFERRED EMBODIMENTS

[0017] The inventors carried out various test operations using the continuous hot dip galvanizing apparatus shown in Fig. 2 and described above. At that time, the support rolls 4 and the touch rolls 7 are arranged as pairs of upper and lower rolls, respectively as shown in Figs. 1 and 2. In the figures, each upper roll is denoted by "a" and each lower roll is denoted by "b".

[0018] A distance L (reference numeral 10, units of mm) was measured between an upper support roll 4a and a lower touch roll 7b in parallel with the pass line 9 of the steel strip 1. Further, a total amplitude of vibration B (reference numeral 11, units of mm) of the steel strip 1 was measured by measuring with a range finder distances between the surfaces of the steel strip 1 and the front edges of the wiping nozzles (hereinafter, simply referred to as nozzles) 5 perpendicular to the pass line 9.

[0019] First, the inventors examined the influence of the distance L between the upper support roll 4a disposed in the bath and the lower touch roll 7b on the total amplitude of vibration B of the steel strip 1 when tension of the steel strip 1 was set to 1.5 kgf/mm^2 and a line speed thereof was set to 90 m/min. As a result, the relationship shown in Fig. 3 was found. That is, the total amplitude of vibration was reduced by a decrease in the distance L whenever a coating weight per one side was 30 g/m^2 and 45 g/m^2. The relationship is represented by the following formula (1).

$$B \propto L \tag{1}$$

[0020] Furthermore, the inventors paid attention to the pressure p of a wiping gas 6 and the tension T of the steel strip 1 as factors which influenced the total amplitude of vibration B of the steel strip 1 and tested them. Fig. 4 shows the result of measurement of the pressure p and the total amplitude of vibration B of the steel strip when the distance L was set to 1000 mm and the distance between the front edges of the nozzles and the surfaces of the steel strip was set to about 6 - 8 mm. Furthermore, Fig. 5 shows the result of measurement of the total amplitude of vibration B of the steel strip 1 when the tension T was variously changed.

[0021] It can be seen from Figs. 4 and 5 that the total amplitude of vibration B of the steel strip 1 is approximately in proportion to the gas pressure p of the nozzles and approximately in inverse proportion to the tension T of the steel strip 1. This relationship can be expressed simply by a formula (2).

$$B \propto P/T \tag{2}$$

[0022] Further, the relationship among the gas pressure of the nozzles, the line speed of the steel strip 1 and the coating weight thereof was examined.

[0023] Fig. 6 shows the relationship between the gas pressure p and the coating weight per one side of the steel strip 1 when the distance between the front edges of the nozzles 5 and the steel strip 1 was set to 6 - 8 mm and the line speed of the steel strip 1 was set to 90 m/min and the gas pressure p was variously changed. In this case, the coating weight per one side is approximately in proportion to the inverse square root of the pressure P. In contrast, Fig. 7 shows the relationship between the line speed of the steel strip 1 and the coating weight per one side when the distance between the front edges of the nozzles and the steel strip 1 was set to about 6 - 8 mm, the pressure P was kept constant and the line speed was variously changed. As a result, it can be seen that the coating weight per one side is approximately in proportion to the square root of the line speed of the steel strip 1.

[0024] Therefore, the following formula (3) will be established, where the coating weight per one side is represented by W (g/m^2), the line speed of the steel strip 1 is represented by V (m/min) and the gas pressure P is represented by P

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(kgf/cm^2).

$$P \propto V/W^2 \quad (3)$$

[0025] Note that the coating weight per one side W was measured with a coating weight meter and shows the value of the coating weight per one side of the steel strip 1. Further, while the relationship between the line speed of the steel strip 1 and the total amplitude of vibration B thereof was examined with the other conditions kept constant in the test, the total amplitude of vibration B of the steel strip 1 was almost entirely uninfluenced by the line speed.

[0026] Thus, the inventors have found that the following formula will be established by arranging the formulas (1), (2), and (3) obtained in the above tests.

$$B \propto L \times V/(T \times W^2) \quad (4)$$

[0027] Next, the expression $L \times V/(T \times W^2)$, which was referred to as a vibration coefficient, was used to arrange test data.

[0028] The inventors thereafter examined the relationship between the total amplitude of vibration B of the steel strip 1 and the variation of the coating weight (evaluation was carried out based on the standard deviation $\sigma(g/m^2)$ of the coating weight). Conventionally, the variation of the coating weight is evaluated on both sides of a steel strip and Japanese Industrial Standards (JIS) also employs so-called "both side guarantee" which evaluates the variation based on both side total coating weight of steel strip. The applicant discloses a both side coating technology in Japanese Unexamined Patent Application Publication No. 10-306356.

[0029] In the variation of the both side total coating weight, when the steel strip 1 approaches one of the wiping nozzles 5 by vibration, the coating weight of the side of the steel strip 1 near to the nozzle is reduced, whereas the coating weight of the side thereof far from the nozzle is increased. However, a "both side total coating weight" which is obtained by adding the coating weights of both the sides of the steel strip 1 does not greatly vary in many cases, and thus the standard deviation σ is made to a small value. Therefore, the "both side guarantee" is used for convenience in technology, and the deviation of the coating weight must be naturally evaluated based on the coating weight per one side from the view point of coating characteristics, an anti-powdering property and the like. As a natural result, automobile manufactures recently require "one side guarantee" beyond the stipulation of JIS.

[0030] Thus, when the inventors reviewed coating weights used in their company at present on the basis of one side, it was found that the standard deviation σ of them was about 2 - 3 g/m^2. Thus, we intended to establish an operating method of coating for obtaining a standard deviation σ smaller than the above value, specifically, a standard deviation σ of 1.5 g/m^2or less. As a result, the inventors have found that the operating method can be established when a total amplitude of vibration B of a steel strip is set to 0.5 mm or less regardless of the change of the operating conditions in coating as shown in Fig. 8. When many tests were carried out to stably minimize the total amplitude of vibration, it was found that the vibration coefficient should satisfy the following formula.

$$L \times V/(T \times W^2) \leq 80$$

The present invention has been completed by employing this condition. That is, the steel strip 1 is advanced with the upper limit of the distance L between the upper support roll 4a and the lower touch roll 7b which is set to satisfy the following formula.

$$L \leq 80 \times V/(T \times W^2)$$

[0031] Furthermore, it is even better to set the upper limit to satisfy $L \leq 60 \times V/(T \times W^2)$.

[0032] Note that the lower limit of the distance L is not particularly critical in the present invention. In an actual coating apparatus, however, the upper support roll 4a ordinarily has a diameter of about 250 mmØ, each support roll has an immersion depth of about 150 - 200 mm at the center thereof, a height of each wiping nozzle 5 above the bath is about 150 - 600 mm, and a distance of at least about 300 mm is necessary from each wiping nozzle 5 to the lower touch roll 7b above the bath from a view point of the structure of the coating apparatus. As a result, in practice the lower limit of the distance L is expected to be about 600 mm.

[0033] Furthermore, it is preferable to move the touch roll 7b to actually change the distance L. This is because it is easier to move the lower touch roll 7b than to move the upper support roll 4a disposed in the bath from the view point of the structure of the coating apparatus.

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Example

[0034] A cold rolled steel strip 1 having a thickness of 0.65 - 0.90 mm was galvanized by the continuous hot dip galvanizing apparatus shown in Fig. 2.

[0035] At that time, operation was carried out using the method of manufacturing a hot dip coated metal strip according to the present invention in which restriction is imposed on the setting of the distance between the above rolls (examples of the present invention) and by a conventional method in which no restriction is imposed thereon (comparative examples). A coating weight was measured on-line while advancing the steel strip 1. The measurement was performed by a fluorescent X-ray coating weight meter (not shown) disposed above the steel strip 1 in travel so as to face downward. Accordingly, the variation σ of the measured coating weights represents the variation thereof on one side of the steel strip 1. Furthermore, the pressure of a wiping gas used under the conditions of the respective examples is a value measured on the side of the steel strip 1 where the coating weight was measured.

[0036] Table 1 shows the operating conditions and the result of the measurements collectively. It is apparent from Table 1 that in the specimens Nos. 1 - 18, which were manufactured by the manufacturing method according to the present invention, the total amplitudes of vibration of the steel strip 1 are 0.5 mm or less because $L \times V/(T \times W^2) \leq 80$ is satisfied therein. As a result, the variation σ of the coating weights is made to 1.5 g/m^2 or less in all the examples (refer to Fig. 9). This suggests that a target value of the coating weight can more closely approach a lower limit value in the operation and the consumption of metal can be greatly reduced thereby. Fig. 10 shows the comparison of an amount of coating metal actually consumed in the conventional manufacturing method with that actually consumed in the manufacturing method according to the present invention. When the consumption in the conventional manufacturing method is represented by 100%, the consumption in the manufacturing method of the present invention is about 90%. This means that the consumption of the coating metal can be greatly reduced.

[0037] On the other hand, in the specimens Nos. 19 - 29 manufactured by the conventional manufacturing method, the steel strip 1 has a large total amplitude of vibration and the variation σ of the coating weights thereof is 2.0 g/m^2 or more.

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Table 1

	No.	Thickness (mm)	Width (mm)	Line Speed (m/min)	Tension (kg/mm²)	Coating Weight per One Side (g/m²)	Pressure of Wiping Gas (kg/cm²)	L (mm)	(V×L)/(T×W²)	Total Amplitude of Vibration (mm)	Variation of coating weights σ(g/m²)
Example of the Invention	1	0.7	1200	60	2.0	31	0.58	800	25	0.19	0.25
	2	0.7	1200	60	1.5	30	0.58	800	36	0.23	0.31
	3	0.7	1200	60	1.0	43	0.28	800	26	0.25	0.30
	4	0.7	1200	57	2.0	32	0.58	1000	28	0.22	0.35
	5	0.75	1150	58	1.5	30	0.58	1000	43	0.30	0.55
	6	0.75	1150	60	1.5	45	0.25	1000	20	0.20	0.23
	7	0.75	1150	60	2.0	28	0.58	1200	46	0.27	0.50
	8	0.75	1150	62	1.5	33	0.58	1200	46	0.33	0.60
	9	0.75	1150	60	1.5	31	0.58	1200	50	0.40	1.05
	10	0.65	1350	90	2.0	30	0.92	800	16	0.26	0.25
	11	0.65	1350	90	2.0	47	0.44	800	16	0.13	0.23
	12	0.65	1350	92	2.0	57	0.23	800	11	0.10	0.20
	13	0.85	1150	122	2.0	32	1.22	800	48	0.35	0.51
	14	0.85	1150	120	2.0	43	0.54	800	26	0.20	0.30
	15	0.85	1150	119	2.0	58	0.32	800	14	0.12	0.20
	16	0.85	1150	120	2.0	35	1.08	1200	59	0.44	1.35
	17	0.85	1150	122	2.0	45	0.55	1200	36	0.25	0.51
	18	0.85	1150	122	2.0	55	0.31	1200	24	0.15	0.30
	19	0.85	1150	120	1.5	35	0.60	1000	65	0.47	1.41
	20	0.85	1150	120	1.5	35	0.60	1200	78	0.50	1.50
Comparative Example	19	0.72	1300	60	1.0	32	0.63	1500	88	0.60	1.9
	20	0.7	1550	60	1.0	31	0.48	1500	94	0.62	1.8
	21	0.7	1550	58	1.3	30	0.59	1800	89	0.55	1.8
	22	0.7	1550	90	1.0	30	0.92	1500	150	1.05	4.0
	23	0.7	1550	90	1.1	35	0.65	1500	100	0.70	2.0
	24	0.67	1050	90	1.5	30	0.88	1500	100	0.65	1.8
	25	0.67	1050	92	1.0	45	0.43	200	91	0.58	1.6
	26	0.9	1450	122	1.0	32	1.13	1500	178	1.35	6.0
	27	0.9	1450	120	1.0	43	0.60	1500	97	0.70	2.2
	28	0.9	1450	120	1.5	35	0.96	1300	85	0.55	1.8
	29	0.9	1450	122	1.5	30	1.22	1300	117	0.70	2.1

[0038] Next, a so-called "hot dip galvanized steel strip" was manufacturing by disposing an alloying furnace 8 above the touch rolls 7 in Fig. 2 and by heating the steel strip 1 on which molten zinc was deposited in the alloying furnace 8 so that the Fe content in the zinc coating layer of the steel strip 1 was made to 8 - 13 wt%. Then, an anti-powdering property, which was one of important characteristics of quality, of the steel strip 1 was examined. Powdering is a defect wherein a deposited coating layer is exfoliated in a powder state from a portion of a hot dip galvanized steel sheet, which detracts from the intimate contact property of the coating during press forming thereof. When this phenomenon occurs during press forming, the powder of the coating falls between a press die and the steel sheet to thereby cause a defect of irregularity to the steel sheet. Thus, it is desired that no powdering occurs.

[0039] Operation was carried out paying attention to the powdering under the conditions of a target coating weight per one side set to 45 - 55 g/m^2, a line speed of the steel strip 1 set to 100 m/min - 150 m/min, and a tension of the steel

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strip 1 set to 1.5 kgf/mm^2 - 2.0 kgf/mm^2. Table 2 shows examples of operating conditions other than the above operating conditions and the result of the operation collectively. Note that the anti-powdering property was evaluated by a known method of putting an adhesive tape on the coating layer of a specimen sampled from a hot dip galvanized steel strip under pressure, peeling off the adhesive tape after the specimen was bent 90° and returned to its original state and then measuring an amount of exfoliation of the coated layer with a fluorescent X-ray. That is, the anti-powdering property is represented by the number of counts, which is counted with the X-ray, of zinc contained in the exfoliated coating layer. Usually, when the number of counts is 1500 or less, no defect due to powdering occurs at an actual press forming. However, when the number of counts exceeds 1500, a defect due to powdering often occurs.

[0040] It is apparent from Table 2 that since the variation of a coating weight can be greatly reduced according to the method of the present invention, the number of counts is stable at a low value, whereby the hot dip galvanized steel strip 1 excellent in the anti-powdering property can be stably manufactured. In contrast, in the conventional method, there was made a product in which the number of counts was increased and made to 1500 or more at some portions and in which the defect due to powdering was liable arise often when the product was processed. This is because a coating weight greatly varied in the product. Fig. 11 shows a ratio of occurrence of defective products after they were press formed. It is apparent from Fig. 11 that almost no defective products are made by the method of the present invention.

[0041] In the above examples, the steel strip was used as a metal strip and the molten zinc was used as molten metal. However, it is needless to say that the present invention is by no means limited thereto and is applicable to other kinds of metal strip and to molten metal other than molten zinc.

Table 2

	Experiment No.	Thickness (mm)	Width (mm)	L (mm)	Total Amplitude of Vibration (mm)	Variation of coating weights σ(g/m^2)	Average Density of Fe in Coating Layer (%)	Number of Counts of Powdering (Count/Sec) *
Example of the Invention	1	0.75	1200	800	0.21	0.25	11.0	400-870
	2	0.75	1200	800	0.24	0.31	11.3	500-950
	3	0.75	1200	800	0.22	0.30	12.5	350-750
	4	0.75	1200	1000	0.40	1.05	12.7	370-1200
	5	0.75	1200	1000	0.29	0.55	10.9	450-850
	6	0.80	1550	800	0.31	0.43	11.8	480-720
	7	0.80	1550	800	0.25	0.50	11.3	500-950
	8	0.80	1550	800	0.35	0.60	12.2	430-830
	9	0.80	1550	800	0.38	1.02	10.7	500-1350
	10	0.80	1550	800	0.27	0.23	10.8	350-730
Comparative Example	11	0.75	1250	1500	0.65	2.02	11.3	430-1950
	12	0.75	1250	1500	0.60	1.90	10.8	520-1750
	13	0.75	1250	1500	0.85	3.50	11.5	480-1550
	14	0.75	1250	1500	1.02	4.20	12.0	550-2500
	15	0.75	1250	1500	0.88	4.00	11.4	450-2550
	16	0.86	1500	1600	0.95	3.60	11.8	580-1950
	17	0.86	1500	1600	1.20	5.20	10.7	550-3200
	18	0.86	1500	1600	1.10	4.30	10.5	650-2900
	19	0.86	1500	1600	0.92	3.75	11.2	800-2300
	20	0.86	1500	1600	0.98	3.80	12.4	600-2050

*: Showing Maximum and Minimum Measured Values

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As described above, a metal strip having molten metal deposited on all surfaces thereof at a uniform coating weight can be manufactured by the present invention. As a result, it is possible to more closely approach a lower target coating weight during a coating operation, whereby the consumption of coating metal can be greatly reduced as compared with a conventional consumption.

Claims

1. A method of manufacturing a hot dip coated metal strip, comprising the steps of:

dipping a metal strip in a hot dip coating bath to continuously deposit molten metal on surfaces of the metal strip;
conveying the metal strip at a substantially constant speed while supporting said strip with a pair of upper and lower support rolls that clamp the surfaces of the metal strip in the coating bath;
adjusting a coating weight of the molten metal deposited on the surfaces of the metal strip by wiping the molten metal with gases from gas wiping nozzles disposed above a surface of the coating bath; and
advancing the metal strip while supporting it with a pair of upper and lower touch rolls disposed outside the coating bath for clamping the surfaces thereof,
wherein the metal strip is advanced by setting the distance L between the upper support roll disposed in the coating bath and the lower touch roll disposed outside the coating bath within the range determined by the following formula

$$L \leq 80 \times T \times W^2/V$$

wherein,

L: distance between the upper support roll in the coating bath and the lower touch roll outside the coating bath (mm);
V: line speed of the metal strip (m/min);
T: tension imposed on the metal strip (kgf/mm^2); and
W: target coating weight per one side of the metal strip (g/m^2).

2. The method according to claim 1, wherein said metal strip is composed of a steel strip and said hot dip coating bath is filled with molten zinc.

3. The method according to claim 1, wherein said metal strip is subjected to an alloying treatment downstream of said upper touch roll.

4. A method of manufacturing a hot dip coated metal strip, comprising the steps of:

conveying a metal strip through a hot dip coating bath to continuously deposit molten metal on surfaces of the metal strip;
supporting said metal strip with a pair of support rolls submerged in the coating bath;
blowing gas on said metal strip as it emerges from said coating bath with gas wiping nozzles disposed above a surface of the coating bath, thereby to adjust a coating weight of molten metal on said strip; and
further conveying the metal strip while supporting it with a pair of touch rolls disposed outside the coating bath, wherein a distance L between an upper support roll disposed in the coating bath and a lower touch roll disposed outside the coating bath is maintained according to the following formula

$$L \leq 80 \times T \times W^2/V$$

wherein,

L: distance between the upper support roll in the coating bath and the lower touch roll outside the coating bath (mm);
V: line speed of the metal strip (m/min);
T: tension imposed on the metal strip (kgf/mm^2); and
W: target coating weight per one side of the metal strip (g/m^2).

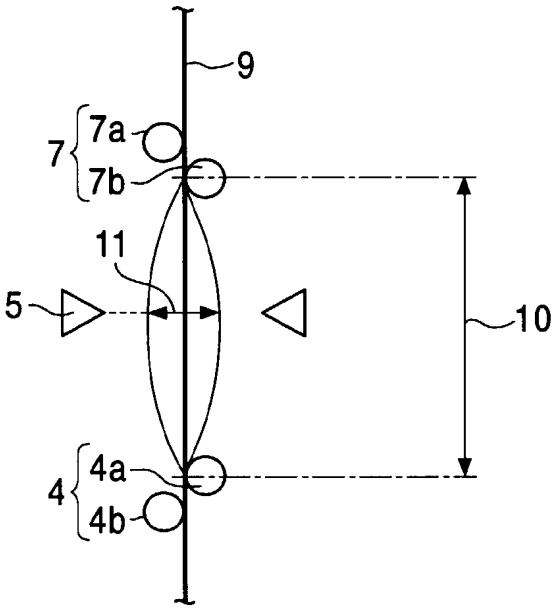
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5. The method according to claim 4, wherein said metal strip is composed of a steel strip and said hot dip coating bath is filled with molten zinc.

6. The method according to claim 4, wherein said metal strip is subjected to an alloying treatment downstream of said upper touch roll.

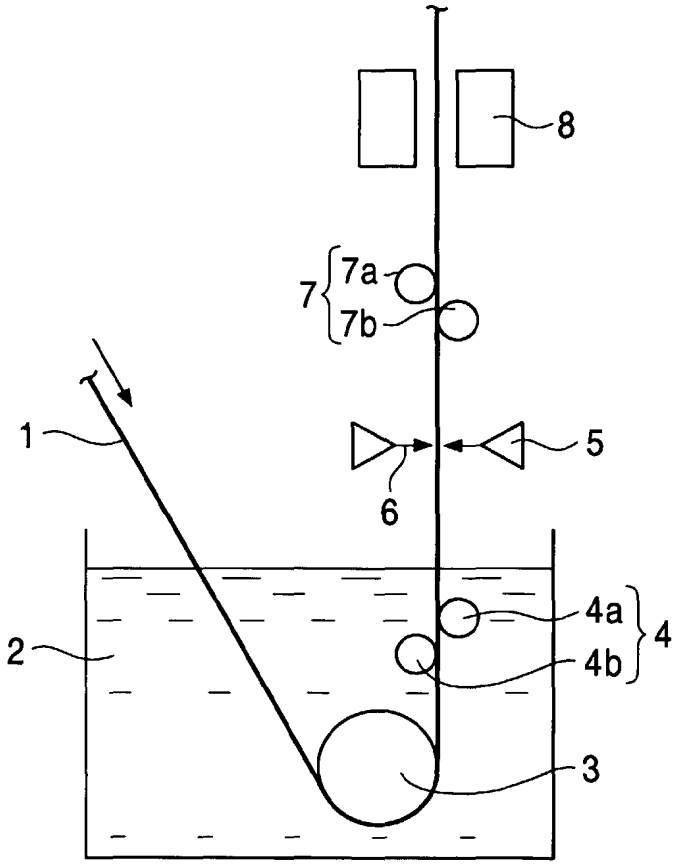
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FIG. 1



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FIG. 2



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FIG. 3

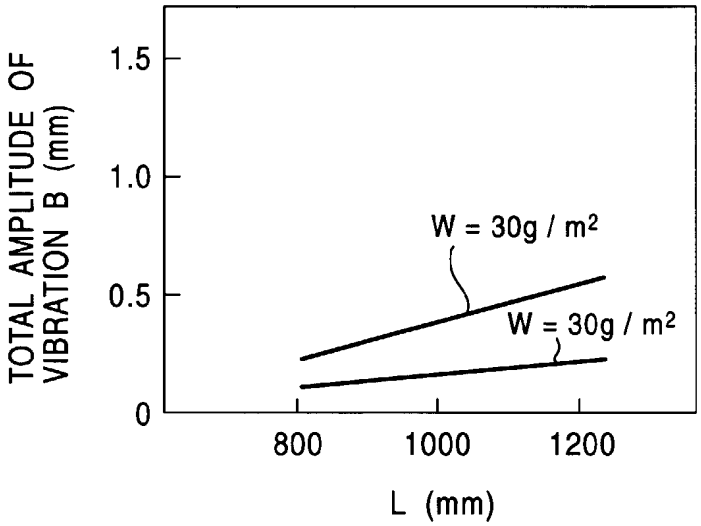
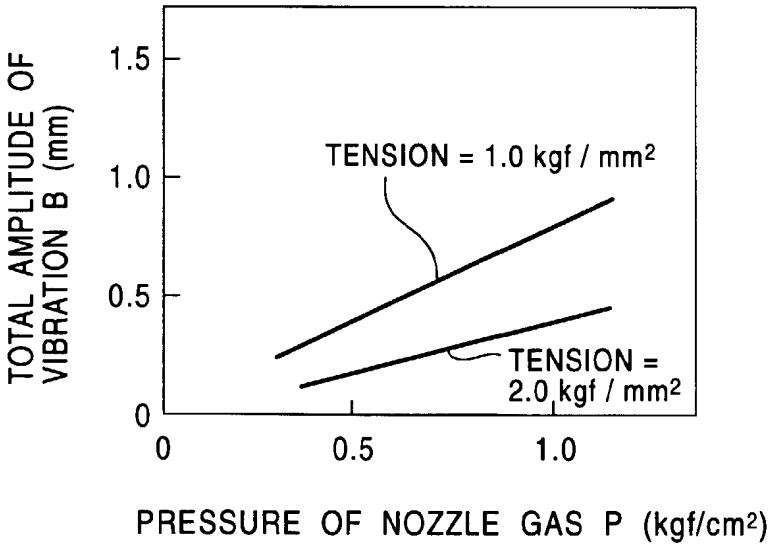


FIG. 4



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FIG. 5

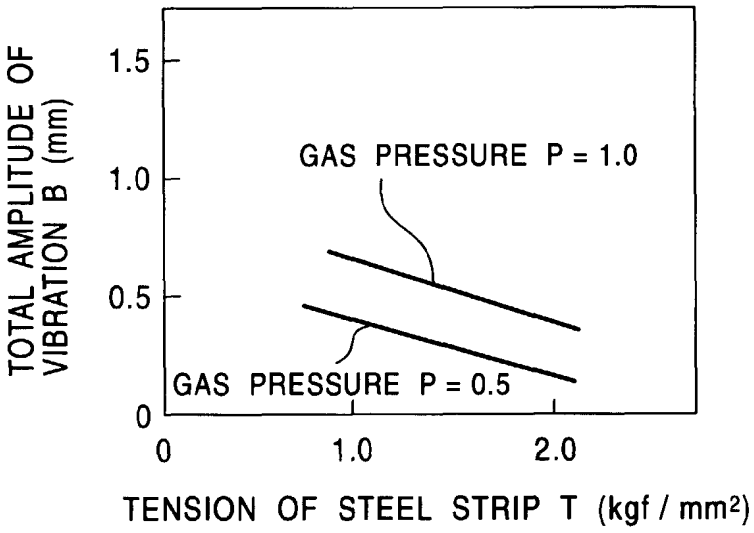
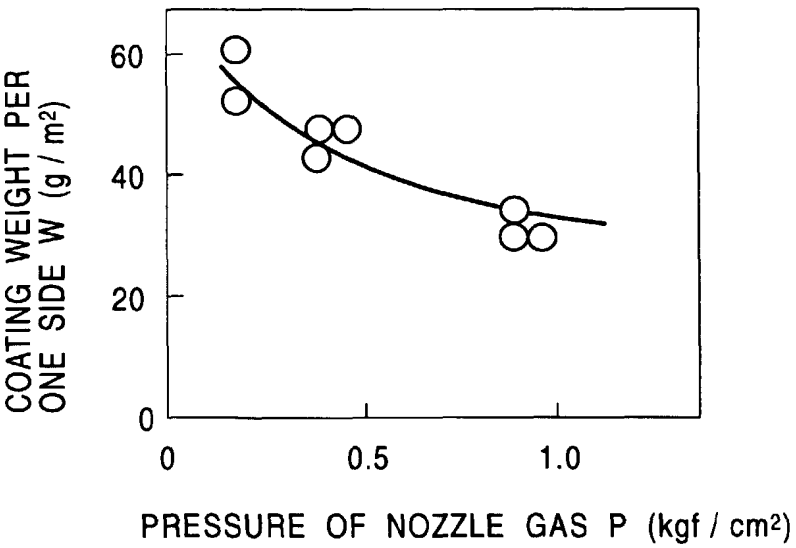


FIG. 6



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FIG. 7

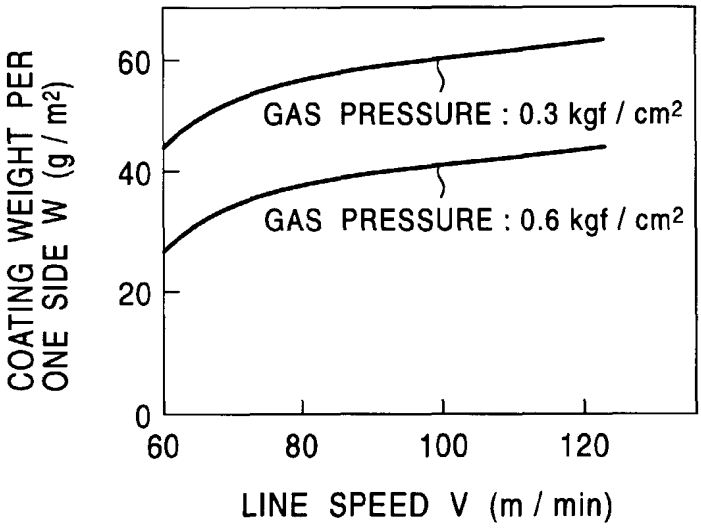
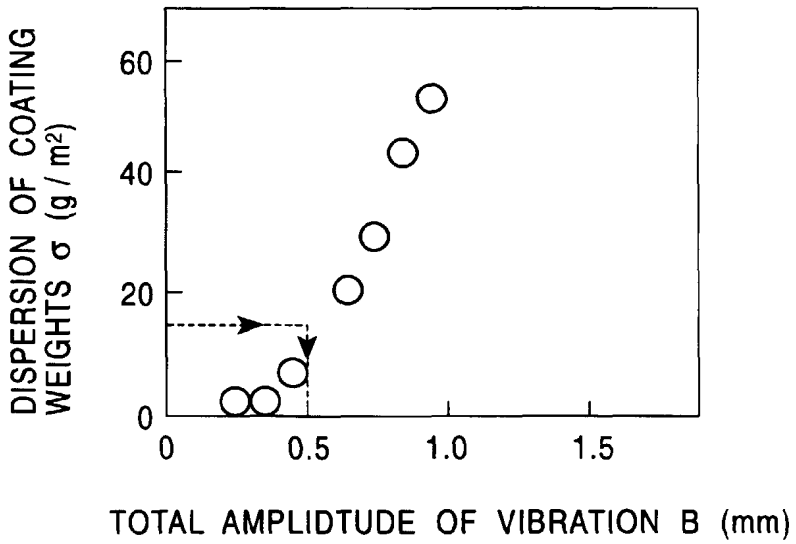


FIG. 8



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FIG. 9

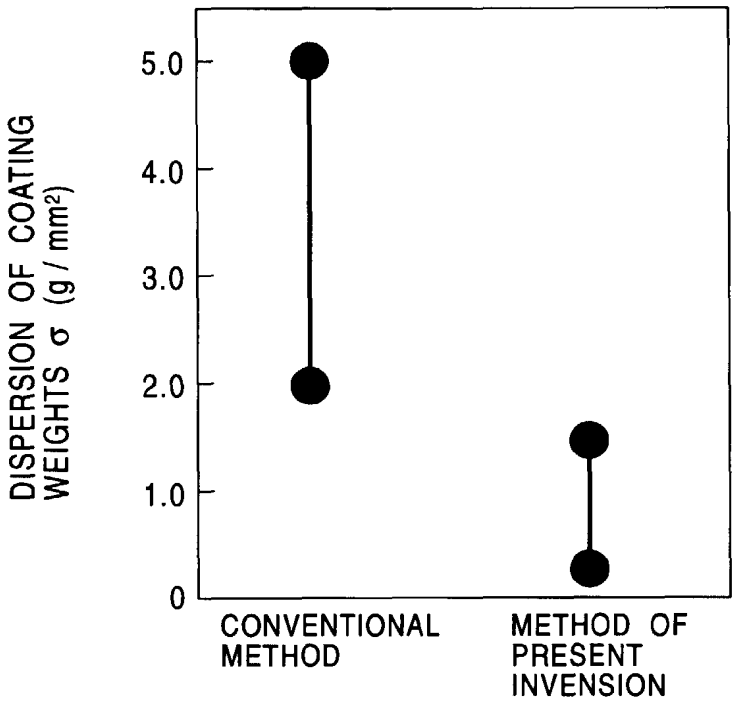
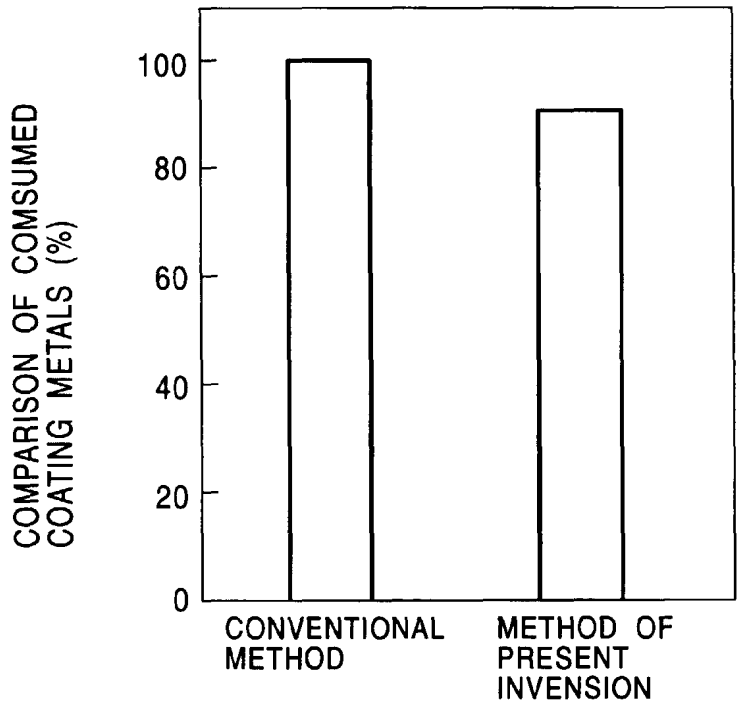
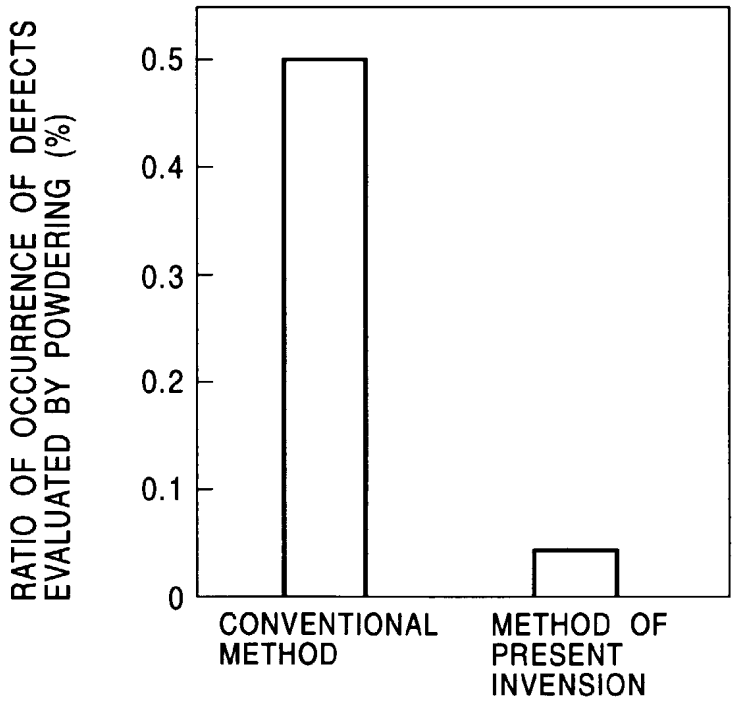


FIG. 10



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FIG. 11



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Application Number
EP 00 11 2814

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 vol. 1997, no. 12, 25 December 1997 (1997-12-25) & JP 09 202955 A (KAWASAKI STEEL CORP), 5 August 1997 (1997-08-05) * abstract *		C23C2/00 C23C2/14 C23C2/20
A	PATENT ABSTRACTS OF JAPAN vol. 009, no. 222 (C-302), 9 September 1985 (1985-09-09) & JP 60 082653 A (KAWASAKI SEITETSU KK;OTHERS: 01), 10 May 1985 (1985-05-10) * abstract *		
A	PATENT ABSTRACTS OF JAPAN vol. 012, no. 219 (C-506), 22 June 1988 (1988-06-22) & JP 63 014847 A (KAWASAKI STEEL CORP), 22 January 1988 (1988-01-22) * abstract *		TECHNICAL FIELDS SEARCHED (Int.Cl.7)
A	PATENT ABSTRACTS OF JAPAN vol. 018, no. 351 (C-1220), 4 July 1994 (1994-07-04) & JP 06 088181 A (SUMITOMO METAL IND LTD), 29 March 1994 (1994-03-29) * abstract *		C23C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	21 September 2000	Elsen, D

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

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EPO FORM 1503 03.82 (P04C01)

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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 00 11 2814

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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21-09-2000

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
JP 09202955 A	05-08-1997	NONE	
JP 60082653 A	10-05-1985	NONE	
JP 63014847 A	22-01-1988	NONE	
JP 06088181 A	29-03-1994	NONE	

EPO FORM P0459

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

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CLAIMS FR2720079A1

CLAIMS

1.

- A method of hot-dipped coating of a part, in particular of a strip, of steel containing at least 0.1% by weight of manganese, in particular of stainless and / or alloy steel in which the strip is prepared before coating following a sequence of treatments carried out under a controlled atmosphere then the strip is dipped in a bath of aluminum or molten aluminum alloy, characterized in that the atmospheres of said treatments are all non-reducing.

2.

- Method according to claim 1 characterized in that the hydrogen concentrations in the atmospheres of said treatments are all less than or equal to 4%.

3.

- Method according to claim 1 or 2 characterized in that said treatments are heat treatments.

4.

- Method according to claim 3 characterized in that, when said sequence of treatments comprises heating and cooling, the heating and cooling atmospheres contain more than 96% nitrogen.

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Espacenet

Bibliographic data: FR2720079 (A1) — 1995-11-24

Hot dip coating steel with aluminium (alloy)

Inventor(s): GODIN JEAN-PIERRE; GUESDON PHILIPPE ± (GODIN JEAN-PIERRE, ; GUESDON PHILIPPE)

Applicant(s): LORRAINE LAMINAGE [FR] ± (SOLLAC)

Classification: **- international:** ***C23C2/02; C23C2/12;*** (IPC1-7): C23C2/02; C23C2/12; C23C2/40
- cooperative: **C23C2/02 (EP); C23C2/12 (EP)**

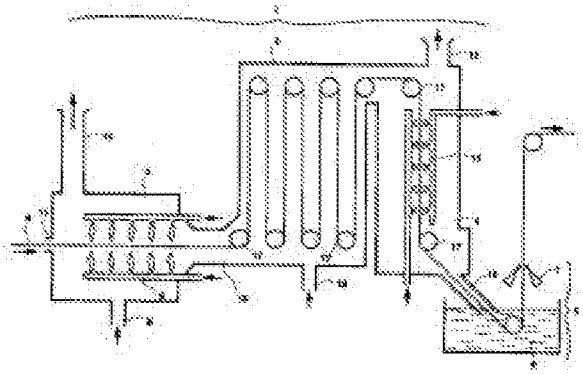
Application number: FR19940006239 19940519

Priority number(s): FR19940006239 19940519

Also published as: FR2720079 (B1) AT158823 (T) DE69500797 (T2) EP0698671 (A1) EP0698671 (B1) more

Abstract of FR2720079 (A1)

A steel strip containing at least 0.1 wt.% Mn is pretreated prior to hot dip coating with Al or Al alloy. During the pretreatments which consist of cleaning, heat treatment and cooling, the atmosphere is maintained as completely non-reducing. Coating esp. stainless and alloy steels. By avoiding the use of hydrogen containing atmospheres, the process becomes more economic and the security of the process is improved.



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DESCRIPTION FR2720079A1

The present invention relates to a process for coating aluminum or aluminum alloys by hot dipping a part, in particular of a strip, made of steel containing at least 0.1% by weight of manganese, in particular stainless steel and / or alloy.

In general, in order to carry out a metal coating by dipping a steel part, the part to be coated is prepared and it is dipped in a coating bath, that is to say here a bath of molten metal.

The preparation of said part generally comprises a certain number of successive treatments.

Thus, for example, to prepare said part, its surface is cleaned, it is heated, then it is cooled.The cleaning of the surface can be carried out in particular by chemical degreasing treatment, by heat treatment called preheating, or even by physical treatment. intended to recrystallize the steel that makes up the part; it is thus carried out for a period and according to a determining temperature profile for the mechanical properties of said part.

The cooling is intended to bring the temperature of the room to a temperature close to that of the bath of molten metal; it is generally carried out under a jet of cold gas.

When the coating is aluminum-based and the parts to be coated are made of stainless steel and / or alloy, in particular containing at least 0.1% manganese, it is known how to prepare the part, in particular the last ones. stages such as heating and cooling, under a reducing atmosphere, in particular containing hydrogen.

Indeed, the part to be coated has on the surface traces of oxides of the alloying elements of said stainless steel and / or alloy; the cleaning treatment, in particular when carried out by preheating, further oxidizes said surface; it is known that these oxides, and in particular the chromium oxides, can prevent the molten metal of the bath from properly wetting the surface of the strip at the time of quenching, which is detrimental to the quality of the coating obtained, in particular at the level of its adherence to the piece and its geometric homogeneity.

This arrangement concerning the atmosphere of the preparation treatments is therefore useful for reducing the oxides of the alloying elements of steel, in particular chromium, which are found on the surface of the part to be coated and for significantly improving the quality of the coating. quenching, especially in terms of its adhesion to the part and its geometric homogeneity.

Thus, it is known to use hydrogen in high proportions in the cooling and heating atmosphere to reduce, at the surface of the part to be coated, the oxides initially present or which were formed during the previous treatments of the preparation; but the use of hydrogen has serious economic and safety drawbacks.

French patent n02 664 617 filed on 07/16/90 in the names of the companies SOLLAC and UGINE SA describes such a process and has the advantage, compared with the processes of the prior art, of avoiding the use of atmospheres reducing agents containing high proportions of hydrogen, during the preparation of a part to be coated, in particular during cooling.

This document describes a preparation process for the dipping aluminum coating of a stainless steel strip in which said strip is preheated in a non-oxidizing atmosphere at a temperature lower than in the prior art, said strip is heated. in a non-oxidizing atmosphere, which may be reducing and contain hydrogen, and said strip is cooled in a non-reactive atmosphere, such as nitrogen, and which may contain hydrogen.

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Thus, thanks to a lower temperature and a non-oxidizing atmosphere during preheating, the formation of oxides at the surface of the strip is limited and the subsequent treatments can advantageously be carried out under less reducing atmospheres, therefore containing less hydrogen than those commonly used previously, while obtaining an aluminum coating of good quality, in particular of good adhesion and good homogeneity.

However, in this process, the counterpart of the lower temperature and the non-oxidizing atmosphere of the preheating can be a reduction in the quality of cleaning, in particular when bodies fouling the surface of the part, in particular fatty substances, do not. are not completely decomposed under these new preheating conditions.

It may also be necessary to extend the duration of the preheating treatment in order to obtain a sufficient quality of the cleaning, but this extension of the duration of the treatment is detrimental to the productivity.

Furthermore, in particular for heating and cooling treatments, it is often necessary to use hydrogen, although obviously in smaller proportions than before; the drawbacks linked to the use of hydrogen, and which relate to the safety and cost of the installations, have therefore not been completely eliminated.

The object of the invention is to avoid the use of hydrogen during the preparation of a part, in particular of a strip, made of stainless steel and / or alloy containing at least 0.1% of manganese for a coating with hardened aluminum or aluminum alloys.

The object of the invention is also to facilitate the carrying out of the preparation treatments of such a strip, and in particular to ensure both the quality of the cleaning and the productivity.

To this end, the invention relates to a process for coating aluminum or aluminum alloy by hot dipping a part, in particular a strip, made of steel containing at least 0.1% by weight. manganese, in particular stainless steel and / or alloy in which the strip is prepared before coating according to a sequence of treatments carried out under a controlled atmosphere then the strip is dipped in a bath of aluminum or molten aluminum alloy, characterized in that said atmospheres are all non-reducing.

The process according to the invention may include one or more of the following characteristics - the hydrogen concentrations in the atmospheres of said treatments are all less than or equal to 4%, - said treatments are heat treatments, - when said sequence of treatments comprises heating and On cooling, the heating and cooling atmospheres contain more than 96% nitrogen.

The invention will now be described in more detail with reference to the appended figure, which shows a schematic view of an installation for preparing and an installation for continuously dipping a metal strip.

As shown in the single Figure, the continuous preparation installation designated as a whole by the reference 1 comprises - a preheating furnace 2, - a heat treatment furnace 3, - a cooling chamber 4, Said preparation installation is installed upstream of a dip coating installation designated as a whole by the reference 5; it comprises tape support rollers 17 distributed throughout the installation and which define the tape path.

The dip coating plant 5 is known in itself and will not be described here in detail; in a conventional manner, it comprises a soaking container containing the coating bath 6, composed of aluminum or of molten aluminum alloy, and spin ejectors 7.

The preheating furnace 2 is a direct flame furnace comprising an air inlet 8, burner ramps 9 arranged on either side of the strip path, and a chimney 10 for evacuating the gases, in particular combustion. ; the preheating furnace 2 also comprises a strip inlet 11 and a strip outlet 12 opening directly into the heat treatment furnace 3.

The heat treatment furnace 3 has radiant tubes and a controlled atmosphere, in particular by a treatment gas inlet 13; its outlet opens directly into the cooling chamber 4.

The cooling chamber 4 is provided with cooling gas ejector ramps 14 arranged on either side of the strip path, the ejectors of which are oriented towards the strip path; the cooling chamber 4 is also provided with a gas discharge chimney 15 and opens out via a strip outlet channel 16 below the level of the free surface of the liquid metal 6 of the coating installation 5.

The preparation installation also comprises means for measuring the temperature of the atmosphere and of the strip, means for measuring the dew points and for controlling the humidity level, which are installed in the preheating furnace 2, the heat treatment furnace 3, and the cooling chamber 4; these means are known in themselves and are not shown here.

The cooling gas ejector ramps 14 and the treatment gas inlet 13 are connected to gas supply means which are not shown here.

In order to proceed with the dip coating of a strip B of stainless steel and / or alloy containing at least 0.1% manganese, said strip is prepared according to the following sequence - said strip is preheated between the burner ramps 9 of the preheating

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furnace 2 supplied in excess of at least 2% of fuel relative to the stoichiometric combustion conditions in a non-oxidizing atmosphere, the temperature of which is generally between 8000C and 13000C; in this way, the temperature of the strip at the outlet of the preheating oven 2 is higher than the decomposition temperature of the bodies fouling the surface of the strip, in particular of the fatty substances, and generally between 4000C and 7000C; the surface of said strip is then cleaned.

- Said strip is heat treated in the heat treatment furnace 3 for a time sufficient for the measured temperature of said strip at the outlet of the heat treatment furnace 3 to be greater than the recrystallization temperature of the stainless and / or alloy steel of the strip, that is to say generally between 7500C and 9500C, and to obtain the required mechanical properties of the strip; the temperature of the atmosphere of the heat treatment furnace is therefore established between 8500C and 10000C and, moreover, its dew point between -450C and -250C.

Said heat treatment is carried out under a non-reducing atmosphere; by means of the gas supply means, a non-reducing treatment gas, here nitrogen containing less than 0.1% hydrogen, is injected into the heat treatment furnace 3 through the gas inlet 13 at a flow rate such that said furnace 3 is in overpressure with respect to the preheating furnace 2 and to the cooling chamber 4.

Without departing from the invention, it is possible to use nitrogen containing 4% hydrogen as the treatment gas; even at these concentrations, the use of hydrogen does in fact present no drawback with regard to the safety and the cost of the installations.

- Said strip is cooled between the cooling gas ejector ramps 14 in the cooling chamber 4 under a non-reducing atmosphere; thanks to the gas supply means, the ramps 14 are in faci supplied with non-reducing cooling gas, here nitrogen at ambient temperature containing less than 0.1% of hydrogen, at a flow rate such as the measured temperature of the strip at the outlet of said chamber 4 is close to that of the molten metal bath 6, ie generally between 6700C and 7000C; the dew point is set between -300C and -150C.

The cooling and, in part, treatment gases are discharged through the exhaust chimney 15; The other part of the treatment gases is discharged through the exhaust chimney 10 of the preheating furnace 2.

The strip emerges from the preparation installation 1 through the outlet channel 16 of the cooling chamber 4 and therefore immediately soaks in the bath of liquid metal 6 of the coating installation 5.

Thus, during the preparation of the strip for the coating, since there is no upper limit temperature for preheating, it is advantageously possible to proceed at a higher temperature to ensure both the quality of cleaning and good productivity. .

Thus also, when preparing the strip for coating, the use of hydrogen and the drawbacks associated with its use, in terms of safety and costs, are completely avoided.

The conduct of the strip preparation treatments for dip coating is greatly facilitated.

After the strip has been prepared, the strip is then dip coated according to a method known per se which is not described here in detail; in particular, the wiper ejectors 7 are adjusted to obtain the desired coating thickness, for example approximately twenty micrometers.

The Applicant has surprisingly observed that, while the strip preparation treatments were all carried out in the absence of hydrogen and in a non-reducing atmosphere, the aluminum or aluminum alloy coating produced by dipping according to methods known from elsewhere exhibit good geometric homogeneity and good adhesion to the strip B of stainless steel and / or alloy provided that said steel contains at least 0.1% manganese; this result is all the more surprising since the preparation conditions are neither able to completely prevent the formation of oxides, nor even to reduce them at the surface of the strip.

Example 1: An alloy steel strip with a thickness of 1 mm is taken, the manganese content of which is 0.178%.

The other alloying elements are in particular: Si: 0.37% - Cr 0.84% - Al: 0.9% - Ti: 0.32% - Nb: 0.21%.

Using the installation described above, the invention is carried out under the following preparation and coating conditions :. Preheating furnace 2: - strip temperature at the furnace outlet: 6500C.

Heating furnace 3 - strip temperature at the furnace outlet: 8500 C.

- composition of the atmosphere: Nitrogen.

- dew point: -300C.

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Cooling chamber 4 - strip temperature at the chamber outlet: 6800C.

- composition of the atmosphere: Nitrogen.

- dew point: -250C.

Coating bath 6 - composition: Al: 87.6% - Si: 9.1% - Fe: 3.3%.

- immersion time: 3 s.

The spin ejectors 7 are adjusted to load the strip of approximately 120 g / m2 on the double side with a coating which has the following composition: Al: 86.8% - Si: 6% - Fe: 7.2%.

The adhesion and the thickness homogeneity of the coating are then measured by the following methods - Standardized adhesion test ASTM No. A 463 488: the method consists of folding at 1800 ° C. a sample of coated strip to a diameter corresponding to two times the thickness of the sample; the test is positive if no chipping of the coating can be detected after bending.

The adhesion tests carried out on samples of the strip, thus prepared and coated according to the invention, are positive.

- Coating thickness or load measurement according to ASTM standard nOA 428-99: the method is based on measuring the weight of several samples before and after chemical stripping of the coating.

The load measurements carried out on three samples of the strip, thus prepared and coated according to the invention, give results 120 g / m2; 123 g / m2; 121 g / m2 ... and correspond to good homogeneity.

Example 2: A 1.4 mm thick F17T stainless steel strip is taken, the manganese content of which is 0.45%.

The other alloying elements are in particular: Cr: 17.7% - Si 0.44% - Ti: 0.29% - Nb: 0.62%.

Using the installation described above, the invention is carried out under the same preparation and coating conditions as in Example 1.

The spin ejectors 7 are adjusted to load the strip of approximately 120 g / m2 on the double side with a coating which has the following composition: Al: 86.8% - Si: 6% - Fe: 7.2%.

The adhesion and the thickness homogeneity of the coating are then measured by the same methods as in Example 1 - The adhesion tests carried out on samples of the strip, thus prepared and coated according to the invention, are positive.

- The load measurements carried out on three samples of the strip, thus prepared and coated according to the invention, give results 122 g / m2; 124 g / m2; 121 g / m2 ... and correspond to good homogeneity.

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(56) **Liste des documents cités dans le rapport de recherche préliminaire :** *Se reporter à la fin du présent fascicule.*

(60) **Références à d'autres documents nationaux apparentés :**

(71) **Demandeur(s) :** *SOLLAC Société anonyme* — FR.

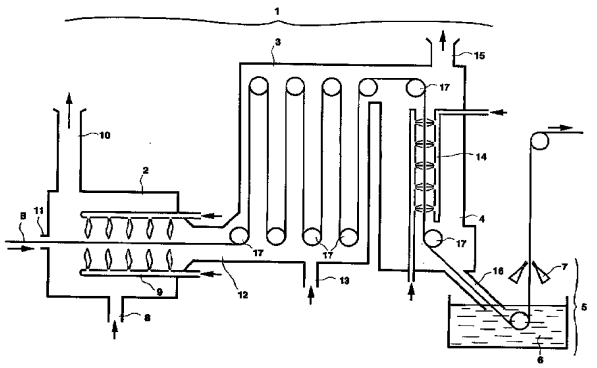
(72) **Inventeur(s) :** Godin Jean-Pierre et Guesdon Philippe.

(73) **Titulaire(s) :**

(74) **Mandataire :** Techmetal Promotion.

(54) Procédé de revêtement d'aluminium par trempe à chaud d'une pièce, notamment d'une bande, en acier contenant au moins 0,1 % en poids de manganèse, notamment en acier inoxydable et/ou allié.

(57) Dans ce procédé, on prépare la bande avant le revêtement suivant une séquence de traitements sous atmosphères toutes non réductrices puis on trempe la bande dans un bain d'aluminium ou d'alliage d'aluminium fondu. Simplification et sécurité de la préparation pour le revêtement au trempé.



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La présente invention est relative à un procédé de revêtement d'aluminium ou d'alliages d'aluminium par trempé à chaud d'une pièce, notamment d'une bande, en acier contenant au moins 0,1% en poids de manganèse, notamment en acier inoxydable et/ou allié.

D'une manière générale, pour procéder à un revêtement métallique au trempé d'une pièce en acier, on prépare la pièce à revêtir et on la trempe dans un bain de revêtement, c'est à dire ici un bain de métal fondu.

La préparation de ladite pièce comporte généralement un certain nombre de traitements successifs.

Ainsi par exemple, pour préparer ladite pièce, on nettoie sa surface, on la chauffe , puis on la refroidit .

Le nettoyage de la surface peut être notamment réalisé par traitement chimique de dégraisssage, par traitement thermique appelé préchauffage, voire par traitement physique .

Le chauffage est destiné à recristalliser l'acier qui compose la pièce ; il est ainsi effectué pendant une durée et selon un profil de température déterminant pour les propriétés mécaniques de ladite pièce.

Le refroidissement est destiné à ramener la température de la pièce à une température proche de celle du bain de métal fondu ; elle est généralement conduite sous jet de gaz froid.

Lorsque le revêtement est à base d'aluminium et que les pièces à revêtir sont en acier inoxydable et/ou allié, notamment contenant au moins 0,1 % de manganèse, il est connu de réaliser la préparation de la pièce, en particulier les dernières étapes comme le chauffage et le refroidissement, sous une atmosphère réductrice, notamment contenant de l'hydrogène.

En effet, la pièce à revêtir présente en surface des traces d'oxydes des éléments d'alliages dudit acier inoxydable et/ou allié ; le traitement de nettoyage, en particulier lorsqu'il est réalisé par préchauffage, oxyde encore davantage ladite surface ; il est connu que ces oxydes, et en particulier les oxydes de chrome, peuvent empêcher le métal fondu du bain de mouiller convenablement la surface de la bande au moment du trempé, ce qui est préjudiciable à la qualité du revêtement obtenu, notamment au niveau de son adhérence à la pièce et de son homogénéité géométrique.

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Cette disposition concernant l'atmosphère des traitements de préparation est donc utile pour réduire les oxydes des éléments d'alliages de l'acier, notamment de chrome, qui se trouvent à la surface de la pièce à revêtir et pour améliorer sensiblement la qualité du revêtement au trempé, notamment au niveau de son adhérence à la pièce et de son homogénéité géométrique.

Ainsi, il est connu d'utiliser de l'hydrogène en fortes proportions dans l'atmosphère de refroidissement et de chauffage pour réduire, à la surface de la pièce à revêtir, les oxydes initialement présents ou qui se sont formés lors des traitements précédents de la préparation ; mais l'utilisation d'hydrogène présente de graves inconvénients économiques et de sécurité.

Le brevet français n°2 664 617 déposé le 16/07/90 aux noms des Sociétés SOLLAC et UGINE S.A. décrit un tel procédé et présente l'avantage, par rapport aux procédés de l'art antérieur, d'éviter l'utilisation d'atmosphères réductrices contenant de fortes proportions d'hydrogène, lors de la préparation d'une pièce à revêtir, en particulier au moment du refroidissement.

Ce document décrit un procédé de préparation pour le revêtement d'aluminium au trempé d'une bande d'acier inoxydable dans lequel on préchauffe ladite bande dans une atmosphère non oxydante à une température plus basse que dans l'art antérieur, on chauffe ladite bande dans une atmosphère non oxydante, pouvant être réductrice et contenir de l'hydrogène, et on refroidit ladite bande dans une atmosphère non réactive, comme de l'azote, et pouvant contenir de l'hydrogène.

Ainsi, grâce à une température plus basse et une atmosphère non oxydante au préchauffage, on limite la formation d'oxydes à la surface de la bande et on peut avantageusement effectuer les traitements ultérieurs sous des atmosphères moins réductrices, donc contenant moins d'hydrogène que celles couramment utilisées auparavant, tout en obtenant un revêtement d'aluminium de bonne qualité, en particulier de bonne adhérence et de bonne homogénéité.

Néanmoins, dans ce procédé, la contrepartie de la température plus basse et de l'atmosphère non oxydante du préchauffage peut être une diminution de la qualité du nettoyage, en particulier lorsque des corps encrassant la surface de la pièce, notamment des corps gras, ne sont pas totalement décomposés dans ces nouvelles conditions de préchauffage.

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Il peut être également nécessaire de prolonger la durée du traitement de préchauffage pour obtenir une qualité suffisante du nettoyage, mais cet allongement de la durée du traitement est préjudiciable à la productivité.

Par ailleurs, notamment pour les traitements de chauffage et de refroidissement, il reste souvent nécessaire d'utiliser de l'hydrogène, bien qu'évidemment en plus faibles proportions qu'auparavant ; on n'a donc pas totalement supprimé les inconvénients lié à l'utilisation d'hydrogène, et qui concernent la sécurité et le coût des installations.

L'invention a pour but d'éviter l'utilisation d'hydrogène lors de la préparation d'une pièce, notamment d'une bande, en acier inoxydable et/ou allié contenant au moins 0,1 % de manganèse pour un revêtement au trempé d'aluminium ou d'alliages d'aluminium.

L'invention a également pour but de faciliter la conduite des traitements de préparation d'une telle bande, et en particulier d'assurer à la fois la qualité du nettoyage et la productivité.

A cet effet, l'invention a pour objet un procédé de revêtement d'aluminium ou d'alliage d'aluminium par trempé à chaud d'une pièce, notamment d'une bande, en acier contenant au moins 0,1% en poids de manganèse, notamment en acier inoxydable et/ou allié dans lequel on prépare la bande avant le revêtement suivant une séquence de traitements effectués sous atmosphère contrôlée puis on trempe la bande dans un bain d'aluminium ou d'alliage d'aluminium fondu, caractérisé en ce que lesdites atmosphères sont toutes non réductrices.

Le procédé suivant l'invention peut comporter une ou plusieurs des caractéristiques suivantes :

- les concentrations en hydrogène des atmosphères desdits traitements sont toutes inférieures ou égales à 4 %,
- lesdits traitements sont des traitements thermiques,
- lorsque ladite séquence de traitements comporte un chauffage et un refroidissement, les atmosphères de chauffage et de refroidissement contiennent plus de 96 % d'azote.

L'invention va maintenant être décrite plus en détail en regard de la figure annexée , qui représente une vue schématique d'une installation de préparation et d'une installation de revêtement au trempé en continu d'une bande métallique.

Comme représenté à la Figure unique, l'installation de préparation en continu désignée dans son ensemble par la référence 1 comprend :

- un four de préchauffage 2,
- un four de traitement thermique 3,
- une chambre de refroidissement 4,

Ladite installation de préparation est installée en amont d'une installation de revêtement au trempé désignée dans son ensemble par la référence 5 ; elle comporte des rouleaux-support de bande 17 répartis dans toute l'installation et qui définissent le chemin de bande.

L'installation de revêtement au trempé 5 est connue par elle-même et ne sera pas décrite ici en détail ; d'une manière classique, elle comporte un récipient de trempage contenant le bain 6 de revêtement, composé d'aluminium ou d'alliage d'aluminium en fusion, et des éjecteurs d'essorage 7.

Le four de préchauffage 2 est un four à flamme directe comportant une entrée d'air 8, des rampes de brûleurs 9 disposées de part et d'autre du chemin de bande, et une cheminée 10 d'évacuation des gaz, en particulier de combustion ; le four de préchauffage 2 comporte encore une entrée de bande 11 et une sortie de bande 12 débouchant directement dans le four de traitement thermique 3.

Le four de traitement thermique 3 est à tubes radiants et à atmosphère contrôlée, en particulier par une entrée de gaz de traitement 13 ; sa sortie débouche directement dans la chambre de refroidissement 4.

La chambre de refroidissement 4 est dotée de rampes d'éjecteurs de gaz de refroidissement 14 disposées de part et d'autre du chemin de bande, dont les éjecteurs sont orientés vers le chemin de bande ; la chambre de refroidissement 4 est également dotée d'une cheminée d'évacuation des gaz 15 et débouche par un canal de sortie de bande 16 sous le niveau de la surface libre du métal liquide 6 de l'installation de revêtement 5.

L'installation de préparation comporte également des moyens de mesure de température de l'atmosphère et de la bande, des moyens de mesure des points de rosée et de contrôle du taux d'humidité, qui sont installés dans le four de préchauffage 2, le four de traitement thermique 3, et la chambre de refroidissement 4 ; ces moyens sont connus en eux-mêmes et ne sont pas représentés ici.

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Les rampes d'éjecteurs de gaz de refroidissement 14 et l'entrée de gaz de traitement 13 sont reliés à des moyens d'alimentation en gaz qui ne sont pas représentés ici.

Afin de procéder au revêtement au trempé d'une bande B d'acier inoxydable et/ou allié contenant au moins 0,1% de manganèse , on prépare ladite bande selon la séquence suivante :

- on préchauffe ladite bande entre les rampes de brûleurs 9 du four de préchauffage 2 alimenté en excès d'au moins 2 % de carburant par rapport aux conditions stoechiométriques de combustion dans une atmosphère non oxydante dont la température est généralement située entre 800°C et 1300°C ; de cette manière, la température de la bande à la sortie du four de préchauffage 2 est supérieure à la température de décomposition des corps encrassant la surface de la bande, notamment des corps gras, et généralement située entre 400°C et 700°C ; la surface de ladite bande est alors nettoyée.

- on traite thermiquement ladite bande dans le four de traitement thermique 3 pendant une durée suffisante pour que la température mesurée de ladite bande à la sortie du four de traitement thermique 3 soit supérieure à la température de recristallisation de l'acier inoxydable et/ou allié de la bande, c'est à dire en général comprise entre 750°C et 950°C, et pour obtenir les propriétés mécaniques requises de la bande ; on établit donc la température de l'atmosphère du four de traitement thermique entre 850°C et 1000°C et, par ailleurs, son point de rosée entre -45°C et -25°C.

On effectue ledit traitement thermique sous une atmosphère non réductrice ; grâce au moyen d'alimentation en gaz, on injecte dans le four de traitement thermique 3 par l'entrée de gaz 13 un gaz de traitement non réducteur, ici de l'azote contenant moins de 0,1% d'hydrogène, à un débit tel que ledit four 3 soit en surpression par rapport au four de préchauffage 2 et à la chambre de refroidissement 4.

Sans se départir de l'invention, il est possible d'utiliser comme gaz de traitement de l'azote contenant 4% d'hydrogène ; même à ces concentrations, l'utilisation d'hydrogène ne présente en effet aucun inconvénient quant à la sécurité et au coût des installations.

- on refroidit ladite bande entre les rampes d'éjecteurs de gaz de refroidissement 14 dans la chambre de refroidissement 4 sous une atmosphère non réductrice ; grâce aux moyens d'alimentation en gaz, on

alimente en effet les rampes 14 en gaz de refroidissement non réducteur, ici de l'azote à température ambiante contenant moins de 0,1% d'hydrogène, à un débit tel que la température mesurée de la bande à la sortie de ladite chambre 4 soit proche de celle du bain de métal fondu 6, c'est à dire en général comprise entre 670°C et 700°C ; on règle le point de rosée entre -30°C et -15°C.

Les gaz de refroidissement et, en partie, de traitement s'évacuent par la cheminée d'évacuation 15 ; l'autre partie des gaz de traitement s'évacue par la cheminée d'évacuation 10 du four de préchauffage 2.

La bande ressort de l'installation de préparation 1 par le canal de sortie 16 de la chambre de refroidissement 4 et trempe donc immédiatement dans le bain de métal liquide 6 de l'installation de revêtement 5.

Ainsi, lors de la préparation de la bande pour le revêtement, puisqu'il n'y a pas de température limite supérieure de préchauffage, on peut avantageusement procéder à une température plus élevée pour assurer à la fois la qualité du nettoyage et une bonne productivité.

Ainsi également, lors de la préparation de la bande pour le revêtement, on évite totalement l'utilisation d'hydrogène et les inconvénients liés à son utilisation, aux plans de la sécurité et des coûts.

La conduite des traitements de préparation de la bande pour le revêtement au trempé est largement facilitée.

Après la préparation de la bande, on procède ensuite au revêtement au trempé de la bande selon un procédé connu en lui-même qui n'est pas décrit ici en détail ; on règle en particulier les éjecteurs d'essorage 7 pour obtenir l'épaisseur de revêtement souhaitée, par exemple de environ vingt micromètres.

La Demanderesse a constaté avec surprise que, alors que les traitements de préparation de la bande ont tous été conduits en l'absence d'hydrogène et en atmosphère non réductrice, le revêtement d'aluminium ou d'alliage d'aluminium réalisé au trempé selon des méthodes connues par ailleurs présente une bonne homogénéité géométrique et une bonne adhérence sur la bande B d'acier inoxydable et/ou allié à condition que ledit acier contienne au moins 0,1 % de manganèse ; ce résultat est d'autant plus surprenant que les conditions de préparation ne sont aptes ni à empêcher totalement la formation d'oxydes, ni même à les réduire à la surface de la bande.

Exemple 1 :

On prend un bande d'acier allié d'épaisseur 1 mm dont la teneur en manganèse est de 0,178 %.

Les autres éléments d'alliage sont notamment : Si : 0,37 % - Cr : 0,84 % - Al : 0,9 % - Ti : 0,32 % - Nb : 0,21 %.

En utilisant l'installation décrite ci-dessus, on procède selon l'invention dans les conditions suivantes de préparation et de revêtement :

. Four de préchauffage 2 :

- température de bande en sortie de four : 650°C.

. Four de chauffage 3 :

- température de bande en sortie de four : 850°C.
- composition de l'atmosphère : Azote.
- point de rosée : -30°C.

. Chambre de refroidissement 4 :

- température de bande en sortie de chambre : 680°C.
- composition de l'atmosphère : Azote.
- point de rosée : -25°C.

. Bain de revêtement 6 :

- composition : Al : 87,6 % - Si : 9,1 % - Fe : 3,3 %.
- durée d'immersion : 3 s.

On règle les éjecteurs d'essorage 7 pour charger la bande de 120 g/m2 environ en double face d'un revêtement qui présente la composition suivante : Al : 86,8 % - Si : 6 % - Fe : 7,2 %.

On mesure ensuite l'adhérence et l'homogénéité en épaisseur du revêtement par les méthodes suivantes :

- Test d'adhérence normalisé ASTM n° A 463 488 : la méthode consiste au pliage à 180°C d'un échantillon de bande revêtue selon un diamètre correspondant à deux fois l'épaisseur de l'échantillon ; le test est positif si aucun écaillage du revêtement ne peut être décelé après pliage.

Les tests d'adhérence effectués sur des échantillons de la bande, ainsi préparée et revêtue selon l'invention, sont positifs.

- Mesure d'épaisseur ou de charge de revêtement selon la norme ASTM n°A 428-99 : la méthode est basée sur la mesure de poids de plusieurs échantillons avant et après décapage chimique du revêtement.

Les mesures de charge effectuées sur trois échantillons de la bande, ainsi préparée et revêtue selon l'invention, donnent comme

résultats : 120 g/m2 ; 123 g/m2 ; 121 g/m2 ... et correspondent à une bonne homogénéité.

Exemple 2 :

On prend un bande d'acier inoxydable F17T d'épaisseur 1,4 mm dont la teneur en manganèse est de 0,45 %.

Les autres éléments d'alliage sont notamment : Cr : 17,7 % - Si : 0,44 % - Ti : 0,29 % - Nb : 0,62 %.

En utilisant l'installation décrite ci-dessus, on procède selon l'invention dans les mêmes conditions de préparation et de revêtement que dans l'exemple 1.

On règle les éjecteurs d'essorage 7 pour charger la bande de 120 g/m2 environ en double face d'un revêtement qui présente la composition suivante : Al : 86,8 % - Si : 6 % - Fe : 7,2 %.

On mesure ensuite l'adhérence et l'homogénéité en épaisseur du revêtement par les mêmes méthodes que dans l'exemple 1 :

- Les tests d'adhérence effectués sur des échantillons de la bande, ainsi préparée et revêtue selon l'invention, sont positifs.
- Les mesures de charge effectuées sur trois échantillons de la bande, ainsi préparée et revêtue selon l'invention, donnent comme résultats : 122 g/m2 ; 124 g/m2 ; 121 g/m2 ... et correspondent à une bonne homogénéité.

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REVENDICATIONS

1.- Procédé de revêtement par trempé à chaud d'une pièce, notamment d'une bande, en acier contenant au moins 0,1% en poids de manganèse, notamment en acier inoxydable et/ou allié dans lequel on prépare la bande avant le revêtement suivant une séquence de traitements effectués sous atmosphère contrôlée puis on trempe la bande dans un bain d'aluminium ou d'alliage d'aluminium fondu, caractérisé en ce que les atmosphères desdits traitements sont toutes non réductrices.

2.- Procédé selon la revendication 1 caractérisé en ce que les concentrations en hydrogène des atmosphères desdits traitements sont toutes inférieures ou égales à 4 %.

3.- Procédé selon la revendication 1 ou 2 caractérisé en ce que lesdits traitements sont des traitements thermiques.

4.- Procédé selon la revendication 3 caractérisé en ce que, lorsque ladite séquence de traitements comporte un chauffage et un refroidissement, les atmosphères de chauffage et de refroidissement contiennent plus de 96 % d'azote.

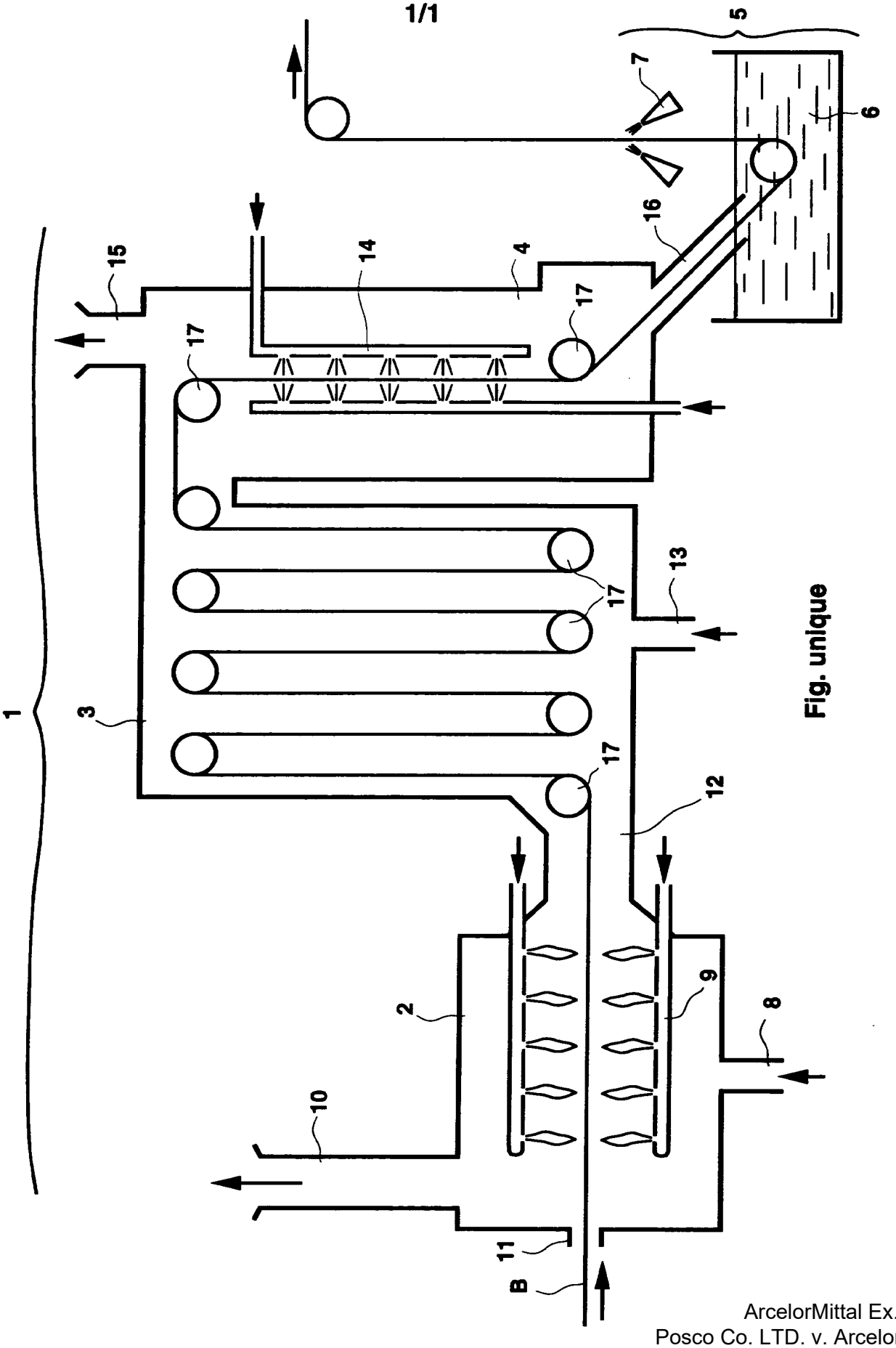


Fig. unique

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REPUBLIQUE FRANÇAISE

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INSTITUT NATIONAL de la PROPRIETE INDUSTRIELLE

RAPPORT DE RECHERCHE PRELIMINAIRE

établi sur la base des dernières revendications déposées avant le commencement de la recherche

N° d'enregistrement national

FA 499504
FR 9406239

DOCUMENTS CONSIDERES COMME PERTINENTS		Revendications concernées de la demande examinée
Catégorie	Citation du document avec indication, en cas de besoin, des parties pertinentes	
A	AU-B-24 455 (JOHN LYSAGHT) * page 6, ligne 30 - ligne 33 * * page 8, ligne 24 - ligne 31; revendications 1,7; figures 1,4 *	1-4
A	FR-A-2 086 302 (N.V. BEKAERT) * page 4, ligne 1 - ligne 16 * * page 5, ligne 23 - ligne 27; revendications 1-3 *	1-4
A	GB-A-676 198 (MICHEL ALFERIEFF) *document entier*	1-4
A	PATENT ABSTRACTS OF JAPAN vol. 14, no. 17 (C-675) 16 Janvier 1990 & JP-A-01 259 153 (NIPPON STEEL CORP) 16 Octobre 1989 * abrégé *	1-4
A	PATENT ABSTRACTS OF JAPAN vol. 5, no. 106 (C-062) 10 Juillet 1981 & JP-A-56 047 554 (NISSHIN STEEL) 30 Avril 1981 * abrégé *	1-4
A,D	EP-A-0 467 749 (SOLLAC) * revendications 1,4,12 *	1-4
A	US-A-4 210 097 (FRED BYRD)	
A	GB-A-2 001 105 (ARMCO STEEL CORPORATION)	
A	PATENT ABSTRACTS OF JAPAN vol. 9, no. 5 (C-260) 10 Janvier 1985 & JP-A-59 157 266 (KAWASAKI SEITETSU) 6 Septembre 1984 * abrégé *	

DOMAINES TECHNIQUES RECHERCHES (Int.Cl.5)

C23C

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Date d'achèvement de la recherche	Examinateur
29 Décembre 1994	Elsen, D

CATEGORIE DES DOCUMENTS CITES

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(12) PATENT ABRIDGMENT (11) Document No. AU-B-39425/89
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HOT DIP ALUMINUM COATED CHROMIUM ALLOY STEEL

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(56) Prior Art Documents
AU 592437 72930/87 C23C 2/12

(57) Claim

1. A method of continuous hot dip coating a steel strip with aluminium, comprising the steps of:

heating a ferritic chromium alloy steel strip to a temperature no greater than about 650°C by direct combustion of fuel and air wherein the gaseous products of said combustion have no free oxygen,

further heating said strip to a temperature of at least about 830°C,

cooling said strip to a temperature no less than the melting point of an aluminium coating metal,

passing said strip through a protective atmosphere having at least about 95% by volume hydrogen,

dipping said strip into a molten bath of said coating metal to deposit a coating layer on said strip,

said coating layer being substantially free of uncoated areas and tightly adherent to said strip.

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S & F Ref: 103460

FORM 10

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COMPLETE SPECIFICATION

(ORIGINAL)

FOR OFFICE USE:

Class Int Class

Complete Specification Lodged:
Accepted:
Published:

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Related Art:

Name and Address of Applicant: AK MANAGEMENT CORPORATION ~~Armco Inc.~~
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AUSTRALIAN PATENT OFFICE SEC 34(4)

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Complete Specification for the invention entitled:

Hot Dip Aluminum ~~Coated~~ Coated Chromium Alloy Steel

The following statement is a full description of this invention, including the best method of performing it known to me/us

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5845/4

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ABSTRACT OF THE DISCLOSURE

Continuous hot dip aluminum coated ferritic chromium alloy steel strip. Strip is cleaned by heating to a temperature no greater than about 650°C in a direct fired furnace. The cleaned strip is further heated in a protective atmosphere containing at least 95% by volume hydrogen, cooled in the protective hydrogen atmosphere to near or slightly above the melting point of an aluminum coating metal, and passed into a bath of the aluminum coating metal. The low direct fired furnace cleaning temperature and hydrogen protective atmosphere provides good wetting of a chromium alloy steel surface to prevent uncoated areas or pin holes in the aluminum coated layer.

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HOT DIP ALUMINUM COATED CHROMIUM ALLOY STEEL

BACKGROUND OF THE INVENTION

This invention relates to a continuously hot dipped metallic coated ferritic chromium alloy ferrous base strip and a process to enhance the wetting of the strip surface with molten aluminum.

Hot dip aluminum coated steel exhibits a high corrosion resistance to salt and finds various applications in automotive exhaust systems and combustion equipment. In recent years, exhaust system requirements have increased with respect to durability and aesthetics. For this reason, there has become a need to increase high temperature oxidation resistance and salt corrosion resistance by replacing aluminum coated low carbon or low alloy steels with aluminum coated chromium alloy steels. For high temperature oxidation, at least part of the aluminum coating layer can be diffused into the iron base by the heat during use to form an Fe-Al alloy layer. If uncoated areas are present in the aluminum coating layer, accelerated oxidation leading to a perforation of the base metal may result if the Fe-Al alloy is not continuously formed on the base metal. For lower

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temperatures, the aluminum coating layer acts as a barrier protection for atmospheric conditions and as a cathodic coating in high salt environments. Again, if uncoated areas are present, accelerated corrosion may occur leading to failure of the coated structure.

It is well known to hot dip metallic coat low carbon steel strip without a flux by subjecting the strip to a preliminary treatment which provides a clean surface free of oil, dirt and iron oxide which is readily wettable by the coating metal. One type of preliminary in-line anneal treatment for low carbon steel is described in U.S. patent 3,320,085 issued to C. A. Turner, Jr. The Turner process, also known as the Selas process, for preparation of low carbon steel strip for hot dip metallic coating includes passing the strip through a direct fired furnace having an atmosphere heated to a temperature of at least 2400°F (1316°C). The atmosphere is formed from the gaseous products of combustion of fuel and air and has no free oxygen. The fuel-air ratio is controlled to provide the necessary reducing characteristics for effecting cleaning of the steel strip. The fuel-air ratio is regulated to provide a slight excess of fuel so that there is no free oxygen but excess combustibles in the form of carbon monoxide and hydrogen. Maintaining a furnace atmosphere of at least 1316°C having at least 3% excess combustibles is reducing to steel up to 1700°F (927°C). Turner teaches his cleaned strip is then passed through a sealed delivery duct having a neutral or protective atmosphere prior to passing the cleaned strip into a coating pot. For coating with molten zinc, Turner teaches heating the strip up to 1000°F (538°C). For coating with molten aluminum, Turner teaches heating the strip within the temperature range of 1250-1300°F (677-704°C) in the direct fired furnace since the atmosphere is still reducing to the steel at these temperatures.

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Modern direct fired furnaces include an additional furnace section normally heated with radiant tubes. This furnace section contains the same neutral or reducing protective atmosphere, e.g. 75% nitrogen - 25% hydrogen, as the delivery duct described above.

U.S. patent No. 3,925,579 issued to C. Flinchum et al describes an in-line pretreatment for hot dip aluminum coating low alloy steel strip to enhance wettability by the coating metal. The steel contains one or more of up to 5% chromium, up to 3% aluminum, up to 2% silicon and up to 1% titanium, all percentages by weight. The strip is heated to a temperature above 1100°F (593°C) in an atmosphere oxidizing to iron to form a surface oxide layer, further treated under conditions which reduce the iron oxide whereby the surface layer is reduced to a pure iron matrix containing a uniform dispersion of oxides of the alloying elements.

The problems associated with nonwetting of aluminum coatings onto ferritic chromium alloy steel are also well known. Hot dip aluminum coatings have poor ~~wetability~~ wettability to ferritic chromium alloy steel base metals and normally have uncoated or bare spots in the aluminum coating layer. By poor adherence is meant flaking or crazing of the coating during bending the strip. To overcome the adherence problem, some have proposed heat treating the aluminum coated steel to anchor the coating layer to the base metal. Others lightly reroll the coated chromium alloy steel to bond the aluminum coating. Finally, those concerned about uncoated spots have generally avoided continuous hot dip coating. Rather, batch type hot dip coating or spray coating processes have been used. For example, after a

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chromium alloy steel article has been fabricated, it is dipped for an extended period of time within an aluminum coating bath to form a very thick coating layer.

U.S. patent 4,675,214 issued to F. M. Kilbane et al, incorporated herein by reference, proposes a solution for enhancing the wetting of ferritic chromium alloy steel strip continuously coated with hot dip aluminum coatings. The Kilbane process includes cleaning a ferritic chromium alloy steel and passing the cleaned steel through a protective hydrogen atmosphere substantially void of nitrogen prior to entry of the steel into an aluminum coating bath. This process resulted in improved wetting of ferritic chromium alloy steel so long as the steel was not cleaned by heating to an elevated temperature in a direct fired furnace. According to Turner, a direct fired furnace having an atmosphere with at least 3% combustibles heated to 2400°F (1316°C) is reducing to steel up to 1700°F (927°C). Nevertheless, heating ferritic chromium alloy steel at temperatures about 1250°F (677°C) and above in a direct fired furnace whose atmosphere has no free oxygen and subsequently passing the steel through a protective atmosphere of substantially pure hydrogen immediately prior to hot dip coating with aluminum still had large uncoated areas. Not being bound by theory, it is believed a direct fired furnace atmosphere having no free oxygen does have significant oxidizing potential due to the presence of water and apparently is oxidizing to the chromium contained in a chromium alloy ferrous strip. The chromium oxide formed on the surface of the strip apparently is not removed sufficiently by the protective hydrogen atmosphere prior to entry into the coating bath thereby preventing complete wetting of the strip surface.

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BRIEF SUMMARY OF THE INVENTION

The invention relates to a continuous hot dip aluminum coated ferritic chromium alloy steel strip heated in a direct fired furnace by the combustion of fuel and air wherein the gaseous products of combustion have no free oxygen. The surface of the strip is heated to a temperature sufficient to remove oil, dirt, iron oxide, and the like but below a temperature causing excessive oxidation of chromium in the strip base metal. The strip is further heated in another furnace portion and is cooled, if necessary, to near or slightly above the melting point of an aluminum coating metal. The strip is then passed through a protective atmosphere of at least 95% by volume hydrogen and then into a molten bath of the aluminum coating metal to deposit a layer of the coating metal on the strip.

It is a principal object of this invention to form hot dip aluminum coated ferritic chromium alloy steels having enhanced wetting by the coating metal.

It is another object of the invention to form a hot dip aluminum coating on a chromium alloy steel strip cleaned in a direct fired furnace.

It is a further object of the invention to form a hot dip aluminum coating on a deep drawing chromium alloy steel strip that is annealed in-line on the coating line.

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According to a broad form of the invention, there is provided a method of continuous hot dip coating a steel strip with aluminium, comprising the steps of:

heating a ferritic chromium alloy steel strip to a temperature no greater than about 650°C by direct combustion of fuel and air wherein the gaseous products of said combustion have no free oxygen,

further heating said strip to a temperature of at least about 830°C,

cooling said strip to a temperature no less than the melting point of an aluminum coating metal,

passing said strip through a protective atmosphere having at least about 95% by volume hydrogen,

dipping said strip into a molten bath of said coating metal to deposit a coating layer on said strip,

said coating layer being substantially free of uncoated areas and tightly adherent to said strip.

The invention is directed to an improvement in or modification of the invention disclosed and claimed in Australian Patent No. 592437.

One feature of the invention is to clean a ferritic chromium alloy steel strip having enhanced wetting by an aluminium coating by heating the strip in a direct fired furnace on an aluminum coating line below a temperature creating excessive oxidation of chromium contained in the strip.

Another feature of the invention is to further heat the cleaned chromium alloy steel strip to a fully annealed condition in another furnace portion having a protective atmosphere containing at least about 95% by volume hydrogen.

Another feature of the invention is to supply less than 80% of the total thermal energy required to fully anneal the deep drawing ferritic chromium alloy steel strip in the direct fired furnace of the aluminum coating line.

Another feature of the invention is to maintain the cleaned chromium alloy steel strip in a protective atmosphere containing at least about 95% by volume hydrogen, less than 200 ppm oxygen, and having a dew point less than +40°F (+4°C) until the cleaned strip is passed into the aluminum coating metal.

Another feature of the invention is to fully anneal and cool the

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heated chromium alloy steel strip in a protective atmosphere containing at least 95% by volume hydrogen having a dew point no greater than 0°F (-18°C), passing the strip through a snout containing a protective atmosphere containing at least 97% by volume hydrogen having a dew point no greater than -20°F (-29°C), and then dip the strip into the aluminum coating metal.



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Advantages of the invention are elimination of uncoated areas and improved adherence to ferritic chromium alloy steel strip cleaned in a direct fired furnace and continuously hot dip coated with aluminum.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a schematic view of a ferrous base strip being processed through a hot dip aluminum coating line incorporating the present invention;

FIG. 2 is a partial schematic view of the coating line of FIG. 1 showing an entry snout and coating pot.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to FIG. 1, reference numeral 10 denotes a coil of steel with strip 11 passing therefrom and around rollers 12, 13 and 14 before entering the top of first furnace section 15. First furnace section 15 is a direct fired type heated by the combustion of fuel and air. The ratio of fuel and air is in a proportion so that the gaseous products of combustion have no free oxygen and preferably at least 3% by volume excess combustibles. The atmosphere in furnace 15 is heated preferably to greater than 2400°F (1316°C) and strip 11 maintained at sufficient speed so that the strip surface temperature is not excessively ~~excessivley~~ oxidizing to chromium while removing surface contaminants such as rolling mill oil films, dirt, iron oxide, and the like. Except for a brief period of time as explained in detail later, the strip

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should not be heated to a temperature above about 1200°F (649°C) and preferably not above about 1150°F (621°C) while in furnace 15.

The second section of the furnace denoted by numeral 16 may be of a radiant tube type. The temperature of strip 11 is further heated to at least about the melting point of an aluminum coating metal, i.e. 1200°F (649°C), and up to about 1750°F (955°C) reaching a maximum temperature at about point 18. A protective atmosphere including at least about 95% by volume hydrogen preferably is maintained in furnace section 16 as well as succeeding sections of the furnace described below.

Sections 20 and 22 of the furnace are cooling zones. Strip 11 passes from furnace portion 22, over turndown roller 24, through snout 26 and into coating pot 28 containing molten aluminum. The strip remains in the coating pot a very short time, i.e. 2-5 seconds. Strip 11 containing a layer of coating metal on both sides is vertically withdrawn from coating pot 28. The coating layers are solidified and the coated strip is passed around turning roller 32 and coiled for storage or further processing as a coil 34. As noted above, furnace sections 20, 22 and 26 contain the protective hydrogen atmosphere.

Referring now to FIG. 2, snout 26 is protected from the atmosphere by having its lower or exit end 26a submerged below surface 44 of aluminum coating metal 42. Suitably mounted for rotation are pot rollers 36 and 38 and stabilizer roller 40. The weight of coating metal 42 remaining on strip 11 as it is withdrawn from coating pot 28 is controlled by finishing means such as jet knives 30. Strip 11 is cooled to a temperature near or slightly above the melting point of the aluminum coating metal in furnace portions 20, 22

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and 26 before entering coating pot 28. This temperature may be as low as 1150°F (620°C) for aluminum alloy coating metals, e.g. Type 1 containing about 10% by weight silicon, to as high as about 1350°F (732°C) for commercially pure aluminum coating metal, e.g. Type 2.

The apparatus shown in FIG. 2 is for two-side coating using air finishing. As will be understood by those skilled in the art, finishing using a sealed enclosure containing a nonoxidizing atmosphere may also be used.

Hydrogen gas of commercial purity may be introduced into the furnace sections through inlets 27 in snout 26 ~~preferrably~~ Preferably to achieve a protective hydrogen atmosphere containing less than about 200 ppm oxygen and having a dew point no greater than +40°F (+4°C). Depending upon factors such as hydrogen flow rate and furnace volume, additional hydrogen inlets may be required in furnace sections 16, 20 and 22.

Ferritic chromium alloy steels as defined herein include iron based magnetic materials characterized by a body centered cubic structure and having about .5 weight % or more chromium. For example, the present invention has particular usefulness for hot dip aluminum coated ferritic stainless steel having up to about 35% by weight chromium and is used in automotive exhaust applications including heavy gauge engine exhaust pipes having thicknesses of 1.2 mm or more, foil having thicknesses less than .25 mm cold reduced from aluminized strip used as catalyst supports for catalytic converters, and fully annealed strip deeply drawn into parts requiring light weight aluminum coatings, e.g. no greater than 185 gm/m^2 total both sides, such as manifolds, muffler parts, catalytic converters,

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resonators, and the like. By full annealing is meant the strip is heated to at least about 830°C in furnace 16 and will have at least about 25% elongation as measured in a tensile test.Type 409 ferritic stainless steel is particularly preferred as the starting material for the present invention. This steel has a nominal composition of about 11% by weight chromium, about 0.5% by weight silicon, and remainder essentially iron. More broadly, a ferritic steel containing from about 10.0% to about 14.5% by weight chromium, about 0.1% to 1.0% by weight silicon, and remainder essentially iron, is preferred.

The following are nonlimiting examples illustrating the invention:

Example 1

A 1.02 mm thick by 122 cm wide Type 409 stainless steel strip was coated with pure molten aluminum coating (Type 2) at a temperature of 699-704°C using the coating line in FIGS. 1 and 2. Hydrogen of commercial purity was flowed at a rate of about 380 m^3/hr into snout 26 and an atmosphere of 75% by volume nitrogen and 25% by volume hydrogen was maintained in furnace portion 16. The dew point of the pure protective hydrogen atmosphere in snout 26 was initially +48°F (+9°C). The fuel to air ratio in direct fired furnace portion 15 was controlled to have about 5% by volume excess combustibles. For various strip speeds and temperatures, the following visual observations were made:

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Sample	Speed (m/min)	DFF(°C)*	RT(°C)**	Oxide***	Coating Condition
A	37	760	917	Dark Blue	random un-coated areas
B	46	704	917	Light Blue	random un-coated areas
C	55	649	871	Gold	uncoated strip edge only
D	37	649	871	Gold	good coating

* Strip temperature in furnace portion 15.

** Strip temperature in furnace portion 16

*** Surface appearance as strip 11 passed from furnace 15

As demonstrated above, a ferritic chromium alloy steel is oxidized when heated to a temperature of at least 649°C in an atmosphere of combustion products having no free oxygen. The dew point of the hydrogen atmosphere in snout 26 increased to a maximum of about +58°F (+14°C) as a result of at least some of the iron and/or chromium oxide being reduced to metal and water by the hydrogen atmosphere. Samples A and B heated to at least 704°C in the direct fired furnace were excessively oxidized and not properly wetted by the aluminum coating metal. The amount of oxidation to the strip when heated to 649°C in the direct fired furnace was marginally excessive as demonstrated by poor coating wetting along one edge of

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Sample C. Using a very dry protective hydrogen atmosphere, e.g. dew point no greater than 0°F (-19°C), throughout furnace portions 16, 20, 22 and snout 26 probably would have sufficiently removed the oxide on Sample C to result in better wetting of the aluminum coating metal. Contrary to conventional wisdom for low carbon steel, ferritic chromium steel is readily oxidized in an atmosphere having no free oxygen and excess combustibles when heated to at least 649°C.

Example 2

A 1.64 mm thick by 94 cm wide coil of Type 409 stainless steel was coated with 183 gm/m^2 of Type 2 aluminum (total both sides) under similar conditions to that of Example 1 except the pure protective hydrogen atmosphere also was maintained in furnace portion 16 and cooling zones 20, 22. Prior to passing this coil through the coating line, the dew point of the hydrogen atmosphere in snout 26 was -9°F (-23°C). The following coating observations were made for various strip temperatures:

Sample	DFF(°C)	RT(°C)	Coating Appearance
A	817	908	poor, frequent uncoated spots
B	620	841	good, infrequent uncoated spots

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Example 3

Three coils of Type 409 stainless steel were processed and coated with 137 gm/m^2 Type 2 aluminum (total both sides) under similar conditions as in Example 2 except the dew point of the hydrogen atmosphere in snout 26 was -50°F (-46°C) and the dew point in radiant tube furnace portion 16 was -4°F (-20°C). The following coating observations were made for various strip temperatures:

Sample	Thickness (mm)	Width (cm)	DFF (°C)	RT (°C)	Coating Appearance
A	1.4	117	676	892	Some uncoated spots
B	1.3	91	677	902	Scattered uncoated spots esp.10 cm from one edge
C	1.4	76	604	871	No uncoated spots

As clearly demonstrated in Examples 1-3, heating the strip to temperatures of at least 676°C in the direct fired furnace caused excessive oxidation of the strip. Using a very dry protective hydrogen atmosphere throughout the furnace portions 16, 20, 22 and snout 26 did not sufficiently remove the oxides to achieve good coating metal wetting. On the other hand, heating the strip to no greater than about 650°C in the direct fired furnace and further heating the strip to temperatures greater than about 830°C in the radiant tube furnace resulted in adherent aluminum coatings having minimal uncoated areas on a fully annealed strip capable of being deeply drawn without flaking or crazing the coating.

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Example 4

A 1.08 mm thick by 76 cm wide Type 409 stainless steel coil was also successfully continuously hot dip coated with 119 gm/m^2 (total both sides) of an aluminum alloy (Type 1) containing 9% by weight silicon. Operating conditions were the same as in Example 2. The strip was heated to about 627°C in furnace portion 15 and to 829°C in furnace portion 16. Very few uncoated areas were observed.

Examples 5-10

Examples 5 through 10 are for .38 mm thick by 12.7 cm wide strip for ferritic, low carbon, titanium stabilized steels containing 2.01, 4.22 and 5.99% by weight chromium. These samples were continuously hot dip aluminum coated (Type 2) on a laboratory coating line similar to that shown in FIGS. 1 and 2 and under conditions similar to those for Example 2. Weights of coating were not measured.

No.	% Cr	Speed (m/min)	DFF* (°C)	% H_2**	Condition
5	2.01	7.6	1204	25	Poor Coating
6	4.22	12.2	1093	25	Poor Coating
7	5.99	12.2	1193	25	Poor Coating
8	2.01	9.1	1227	100	Very good coating

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No.	% Cr	Speed (m/min)	DFF* (°C)	% H_2**	Condition
9	4.22	9.1	1238	100	Good coating
10	5.99	9.1	--	100	Good coating

* Furnace Zone temperatures

** Hydrogen content in protective atmosphere

While strip temperatures out of the direct fired furnace were not measured, the data clearly supports the use of a 100% by volume hydrogen atmosphere in all areas of the furnace except the direct fired portion. Since the chromium content was lowered in Examples 5-10 from previous examples (11% by weight), it is reasonable to expect less dependence on direct fired furnace strip exit temperature with the lower chromium alloys (2, 4, 6% by weight). In other words, there would be less oxidation potential with less chromium content.

As noted above, a direct fired atmosphere of the gaseous products of combustion of fuel and air having no free oxygen is oxidizing to ferritic chromium alloy steel at about 1200°F (649°C). Accordingly, the strip temperature in direct fired furnace 15 should not exceed this temperature, particularly for ferritic stainless steel having chromium content of 10% by weight or more. Preferably, this strip cleaning temperature should not exceed about 1150°F (621°C). Nevertheless, the strip temperature on occasion will exceed 649°C resulting from strip width and/or gauge changes. Brief exclusions, i.e. less than 10 minutes of temperature about or slightly above 649°C, can be tolerated by carefully controlling the protective

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atmosphere conditions throughout furnace portion 16, cooling zones 20, 22 and snout 26. By maintaining a protective atmosphere containing at least about 95% by volume hydrogen in furnace portion 16, cooling zones 20, 22 and snout 26, minimal ~~exidization~~ oxidation of strip 11 in furnace portion 15 can be removed. In this regard, we have determined it to be especially beneficial to maintain extremely low dew points in the protective hydrogen atmosphere to compensate for water formation as iron and/or chromium oxide is reduced by hydrogen in the protective atmosphere. Preferably, the protective atmosphere in snout 26 contains at least 97% by volume hydrogen and the dew point should not exceed about -20°F (-29°C). A dew point of 0°F (-18°C) preferably should be maintained in furnace portion 16 and cooling zones 20, 22.

As disclosed in U.S. patent 4,675,214, the reactivity of the aluminum coating metal increases at elevated temperatures. Accordingly, maintaining the aluminum coating at 1280-1320°F (693-716°C) also helps to remove any residual surface oxide not removed by the protective atmosphere. However, removal of oxide from the strip surface while submerged in the aluminum coating metal bath is undesirable because the reduced oxide forms aluminum oxide (dross) on the surface of the coating bath. Aluminum oxide can also cause uncoated areas by attachment as fragments to the strip as it emerges from the coating pot preventing metallurgical bonding of the aluminum coating metal to the steel strip.

The teachings of the present invention are especially important when high strip temperatures, e.g greater than 830°C, are required for full ar ealing to produce deep drawing strip for high formability products. For

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high temperature annealing for low carbon steel strip, up to about 90% of the total heat input to the strip is accomplished in the direct fired portion of the furnace. The tables below show the percent of total thermal content achieved in the direct fired furnace portion for low carbon steel (prior art) and for ferritic chromium alloy steel (invention).

Prior Art

t(mm)	w(cm)	t X w	s(mpm)	T_1(°C)	T_2(°C)	MW/Hr. To T_1	MW/Hr. To T_2	% T_2*
.81	76	62	95	760	857	3.9	4.4	88.4
1.40	76	106	64	749	857	4.4	5.0	87.0
1.75	86	151	43	760	857	4.3	4.9	88.4
				Invention				
.81	76	62	64	624	831	2.1	2.9	74.5
1.40	76	106	40	628	832	2.3	3.1	74.8
1.75	86	151	33	631	849	2.8	3.8	73.6

t = strip thickness

w = strip width

s = strip speed through furnace

T_1 = strip temperature in direct fired furnace

T_2 = strip temperature in radiant tube heated furnace

* = % total thermal content

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As demonstrated above, nearly 90% of total thermal content for fully annealed low carbon steel is achieved in the direct fired portion of the furnace while less than 80% of total thermal content for fully annealed hot dip aluminum coated chromium alloy steel can be achieved in the direct fired portion of the furnace if excessive oxidation is to be avoided. In other words, for fully annealed strip of the invention, the maximum allowed direct fired furnace strip temperature must be less than that necessary to provide at least 80% of total thermal input.

Various modifications can be made to the invention without departing from the spirit and scope of it so long as the chromium alloy steel strip is not heated to a temperature excessively oxidizing to the strip in a direct fired furnace and is passed through a protective atmosphere containing at least about 95% by volume hydrogen prior to entry into the coating metal bath. For example, the hydrogen atmosphere can be used throughout any heating and cooling portions of the coating line between the direct fired furnace and the coating pot delivery duct. The coating metal can include pure aluminum and aluminum base alloys. The coating metal weight may be controlled by finishing in air or a sealed enclosure. Therefore, the limits of the invention should be determined from the appended claims.

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The claims defining the invention are as follows:

1. A method of continuous hot dip coating a steel strip with aluminium, comprising the steps of:

heating a ferritic chromium alloy steel strip to a temperature no greater than about 650°C by direct combustion of fuel and air wherein the gaseous products of said combustion have no free oxygen,

further heating said strip to a temperature of at least about 830°C,

cooling said strip to a temperature no less than the melting point of an aluminium coating metal,

passing said strip through a protective atmosphere having at least about 95% by volume hydrogen,

dipping said strip into a molten bath of said coating metal to deposit a coating layer on said strip,

said coating layer being substantially free of uncoated areas and tightly adherent to said strip.

2. The method of claim 1 wherein said strip is heated to no greater than about 621°C by said direct combustion of fuel and air.

3. The method of claim 1 or claim 2 wherein said strip is further heated to a temperature of 845°C to 955°C in said atmosphere.

4. The method of any one of claims 1 to 3 wherein said strip is cooled in said atmosphere.

5. The method of any one of claims 1 to 4 wherein said atmosphere has less than about 200 ppm oxygen and a dew point of less than about +4°C.

6. The method of any one of claims 1 to 5 wherein said coating metal is substantially pure aluminum.

7. The method of any one of claims 1 to 6 wherein said strip includes at least 10% by weight chromium.

8. A method of continuous hot dip coating a steel strip with aluminium, which method is as defined in claim 1 and substantially as herein described with reference to any one of Sample D of Example 1, Sample B of Example 2, Sample C of Example 3, or Example 4.

9. A method of continuous hot dip coating a steel strip with

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aluminium, which method is as defined in claim 1 and substantially as herein described with reference to Figures 1 and 2.

10. A coated steel strip when prepared by the method of any one of claims 1 to 9.

DATED this FIFTH day of FEBRUARY 1992
A K Management Corporation

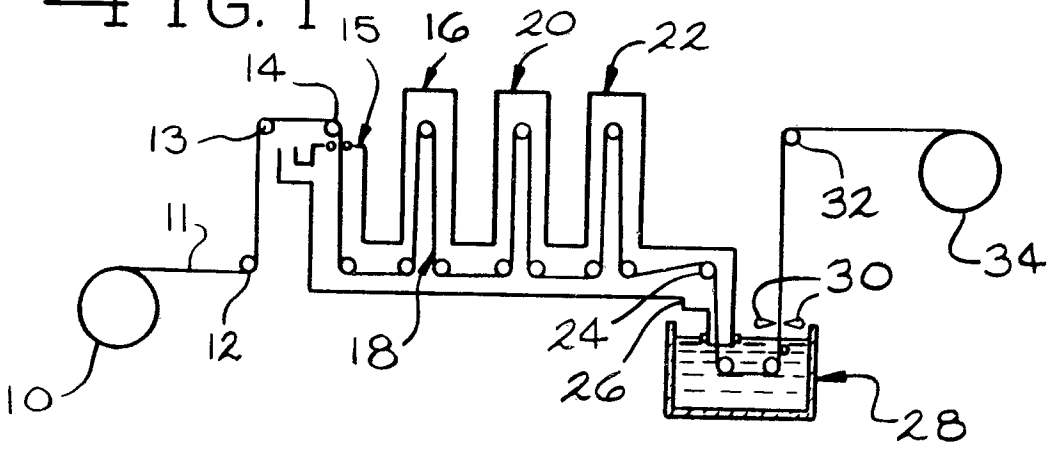
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FIG. 1



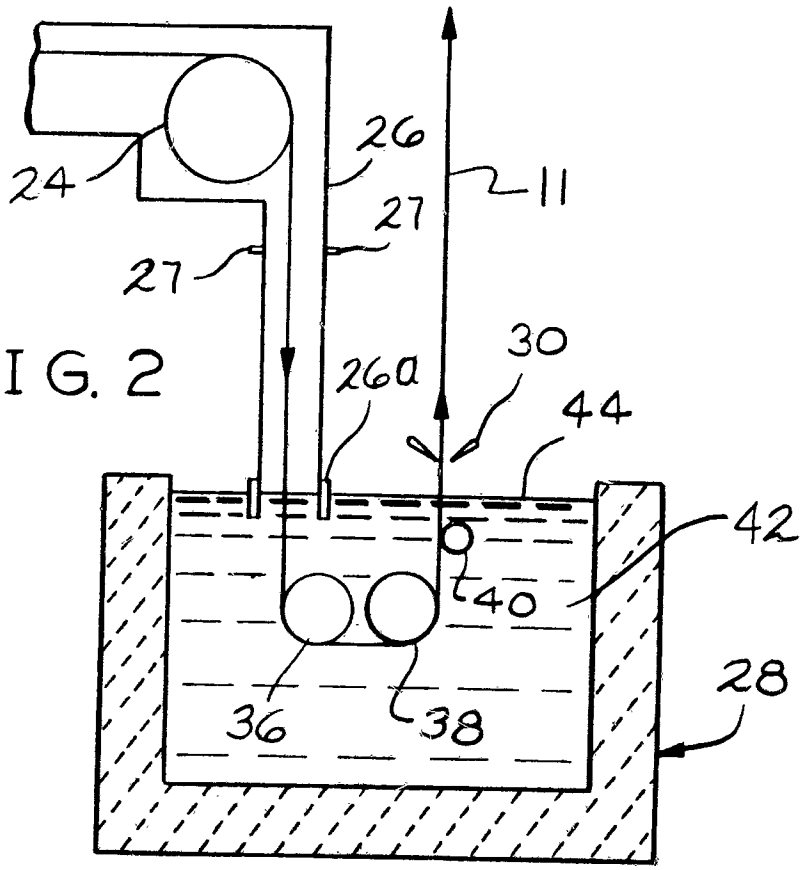


FIG. 2

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CLAIMS JPH08144037A

1.

In a method for producing a molten aluminum-zinc alloy plated steel sheet in which spangles are suppressed, which is performed after hot-dip plating and immediately before solidification of the hot-dip plating layer, the surface temperature distribution of the steel sheet in the longitudinal direction is measured and refined after hot-dip plating. Supgle suppression, which is characterized by determining the treatment point, measuring the change in the amount of plating adhesion in the width direction, and overcooling the thickened region where the amount of adhesion is larger than the average value prior to the miniaturization treatment. A method for manufacturing a hot-dip aluminum-zinc alloy plated steel sheet.

2.

On the hot-dip galvanizing bath outlet side, a surface temperature measuring means in the longitudinal direction of the hot-dip galvanized steel sheet, a plating adhesion amount measuring means for measuring the plating adhesion amount in the plate width direction, and a region designated as a thickening area by the plating adhesion amount measuring means. A cooling means capable of selectively overcooling, a movable micronization treatment means provided downstream of the cooling means, and the cooling means and the cooling means based on the temperature distribution of the steel plate in the longitudinal direction and the amount of plating adhered in the plate width direction. An apparatus for producing a hot-dip aluminum-zinc alloy plated steel sheet in which spangles are suppressed, which comprises an arithmetic apparatus for controlling the micronization processing means.

3.

The molten aluminum according to claim 2, further comprising a heating means and another cooling means for the plated steel sheet upstream of the cooling means on the hot-dip galvanizing bath side, and these heating means and the cooling means are also controlled by the arithmetic unit. -Zinc alloy plated steel sheet manufacturing equipment.

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DESCRIPTION JPH08144037A

[0001]

INDUSTRIAL APPLICABILITY The present invention relates to a method for producing a molten aluminum-zinc alloy plated steel sheet and a method for producing a molten aluminum-zinc alloy plated steel sheet in which a so-called spangle pattern appearing on the surface of the molten aluminum-zinc alloy plated steel sheet is suppressed.

[0002]

[Conventional Technology] Hot-dip aluminum-zinc alloy-plated steel sheet represented by 55% Al-Zn alloy-plated steel sheet (hereinafter referred to as hot-dip Al-Zn alloy-plated steel sheet or simply Al-Zn alloy-plated steel sheet) is a hot-dip galvanized steel sheet. Since it has significantly better corrosion resistance, its use in building materials such as roofing materials is expanding.

[0003]

Al-Zn alloy plated steel sheets are generally manufactured using a continuous hot dip galvanizing line.

Therefore, after being annealed in the line by the Zenzimir method or the non-oxidizing furnace method, which is the mainstream in the continuous hot-dip galvanizing line, plating is performed. Specifically, after preheating while removing dirt (oils and fats, etc.) on the surface of the plating original plate in an oxidizing furnace or non-oxidizing furnace of a continuous hot-dip galvanizing line, a reduction furnace maintained in an H2-N2 mixed gas atmosphere. The surface is activated and annealed at. Next, the original plate was cooled to a temperature suitable for molten Al-Zn alloy plating, then passed through a plating bath to perform Al-Zn alloy plating, and the amount of plating adhered was adjusted by a wiping nozzle on the plating bath outlet side and cooled. After winding the plated steel sheet.

[0004]

On the surface of the molten Al-Zn alloy plated steel sheet produced in this way, a flower-shaped pattern called spangle spots (hereinafter, simply referred to as spangle) is generated, and the plated surface is uneven along the pattern. There is. When spangles become coarse, the appearance of the product deteriorates and the commercial value decreases. Further, for example, when it is used as a base material for a coated steel sheet, there is an inconvenience that a uniform coated surface cannot be secured. Therefore, there is a strong demand for a molten Al—Zn alloy plated steel sheet having a uniform and beautiful surface appearance in which spangle patterns are suppressed.

[0005]

As a method of suppressing (miniaturizing) the spangle pattern of a molten Al-Zn alloy plated steel sheet, a method of spraying air or a chemical solution after plating to quench the steel sheet (Japanese Patent Laid-Open No. 60-16[illegible]

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melting point than the plated metal. A method of spraying and cooling fine metal powder (Japanese Patent Laid-Open No. 59-170271) has been proposed so far. Further, a method of spraying a metal oxide powder as a spangle miniaturization treatment for hot-dip zinc alloy plating and hot-dip aluminum plating is also known (Japanese Patent Laid-Open No. 63-157849). It is most effective to suppress spangles by performing these miniaturization treatments immediately before the hot-dip galvanizing layer solidifies, that is, when the plating layer is at a temperature slightly higher than the melting point.

[0006]

However, even if molten Al---Zn alloy plating is performed by applying these miniaturization treatment methods, spangles often remain in the plated products. This is often due to the non-uniform adhesion of the Al---Zn alloy plating layer before the miniaturization treatment, or the non-uniform cooling in the plate width direction. For example, after hot-dip galvanizing, when the plating layer is miniaturized at a temperature considerably higher than the melting point of the Al---Zn alloy, the plated surface exhibits a pit-like rough skin appearance. On the contrary, if the miniaturization treatment time is too late and the plating layer is already solidified before that, the spangle cannot be sufficiently miniaturized.

[0007]

Regarding the cooling control for suppressing the spangle pattern, although it is an example of hot dip galvanizing, the following method has been proposed so far. A method of locally heating the edge portion of a steel plate in order to correct the deviation of the temperature distribution in the width direction of the molten zinc layer (Japanese Patent Laid-Open No. 48-84038), the width direction of the steel strip before and after the zinc powder spraying position. The temperature distribution of the steel strip is measured, and from the measured temperature distribution in the width direction, the line position where the temperature of the steel strip is slightly higher than the solidification temperature of zinc over the entire width is calculated, and the appropriate zinc powder spraying position is determined. Method for determining (Japanese Unexamined Patent Publication No. 1-30547), thermometers are arranged before and after the spangle refining processing device, and heating and cooling means are arranged in front of the spangle cooling device, and the two directions are the longitudinal direction and the width direction. A method for obtaining an appropriate temperature distribution by measuring a dimensional temperature distribution and changing the heating / cooling method and the position of a spangle micronization treatment device (Japanese Patent Laid-Open No. 2-298248).

[0008]

In both of the methods and methods, the surface temperature of the plated steel sheet is measured to determine the miniaturization treatment point (cooling timing) so that the miniaturization treatment can be performed immediately before the hot-dip galvanized layer solidifies. These methods can also be sufficiently applied to suppress spangles in molten Al---Zn alloy plated steel sheets.

[0009]

However, even if the cooling control method after plating as described above is applied to molten Al-Zn alloy plating, the finally obtained Al-Zn alloy plated steel sheet can be obtained. It has been experienced that unwanted spangles remain on the surface, especially in specific areas in the width direction. That is, the determination of an appropriate cooling time and the uniform cooling in the width direction by the conventional measurement of the surface temperature distribution of the steel sheet are not perfect for suppressing spangles.

[0010]

Therefore, an object of the present invention is to provide a method and a manufacturing apparatus for a molten Al---Zn alloy plated steel sheet capable of reliably suppressing spangles. Specifically, a technology that can surely eliminate the residual or generation of spangles that may occur even if the steel sheet temperature is properly controlled and the appropriate cooling time is determined during hot-dip Al-Zn alloy plating. To develop.

[0011]

PROBLEM TO BE SOLVED: To investigate the cause of spangle residue on a molten Al---Zn alloy plated steel sheet even if the cooling time is appropriately determined as described above. As a result, the final product may have a rough spangle

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shape due to reheating, or spangle may occur locally. The cause is that the amount of Al—Zn alloy adhered is non-uniform in the plate width direction. It was clarified that this is because the amount of latent heat is large in the portion where the amount of Al—Zn alloy adhered is large in the plate width direction, and therefore the amount of reheat is also large, and solidification is partialiy delayed.

[0012]

If solidification is delayed in a part of the plate width direction due to such non-uniform reheating, the plating layer temperature is still fine in the part where solidification is delayed even if spangle miniaturization treatment is performed at an appropriate time thereafter. It is too expensive for the conversion process, and spangles will remain even after the miniaturization process. Therefore, in order to reliably obtain a molten Al—Zn alloy-plated steel sheet in which spangles are suppressed throughout the plate width direction, it is necessary to consider reheat in addition to determining an appropriate cooling time.

[0013]

Thus, the present invention measures the amount of Al-Zn alloy adhering to the steel sheet in the plate width direction when producing the molten Al-Zn alloy plated steel sheet in which spangles are suppressed by the micronization treatment, and the plate width direction. By overcooling only the portion where the amount of adhesion is large, it is a basic feature that uniform cooling of the Al—Zn alloy from immediately before the freezing point is possible over the entire width in the plate width direction during the miniaturization process.

[0014]

That is, the gist of the present invention is a method for producing a hot-dip Al—Zn alloy-plated steel sheet in which spangles are suppressed, in which a micronization treatment is performed after hot-dip plating and immediately before solidification of the hot-dip plating layer. The surface temperature distribution of the steel sheet is measured to determine the point of micronization, and the change in the amount of plating adhesion in the width direction is measured to overcool the thickened area where the amount of adhesion is larger than the average value prior to the miniaturization. This is a method for producing a hot-dip Al—Zn alloy-plated steel sheet in which spangles are suppressed.

[0015]

Here, supercooling means that the degree of cooling is stronger than that of cooling of other parts in the width direction (that is, the part where the amount of adhesion is below the average), but specifically, consideration is given to reheating. Therefore, the cooling is performed so as to be 1 to 5 ° C lower than the cooling temperature required for the target temperature when the other parts reach the miniaturization processing device.

[0016]

From another aspect, the present invention presents the hot-dip galvanized steel sheet with a surface temperature measuring means in the longitudinal direction, a plating adhesion amount measuring means for measuring the plating adhesion amount in the plate width direction, and the plating adhesion. A cooling means capable of selectively overcooling a region designated as a thickened region by a quantity measuring means, a movable micronization processing means provided downstream of the cooling means, and a steel plate temperature distribution and a plate width in the longitudinal direction. It is an apparatus for producing a hot-dip Al—Zn alloy-plated steel sheet in which spangles are suppressed, which comprises an arithmetic apparatus for controlling the cooling means and the micronization processing means based on the amount of plating adhesion in the direction.

[0017]

In a preferred embodiment, the manufacturing apparatus further includes a heating means for the plated steel sheet and another cooling means upstream of the cooling means on the hot-dip galvanizing bath side, and these heating means and cooling means are also the arithmetic unit. Is controlled by.

[0018]

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[Action] As described above, even in the conventional method for manufacturing a molten Al-Zn alloy plated steel sheet in which spangles are suppressed, heating, cooling, and miniaturization treatment points are performed so that the miniaturization treatment is performed immediately before solidification of the plating layer. It is in control.

However, conventionally, these controls have been performed by paying attention only to the width direction of the hot-dip galvanized steel sheet or only the temperature distribution in the width direction and the longitudinal direction.

[0019]

For example, FIG. 2 shows a hot-dip galvanizing apparatus for carrying out the above method.

This device includes a burner box 4 for heating, a cooler box 5 for cooling, a radiation thermometer 6 for two-dimensional temperature measurement, a miniaturization processing device 7, and an arithmetic device 8.

Note that 1 is a hot-dip galvanized bath, 2 is a steel plate, 3 is a wiping nozzle, and 9 is a plated steel plate.

The temperature of the plated steel sheet 9 that has exited the hot-dip galvanized bath 1 is measured in the width direction and the longitudinal direction by the two-dimensional temperature measuring device 6, and the heating means 4 or the heating means 4 or The temperature of the steel sheet is controlled by heating or cooling by the cooling means 5.

These measurement, heating, and cooling data are sent to the arithmetic unit 8, and the miniaturization processing device is moved to a position where the entire width of the plate is slightly higher than the solidification temperature, and the miniaturization processing is performed.

[0020]

On the other hand, in the present invention, attention is paid to the fact that the adhesion amount of the hot-dip galvanized steel sheet is non-uniform in the width direction, and for spangles, the reheat in the thickened region where the adhesion amount is larger than the average value is other. It was found that this large reheat, which is larger than the part, affects the spangle. It is presumed that the reason why the amount of hot-dip galvanized varies in the width direction is that the shape of the steel sheet passing between the gas injection nozzles is unstable.

[0021]

In order to prevent the generation of spangles due to this reheating, in the present invention, prior to the miniaturization process, a thickened region in the width direction of the plated steel sheet is detected, and the region is particularly supercooled to be fine. The effect of reheating before and after the conversion process is minimized. The degree of supercooling at this time is determined in relation to the degree of thickening, but if the temperature of the thickening region at the time of miniaturization processing is cooled to be the same as the temperature of other parts. Good. That is, since the amount of reheat generated between the cooling and the miniaturization process is proportional to the amount of plating adhesion, supercooling is performed so as to offset it. Specifically, as described above, the cooling may be performed so as to be 1 to 5 ° C lower than the cooling temperature required for the target temperature at the time of reaching the miniaturization processing apparatus in other parts.

[0022]

Therefore, as shown in FIG. 1, the hot-dip Al---Zn alloy-plated steel sheet manufacturing apparatus of the present invention is capable of partially overcooling in the width direction as compared with the conventional hot-dip galvanizing apparatus shown in FIG. Means (eg, second cooler box 10) and hot-dip galvanizing amount measuring means 11 in the width direction may be attached.

[0023]

Thus, according to the present invention, since only the portion having a large amount of plating adhesion (thickening region) in the width direction is selectively overcooled and then the miniaturization treatment is performed, the plating surface temperature is the width of the steel sheet during the miniaturization treatment. Since it is substantially uniform over the entire width in the direction, the miniaturization treatment effect can be uniformly achieved over the entire width, and a molten Al---Zn alloy plated steel sheet in which spangles are uniformly

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suppressed in the width direction can be obtained. it can.

[0024]

On the other hand, in the past, since the degree of cooling is not changed in the width direction, the amount of heat recovery in the thickening region becomes large, and the miniaturization treatment is performed at a temperature higher than the optimum temperature, so that the effect of the miniaturization treatment is sufficient. However, spangles occur and spangles remain in the thickening area.

[0025]

The cooling means for supercooling may be the same as the conventional cooling means, but must be capable of changing the degree of cooling in the width direction.

In addition, there are no restrictions on the means of micronization, and powders with a higher melting point than air, air-water (gas in which minute water droplets are mixed), chemicals, and Al-Zn alloy, which is the material to be plated (eg, zinc powder, metal). It can be carried out using a medium that has been used conventionally, such as oxide powder).

[0026]

[Example] FIG. 1 is a schematic explanatory view of an apparatus for manufacturing a molten Al—Zn alloy plated steel sheet according to the present invention.

Hereinafter, examples of the present invention will be described with reference to this figure.

[0027]

In the apparatus of the present invention shown in FIG. 1, similarly to the conventional apparatus shown in FIG. 2, the steel plate 2 immersed in the molten Al—Zn alloy plating bath 1 is subjected to predetermined plating by the wiping nozzle 3 when it is pulled up from the bath. it is adjusted to the amount of adhesion.

Next, the temperature of the steel sheet is adjusted by heating the steel sheet with the burner box 4 or cooling it in the first cooler box 5 so that the micronization treatment is performed immediately before the molten Al—Zn alloy plating layer solidifies. This adjustment of the steel sheet temperature is not essential, but by adjusting the steel sheet temperature to be almost constant by heating or cooling in this way, the fluctuation range of the position of the miniaturization processing device 7 becomes small, and the miniaturization processing point can be controlled. It is preferable to adjust the temperature because it is easy.

[0028]

The temperature distribution in the longitudinal direction of the steel sheet 2 is monitored by the radiation thermometer 6, and based on this, the degree of heating or cooling for adjusting the temperature of the steel sheet is determined. In order to know the possibility of partial solidification in the width direction, it is preferable to monitor not only the longitudinal direction of the plated steel sheet but also the temperature distribution in the width direction at the same time with the radiation thermometer 6. Then, all of these heating, cooling, and temperature distribution data are sent to the arithmetic unit 8, and the position of the miniaturization processing device 7, that is, the miniaturization processing point is determined by this arithmetic unit. The miniaturization processing device 7 is movable, that is, it can be moved by moving up and down along the plate passing line according to the position where the molten Al-Zn alloy plating layer solidifies, and this device is a molten Al-Zn alloy plating layer. The required amount of movement is determined by the command of the arithmetic unit 8 so as to come to the point immediately before solidification.

[0029]

The hot-dip galvanizing apparatus of the present invention includes a means 11 for measuring the amount of plating adhesion in the width direction of the hot-dip galvanized steel sheet 9. The amount of plating adhered can be quickly measured by an analytical means such as fluorescent X-ray. The measurement result of the plating

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adhesion amount measuring means is sent to the arithmetic unit 8 to detect a thick basis weight region in which the adhesion amount is larger than the average adhesion amount in the width direction. Then, based on the result, the second cooler box 10 provided on the upstream side of the miniaturization processing device 7 and capable of changing the degree of cooling in the width direction is operated. Therefore, the position of the adhesion amount measuring means 11 may be any point between the wiping nozzle 3 and the second cler box 10, but is preferably immediately after the wiping nozzle 3.

[0030]

The second cooler box is specifically 1 to 5 ° C from the target temperature so as to offset the excessive amount of reheat for the thickened region detected based on the measurement result of the adhesion amount measuring means 11. C The hot-dip galvanized layer is cooled by changing the degree of cooling in the width direction so as to supercool to a low temperature. This cooling can be performed by partially cooling only the thickening area (not cooling the other parts) or by making the cooling degree of the thickening area stronger than the cooling degree of the other parts. For example, the second cooler box 10 can consist of a large number of spray nozzles, one in each of a large number of areas evenly partitioned (eg, 1 to 50 mm wide) along the width direction of the steel sheet. In that case, the cooling medium (eg, air, air, water, chemical solution) is sprayed onto the plated steel plate only from the spray nozzle of the section designated as the thickening area, or the amount of the cooling medium sprayed from the spray nozzle of the section is changed. By increasing the amount of spraying in the section of the above, it is possible to overcool the thickened area.

[0031]

After selectively supercooling the thickening region in this way, the plating layer miniaturization processing apparatus is performed. The miniaturization processing apparatus 7 is an apparatus for producing a steel sheet in which spangles are suppressed by spraying an appropriate medium such as air, brackish water, a chemical solution, or a metal powder onto the hot-dip galvanized layer immediately before solidification and uniformly quenching the layer. Is.

[0032]

As described above, the position of the micronization processing device 7 is the steel plate temperature distribution measured by the radiation thermometer 6, the heating or cooling of the plated steel sheet by the burner box 4 or the first cooler box 5, and further the second cooler box 10. The data regarding the cooling of the steel sheet by the above is sent to the arithmetic unit 8 to determine that the molten Al—Zn alloy plating layer is unsolidified over the entire width and is at the position immediately before solidification. Then, based on the command from the arithmetic unit 8, the miniaturization processing device 7 is moved up and down along the plate line (that is, moved in the same direction as the steel plate traveling direction or in the opposite direction) to solidify the hot-dip galvanized layer. Set to the previous position.

[0033]

In the past, the effect of reheat due to the uneven amount of plating adhering in the width direction was ignored, so in the thickened area, miniaturization treatment is performed in a state of insufficient cooling due to reheating, and even after the miniaturization treatment, this is performed. The plated surface has spangles remaining in the area. On the other hand, according to the present invention, since only the thickening region is supercooled upstream of the miniaturization processing apparatus, a relatively large reheat that occurs in this region while the plated steel plate advances to the miniaturization processing apparatus. It is offset by supercooling, and a local temperature rise (insufficient cooling) in the thickening region is avoided, so that the miniaturization treatment can be uniformly performed at the optimum temperature over the entire width in the plate width direction. As a result, the effect of the miniaturization treatment is uniformly exhibited over the entire width, and a plated surface in which spangles are uniformly suppressed in the plate width direction can be obtained. Since the hot-dip galvanized steel sheet is usually double-sided plated, the controlled plating method according to the present invention described above is independently performed on both sides of each side. However, in the case of single-sided plating, or when only one side needs to be a beautiful surface, the

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above-mentioned controlled plating method of the present invention may be applied to only one side.

[0034]

3 (a) and 3 (b) schematically explain the formation of a thickened region and supercooling of a molten Al—Zn alloy-plated steel sheet obtained by using the apparatus according to the present invention shown in FIG. .. In the illustrated example, the plate thickness is 0.5 mm, the plate width is 1219 mm, and the target plating adhesion amount is 90 g / m2 per side. The adhesion amount distribution of the molten Al—Zn alloy plating layer in the plate width direction measured by the plating adhesion amount measuring means 11 is as shown in FIG. 3 (a), and two thickening regions were detected. On the other hand, as shown in FIG. 1B, the second cooler box 10 includes 12 water spray nozzles A to L arranged at equal distances in the plate width direction. That is, it can be evenly divided into 12 sections in the width direction, and each section can be supercooled. In the illustrated example, only the thickening area is selectively supercooled by operating only the spray nozzles C and I located at the positions corresponding to the detected thickening area to spray the cooling water, and then fine. The conversion process was performed.

[0035]

The plated appearance of the molten Al-Zn alloy-plated steel sheet finally obtained after the miniaturization treatment, especially the spangle pattern, was observed by dividing the plate width direction into 12 sections corresponding to the nozzle positions A to L. However, spangles were sufficiently suppressed. On the other hand, for comparison, when the same molten Al—Zn alloy plated steel sheet was manufactured without operating the above second cooler box at all (thus, without selective supercooling in the width direction), the plate width was obtained. In the section corresponding to the thickening area in the direction (that is, the section corresponding to the nozzle positions C and I), a visually recognizable spangle pattern remained, and the suppression of spangle was insufficient.

[0036]

INDUSTRIAL APPLICABILITY As described above, when a molten Al—Zn alloy-plated steel sheet in which spangles are suppressed is produced by performing a micronization treatment immediately before solidification of a hot-dip galvanized layer, melting in the plate width direction is performed according to the present invention. By measuring the change in the amount of plating adhesion and selectively overcooling only the thickened area where the amount of plating adhesion is large, a beautiful plated surface in which spangles are suppressed uniformly over the entire width in the plate width direction can be obtained. As a result, even when a painted steel sheet is used, it can be painted uniformly, and the painted appearance is improved.

[0037]

A brief description of the drawing

[0038]

FIG. 1 is a schematic explanatory view of an apparatus for manufacturing a molten Al—Zn alloy plated steel sheet in which spangles are suppressed according to the present invention.

[0039]

FIG. 2 is a schematic explanatory view of a conventional similar device.

[0040]

3 Fig. 3 (a) and 3 (b) show the formation and supercooling of the thickened region of the molten Al—Zn alloy plated steel sheet obtained by using the apparatus according to the present invention shown in FIG.

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1, respectively. It is a figure to explain.

[0041]

Code description

[0042]

1: Hot-dip galvanized bath 2: Steel plate 3: Wiping nozzle 4: Burner box 5: First cooler box 6: Radiation thermometer 7: Miniaturization processing device 8: Computing device 9: Hot-dip galvanized steel sheet 10: Second cooler box 11: Plate width direction plating adhesion amount measuring means

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CLAIMS JPH08144037A

1.

In a method for producing a molten aluminum-zinc alloy plated steel sheet in which spangles are suppressed, which is performed after hot-dip plating and immediately before solidification of the hot-dip plating layer, the surface temperature distribution of the steel sheet in the longitudinal direction is measured and refined after hot-dip plating. Supgle suppression, which is characterized by determining the treatment point, measuring the change in the amount of plating adhesion in the width direction, and overcooling the thickened region where the amount of adhesion is larger than the average value prior to the miniaturization treatment. A method for manufacturing a hot-dip aluminum-zinc alloy plated steel sheet.

2.

On the hot-dip galvanizing bath outlet side, a surface temperature measuring means in the longitudinal direction of the hot-dip galvanized steel sheet, a plating adhesion amount measuring means for measuring the plating adhesion amount in the plate width direction, and a region designated as a thickening area by the plating adhesion amount measuring means. A cooling means capable of selectively overcooling, a movable micronization treatment means provided downstream of the cooling means, and the cooling means and the cooling means based on the temperature distribution of the steel plate in the longitudinal direction and the amount of plating adhered in the plate width direction. An apparatus for producing a hot-dip aluminum-zinc alloy plated steel sheet in which spangles are suppressed, which comprises an arithmetic apparatus for controlling the micronization processing means.

3.

The molten aluminum according to claim 2, further comprising a heating means and another cooling means for the plated steel sheet upstream of the cooling means on the hot-dip galvanizing bath side, and these heating means and the cooling means are also controlled by the arithmetic unit. -Zinc alloy plated steel sheet manufacturing equipment.

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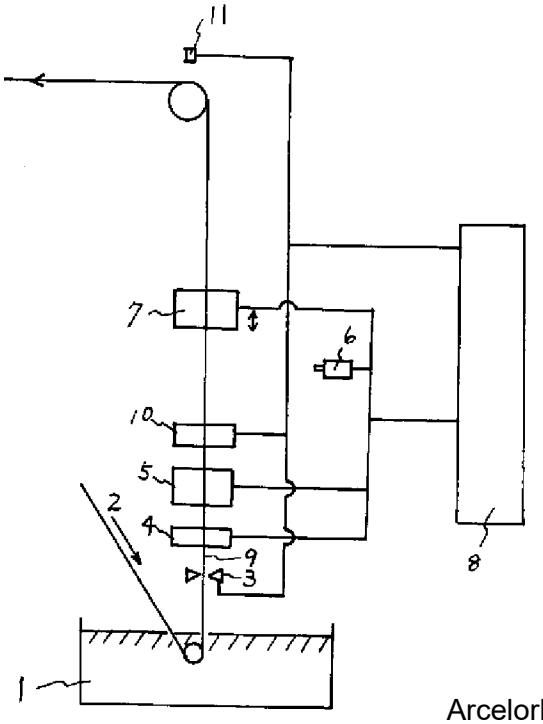
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(54)【発明の名称】　溶融アルミニウム－亜鉛合金メッキ鋼板の製法及び装置

(57)【要約】

【構成】　溶融メッキ浴１でメッキ後、メッキ層の凝固直前に７で微細化処理する、スパングルの抑制された溶融アルミニウム－亜鉛合金メッキ鋼板の製造において、溶融メッキ鋼板９の長手方向の鋼板表面温度分布を６で計測し、この温度分布および４、５での加熱、冷却のデータを演算装置８で処理して微細化処理地点を決定する。さらに、幅方向におけるメッキ付着量の変化を11で計測し、平均値より付着量の大きい厚目付け領域を、微細化処理に先立って冷却手段10で過冷却する。

【効果】　厚目付け領域での復熱に起因するスパングルの発生がなく、均一にスパングルが抑制された溶融Al－Zn合金メッキ鋼板が得られる。



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【特許請求の範囲】
【請求項１】　溶融メッキ後、溶融メッキ層の凝固直前に微細化処理を行う、スパングルの抑制された溶融アルミニウム－亜鉛合金メッキ鋼板の製造方法において、溶融メッキ後に長手方向の鋼板表面温度分布を計測して微細化処理地点を決定するとともに、幅方向におけるメッキ付着量の変化を計測し、平均値より付着量の大きい厚目付け領域を、微細化処理に先立って過冷却することを特徴とする、スパングルの抑制された溶融アルミニウム－亜鉛合金メッキ鋼板の製造方法。
【請求項２】　溶融メッキ浴出側に、溶融メッキ鋼板の長手方向の表面温度計測手段、板幅方向のメッキ付着量を計測するメッキ付着量計測手段、該メッキ付着量計測手段によって厚目付け領域とされた領域を選択的に過冷却することのできる冷却手段、該冷却手段の下流に設けた可動型の微細化処理手段、および長手方向の鋼板温度分布および板幅方向のメッキ付着量に基づいて該冷却手段および該微細化処理手段を制御する演算装置を備えた、スパングルの抑制された溶融アルミニウム－亜鉛合金メッキ鋼板の製造装置。
【請求項３】　溶融メッキ浴出側の前記冷却手段より上流に、メッキ鋼板の加熱手段および別の冷却手段をさらに備え、これらの加熱手段および冷却手段も前記演算装置により制御される、請求項２記載の溶融アルミニウム－亜鉛合金メッキ鋼板の製造装置。
【発明の詳細な説明】
【０００１】
【産業上の利用分野】本発明は、溶融アルミニウム－亜鉛合金メッキ鋼板の表面に現れる、いわゆるスパングル模様が抑制された、溶融アルミニウム－亜鉛合金メッキ鋼板の製造方法および製造方法に関する。
【０００２】
【従来の技術】55%Al－Zn合金メッキ鋼板で代表される溶融アルミニウム－亜鉛合金メッキ鋼板（以下、溶融Al－Zn合金メッキ鋼板または単にAl－Zn合金メッキ鋼板という）は、溶融亜鉛メッキ鋼板より耐食性が著しく優れていることから、特に屋根材などの建材への利用が拡大している。
【０００３】Al－Zn合金メッキ鋼板は、一般に連続溶融亜鉛メッキラインを利用して製造される。従って、連続溶融亜鉛メッキラインで主流となっている、ゼンジミアー方式または無酸化炉方式によりライン内焼鈍を受けた後、メッキが施されることになる。具体的には、連続式溶融メッキラインの酸化炉または無酸化炉でメッキ原板表面の汚れ（油脂分など）を除去しながら予熱を行った後、H_2-N_2 混合ガス雰囲気に保持された還元炉にて表面の活性化および焼鈍を行う。次いで、原板を溶融Al－Zn合金メッキに適した温度に冷却した後、メッキ浴を通過させてAl－Zn合金メッキを施し、メッキ浴出側でワイピングノズルによりメッキ付着量を調整し、冷却した後メッキ鋼板を巻取る。
【０００４】このようにして製造された溶融Al－Zn合金メッキ鋼板の表面には、スパングル斑（以下、単にスパングルという）と称する華状の模様が生成し、その模様に沿ってメッキ表面に凹凸を生じている。スパングルが粗大化すると、製品としての見栄えが悪くなり、商品価値が低下する。さらに、例えば、塗装鋼板用母材とした場合に均一な塗装仕上り表面が確保できないといった不都合もある。そのため、スパングル模様が抑制された、一様で美麗な表面外観を有する溶融Al－Zn合金メッキ鋼板に対する要求が強い。
【０００５】溶融Al－Zn合金メッキ鋼板のスパングル模様を抑制（微細化）する方法として、メッキ後に空気や薬液を噴霧して急冷する方法（特開昭60－162763号公報）、メッキ金属より高い融点を有する金属微粉末を吹付けて冷却する方法（特開昭59-170271号公報）等がこれまでに提案された。また、溶融亜鉛合金メッキおよび溶融アルミニウムメッキのスパングル微細化処理として、金属酸化物粉末を吹付ける方法も知られている（特開昭63－157849号公報）。これらの微細化処理は、溶融メッキ層の凝固直前、即ち、メッキ層が融点よりわずかに高温にある時期に行うことがスパングル抑制に最も効果的である。
【０００６】しかし、これらの微細化処理方法を適用して溶融Al－Zn合金メッキを行っても、メッキ製品にスパングルが残ることが多い。この原因は、微細化処理前のAl－Zn合金メッキ層の付着量不均一に基づくか、或いはこの冷却が板幅方向に不均一である場合が多い。例えば、溶融メッキ後、Al－Zn合金の融点よりもかなり高温時にメッキ層が微細化処理されると、メッキ表面がピット状の肌荒れ外観を呈する。逆に、微細化処理時期が遅すぎて、その前に既にメッキ層が凝固していると、スパングルを十分に微細化することはできない。
【０００７】スパングル模様の抑制のための冷却制御に関しては、溶融亜鉛メッキの例ではあるが、次の方法がこれまでに提案されている。
溶融亜鉛層の幅方向における温度分布の偏差を修正するために、鋼板の端縁部分を局部加熱する方法（特開昭48－84038 号公報）、
亜鉛粉吹付け位置の前後における鋼帯幅方向の温度分布を測定し、測定された幅方向温度分布から、該鋼帯の温度が全幅に亘って亜鉛の凝固温度より僅かに高くなるライン位置を算出し、適切な亜鉛粉の吹付け位置を決定する方法（特開平１－306547号公報）、
スパングル微細化処理装置の前後に温度計を配置し、さらにスパングル冷却装置の前に加熱、冷却手段を配して、長手方向と幅方向の二次元温度分布を測定し、加熱冷却方法とスパングル微細化処理装置の位置を変更することにより、適切な温度分布を得る方法（特開平２－298248号公報）。

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【０００８】およびの方法はいずれも、溶融メッキ層の凝固直前に微細化処理を行うことができるように、メッキ鋼板表面温度を測定して微細化処理地点（冷却時期）を決定するものである。これらの方法はAl－Zn合金メッキ鋼板のスパングル抑制にも十分に適用できる。

【０００９】

【発明が解決しようとする課題】しかし、上記～のようなメッキ後の冷却の制御方法を、溶融Al－Zn合金メッキに適用しても、最終的に得られたAl－Zn合金メッキ鋼板の表面、特に板幅方向の特定領域に、望ましくないスパングルが残ることが経験されてきた。即ち、従来の鋼板表面温度分布の測定による適切な冷却時期の決定や幅方向の冷却均一化は、スパングルの抑制にとって万全ではない。

【００１０】よって本発明の目的は、スパングルを確実に抑制することのできる溶融Al－Zn合金メッキ鋼板の製造方法と製造装置を提供することである。具体的には、溶融Al－Zn合金メッキ時に、鋼板温度の適正な管理や適切な冷却時期の決定を行っても生じることがある、スパングルの残留または発生を確実に解消することのできる技術を開発することである。

【００１１】

【課題を解決するための手段】本発明者らは、上述のように適切に冷却時期を決定しても溶融Al－Zn合金メッキ鋼板にスパングル残りが見られる原因について検討した。その結果、復熱により最終製品では粗いスパングル状になるか、局部的にスパングルが発生する場合があること、その原因としては、Al－Zn合金付着量が板幅方向に不均一であるため、板幅方向でAl－Zn合金付着量の多い部分が潜熱の量が大きく、従って復熱量も多くなり、部分的に凝固が遅れるからであること、を究明した。

【００１２】このような不均一な復熱により板幅方向の一部で凝固が遅れると、その後にスパングル微細化処理を適切な時期に行ったとしても、凝固が遅れた部分では、メッキ層温度がなお微細化処理には高すぎ、微細化処理してもスパングルが残ることになる。従って、スパングルが板幅方向の全体にわたって抑制された溶融Al－Zn合金メッキ鋼板を確実に得るためには、適切な冷却時期の決定に加えて、復熱に対する配慮が必要である。

【００１３】かくして、本発明は、微細化処理によりスパングルの抑制された溶融Al－Zn合金メッキ鋼板を製造する際に、鋼板に付着したAl－Zn合金の板幅方向の付着量を測定し、板幅方向で付着量の多い部分のみを過冷却することにより、微細化処理時に板幅方向の全幅に亘ってAl－Zn合金の凝固点直前からの均一冷却を可能にすることを基本的特徴とする。

【００１４】即ち、本発明の要旨とするところは、溶融メッキ後、溶融メッキ層の凝固直前に微細化処理を行う、スパングルの抑制された溶融Al－Zn合金メッキ鋼板の製造方法において、溶融メッキ後に長手方向の鋼板表面温度分布を計測して微細化処理地点を決定するとともに、幅方向におけるメッキ付着量の変化を計測し、平均値より付着量の大きい厚目付け領域を、微細化処理に先立って過冷却することを特徴とする、スパングルの抑制された溶融Al－Zn合金メッキ鋼板の製造方法である。

【００１５】なお、ここで、過冷却とは、幅方向の他の部分（即ち、付着量が平均以下の部分）の冷却より冷却度を強めることを意味するが、具体的には、復熱に配慮して、他の部分の微細化処理装置到達時の目標温度に必要な冷却温度より１～５℃低くなるように冷却することである。

【００１６】また、別の面からは、本発明は、溶融メッキ浴出側に、溶融メッキ鋼板の長手方向の表面温度計測手段、板幅方向のメッキ付着量を計測するメッキ付着量計測手段、該メッキ付着量計測手段によって厚目付け領域とされた領域を選択的に過冷却することのできる冷却手段、該冷却手段の下流に設けた可動型の微細化処理手段、および長手方向の鋼板温度分布および板幅方向のメッキ付着量に基づいて該冷却手段および該微細化処理手段を制御する演算装置を備えた、スパングルの抑制された溶融Al－Zn合金メッキ鋼板の製造装置である。

【００１７】好適態様にあっては、この製造装置は、溶融メッキ浴出側の前記冷却手段より上流に、メッキ鋼板の加熱手段および別の冷却手段をさらに備え、これらの加熱手段および冷却手段も前記演算装置により制御される。

【００１８】

【作用】前述したように、従来のスパングルが抑制された溶融Al－Zn合金メッキ鋼板の製造方法においても、微細化処理をメッキ層の凝固直前で行うように加熱、冷却、微細化処理地点の制御を行っている。しかし、従来は、溶融メッキ鋼板の幅方向のみ、或いは幅方向と長手方向の温度分布だけに注目して、これらの制御を行っていた。

【００１９】例えば、上記の方法を実施するための溶融メッキ装置を図２に示す。この装置は、加熱用のバーナーボックス４、冷却用のクーラーボックス５、二次元温度測定用の放射温度計６、微細化処理装置７、および演算装置８を備えている。なお、１は溶融メッキ浴、２は鋼板、３はワイピングノズル、９はメッキ鋼板である。溶融メッキ浴１を出たメッキ鋼板９は、二次元温度測定装置６で幅方向と長手方向の温度が測定され、溶融メッキ層が凝固する直前に微細化処理を受けるように、加熱手段４または冷却手段５による加熱または冷却により鋼板温度を制御する。これらの測定、加熱、冷却のデータが演算装置８に送られ、板幅の全幅が凝固温度よりわずかに高温にある位置に微細化処理装置を移動させ、微細化処理を行う。

【００２０】これに対して、本発明では、溶融メッキ鋼

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板の付着量が幅方向に不均一であることに着目し、スパングルに対しては、付着量が平均値より大きい厚目付け領域における復熱が他の部分より大きく、この大きな復熱がスパングルに影響することを究明したのである。溶融メッキの付着量が幅方向で変動する理由としては、気体噴射ノズル間を通過する鋼板の形状不安定等によるものと推測される。

【００２１】この復熱によるスパングルの発生を防止するために、本発明にあっては、微細化処理に先立って、メッキ鋼板の幅方向における厚目付け領域を検知し、その領域を特に過冷却して、微細化処理前後の復熱の影響を可及的に小とするのである。この時の過冷却の程度は、厚目付けの程度との関係で決定されるが、微細化処理時点での厚目付け領域の温度が、他の部分の温度と同じようになるように冷却すればよい。即ち、冷却から微細化処理までの間に起こる復熱の量はメッキ付着量に比例するので、それを相殺するように過冷却する。具体的には、前述したように、他の部分における微細化処理装置到達時の目標温度に必要な冷却温度より１～５℃低温になるように冷却すればよい。

【００２２】従って、本発明の溶融Al－Zn合金メッキ鋼板製造装置は、図１に示すように、図２に示した従来の溶融メッキ装置に対して、さらに幅方向の部分的な過冷却が可能な冷却手段（例、第二クーラーボックス10）と幅方向の溶融メッキ付着量計測手段11を付設すればよい。

【００２３】かくして、本発明によれば、幅方向においてメッキ付着量の多い部分（厚目付け領域）だけを選択的に過冷却してから微細化処理を行うため、微細化処理時にはメッキ表面温度が鋼板の幅方向の全幅にわたって実質的に均一になっているので、微細化処理効果を全幅にわたって均一に達成することができ、幅方向で均一にスパングルが抑制された溶融Al－Zn合金メッキ鋼板を得ることができる。

【００２４】これに対し、従来は、幅方向で冷却の程度を変化させないため、厚目付け領域での復熱量が大きくなり、適温より高温で微細化処理を受けることになって、微細化処理の効果が十分に得られず、スパングルの発生が起こって、厚目付け領域にスパングルが残る。

【００２５】過冷却のための冷却手段は、従来の冷却手段と同様でよいが、幅方向の冷却度の変化が可能なものでなければならない。また、微細化処理手段も制限がなく、空気、気水（微小水滴が混合状態となった気体）、薬液、被メッキ材であるAl－Zn合金より高融点の粉末（例、亜鉛粉末、金属酸化物粉末など）など、従来より用いてきた媒体を用いて実施することができる。

【００２６】

【実施例】図１は、本発明にかかる溶融Al－Zn合金メッキ鋼板の製造装置の概略説明図である。以下、この図に基づき、本発明の実施例について説明する。

【００２７】図１に示す本発明の装置においても、図２に示す従来装置と同様に、溶融Al－Zn合金メッキ浴１に浸漬された鋼板２は、浴から引き上げられると、ワイピングノズル３によって所定のメッキ付着量に調整される。次いで、溶融Al－Zn合金メッキ層が凝固する直前に微細化処理を行うように、鋼板をバーナーボックス４によって加熱するか、或いは第１クーラーボックス５において冷却することによって鋼板温度の調整を行う。この鋼板温度の調整は必須ではないが、このように加熱または冷却により鋼板温度をほぼ一定に調整することで、微細化処理装置７の位置の変動幅が小さくなり、微細化処理地点の制御が容易となるので、この温度調整を行うことが好ましい。

【００２８】鋼板２の長手方向の温度分布は放射温度計６によって監視されており、それに基づいて上記の鋼板温度の調整のための加熱または冷却の程度が決定される。なお、幅方向の部分的な凝固の可能性を知るために、放射温度計６によってメッキ鋼板の長手方向だけでなく、幅方向の温度分布も同時に監視することが好ましい。そして、これらの加熱、冷却、および温度分布のデータはいずれも演算装置８に送られ、この演算装置によって微細化処理装置７の位置、つまり微細化処理地点が決定される。微細化処理装置７は可動型、即ち、溶融Al－Zn合金メッキ層が凝固する位置に応じて、通板ラインに沿った昇降により移動可能であり、この装置が溶融Al－Zn合金メッキ層の凝固直前の地点にくるように、必要な移動量が演算装置８の指令によって決定される。

【００２９】本発明の溶融メッキ装置は、溶融メッキ鋼板９の幅方向のメッキ付着量の計測手段11を備えている。メッキ付着量は、蛍光Ｘ線などの分析手段により迅速に測定できる。このメッキ付着量計測手段の測定結果を演算装置８に送って、幅方向において平均付着量より付着量の大きい厚目付け領域を検出する。そして、その結果に基づいて、微細化処理装置７の上流側に設けた、幅方向に冷却度を変化させることができる第２クーラーボックス10を作動させる。従って、付着量計測手段11の位置は、ワイピングノズル３と第２クラーボックス10の間の任意の地点でよいが、好ましくはワイピングノズル３の直後である。

【００３０】第２クーラーボックスは、付着量計測手段11の測定結果に基づいて検出された厚目付け領域に対しては、その過大な復熱量を相殺するように、具体的には目標温度より１～５℃低い温度に過冷却するように、幅方向に冷却度を変化させて、溶融メッキ層の冷却を行う。この冷却は、厚目付け領域のみを部分的に冷却する（他の部分は冷却しない）か、或いは厚目付け領域の冷却度を他の部分の冷却度より強めることによって行うことができる。例えば、第２クーラーボックス10は、鋼板の幅方向に沿って均等に区画された（例、１～50㎜幅）多数の領域に１個づつ設置された多数のスプレーノズル

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から構成することができる。その場合、厚目付け領域とされた区画のスプレーノズルだけから冷却媒体（例、空気、気水、薬液）をメッキ鋼板に吹付けるか、或いはその区画のスプレーノズルの冷却媒体の吹付け量を他の区画での吹付け量より増大させることにより、厚目付け領域の過冷却を行うことができる。

【００３１】このようにして厚目付け領域を選択的に過冷却してから、メッキ層の微細化処理装置を行う。微細化処理装置７は、凝固直前の溶融メッキ層に空気、気水、薬液、金属粉末などの適当な媒体を噴霧して、均一に急冷することにより、スパングルの抑制された鋼板を製造する装置である。

【００３２】微細化処理装置７の位置は、前述したように、放射温度計６により測定された鋼板温度分布、バーナーボックス４もしくは第１クーラーボックス５によるメッキ鋼板の加熱もしくは冷却、さらには第２クーラーボックス10による鋼板の冷却、に関するデータを演算装置８に送って、溶融Al－Zn合金メッキ層が全幅にわたって未凝固で、かつ凝固する直前の位置にくるように決定する。そして、この演算装置８からの指令に基づいて、微細化処理装置７を通板ラインに沿って昇降（即ち、鋼板進行方向と同方向または逆方法に移動）させて、上記の溶融メッキ層凝固直前の位置にセットする。

【００３３】従来は、幅方向における不均一なメッキ付着量による復熱の影響を無視していたため、厚目付け領域では復熱による冷却不足の状態で微細化処理を受けることになり、微細化処理後もこの領域にスパングルが残ったメッキ表面となる。これに対し、本発明によれば、厚目付け領域のみを微細化処理装置の上流で過冷却するため、微細化処理装置までメッキ鋼板が進行する間にこの領域において起こる相対的に大きな復熱が過冷却により相殺され、厚目付け領域における局部的な温度上昇（冷却不足）が避けられので、板幅方向の全幅にわたって均一に最適温度で微細化処理を受けさせることが可能となる。その結果、微細化処理の効果が全幅にわたって均一に発揮され、板幅方向に一様にスパングルが抑制されたメッキ表面が得られる。なお、溶融メッキ鋼板は、通常は両面メッキであるから、以上に説明した本発明にかかる制御されたメッキ方法を片面づつ独立して両面に対して行う。但し、片面メッキの場合、或いは１面だけを美麗な表面にすればよい場合には、片面のみに対して上記の本発明の制御されたメッキ方法を適用してもよい。

【００３４】図３(a) および(b) に、図１に示す本発明にかかる装置を使用して得た溶融Al－Zn合金メッキ鋼板の厚目付け領域の形成および過冷却の様子を図式的に説明する。図示例では、板厚は0.5 ㎜、板幅は1219 ㎜ 、目標のメッキ付着量は片面当たり90 g/㎡ である。メッキ付着量計測手段11で測定された板幅方向の溶融Al－Zn合金メッキ層の付着量分布は、図３(a) に示す通りであり、二箇所の厚目付け領域、が検出された。一方、第２クーラーボックス10は、図１(b) に示すように、板幅方向に均等な距離で配置された12個の水スプレーノズルＡ～Ｌを備えている。即ち、幅方向に12区画に均等分割して、各区画ごとに過冷却することができる。図示例では、検出された厚目付け領域、に対応する位置にあるスプレーノズルＣ、Ｉだけを作動させて冷却水をスプレーすることにより、厚目付け領域だけを選択的に過冷却してから、微細化処理を行った。

【００３５】微細化処理後に最終的に得られた溶融Al－Zn合金メッキ鋼板のメッキ外観、特にスパングル模様について、板幅方向をノズル位置Ａ～Ｌに対応する12区画に分けて観察したが、いずれの区画もスパングルが十分に抑制されていた。一方、比較のために、上記の第２クーラーボックスを全く作動させずに（従って、幅方向における選択的過冷却を行わずに）、同様溶融Al－Zn合金メッキ鋼板を製造したところ、板幅方向における厚目付け領域、に対応する区画（即ち、ノズル位置Ｃ、Ｉに対応する区画）では、目視ではっきり認識できるスパングル模様が残っており、スパングルの抑制が不十分であった。

【００３６】

【発明の効果】以上に説明したごとく、溶融メッキ層の凝固直前に微細化処理を行ってスパングルの抑制された溶融Al－Zn合金メッキ鋼板を製造する際、本発明に従って、板幅方向の溶融メッキ付着量の変化を測定し、メッキ付着量の多い厚目付け領域のみを選択的に過冷却することにより、板幅方向に均一に全幅にわたってスパングルが抑制された、美麗なメッキ表面が得られる。それにより、塗装鋼板にした場合にも均一に塗装でき、塗装外観が向上する。

【図面の簡単な説明】

【図１】本発明にかかる、スパングルの抑制された溶融Al－Zn合金メッキ鋼板の製造装置の概略説明図である。

【図２】従来の同様の装置の概略説明図である。

【図３】図３ (a)、(b) は、それぞれ、図１に示す本発明にかかる装置を使用して得た溶融Al－Zn合金メッキ鋼板の厚目付け領域の形成および過冷却の様子を図式的に説明する図である。

【符号の説明】

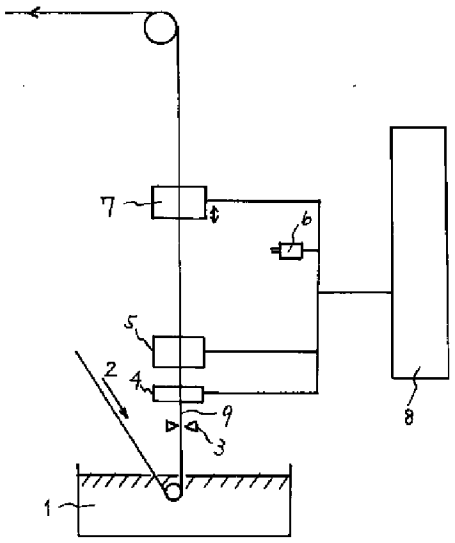
１：溶融メッキ浴
２：鋼板
３：ワイピングノズル
４：バーナーボックス
５：第１クーラーボックス
６：放射温度計
７：微細化処理装置
８：演算装置
９：溶融メッキ鋼板
10：第２クーラーボックス

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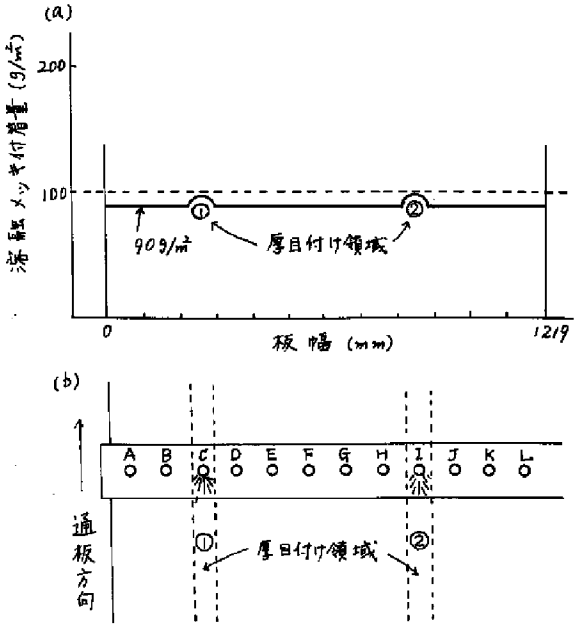
11：板幅方向メッキ付着量計測手段

【図１】

【図２】



【図３】



```
ERROR: undefined
OFFENDING COMMAND: eexec

STACK:

/quit
-dictionary-
-mark-
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PTO/SB/08a (03-15)
Approved for use through 07/31/2016. OMB 0651-0031
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	16413799
Filing Date	2019-05-16
First Named Inventor	Pascal DRILLET
Art Unit	
Examiner Name	SCHLEIS, DANIEL J
Attorney Docket Number	20631.1028CON5

U.S.PATENTS Remove

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	5116645	A	1992-05-26	ARMCO STEEL CO LP	
	2	4257549	A	1981-03-24	ROBERTSON CO H H	
	3	5495736	A	1996-03-05	Nishi et al.	

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Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	20020114884	A1	2002-08-22	FRIEDERSDORF FRITZ J et al.	

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Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1	19749706	DE	C1	1999-03-04	MANNESMANN AG	See English Abstract and EPO machine translation	

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
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	First Named Inventor	Pascal DRILLET
	Art Unit	
	Examiner Name	SCHLEIS, DANIEL J
	Attorney Docket Number	20631.1028CON5

	2	0724919	EP	A2	1996-08-07	HITACHI LTD	In English	
	3	1657004	EP	A1	2006-05-17	ARVEDI GIOVANNI	In English	
	4	2573226	CA	A1	2006-01-19	NIPPON STEEL CORP	In English	
	5	0692549	EP	A1	1996-01-17	UNITAS SA	In English	
	6	1063314	EP	A1	2000-12-27	KAWASAKI STEEL CO	In English	
	7	2720079	FR	A1	1995-11-24	LORRAINE LAMINAGE	See English Abstract and EPO machine translation	
	8	622697	AU	B2	1992-04-16	ARMCO INC	In English	
	9	H08144037	JP	A	1996-06-04	SUMITOMO METAL IND	See English Abstract and EPO machine translation	
	10							
	11							
	12							

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	Art Unit	
	Examiner Name	SCHLEIS, DANIEL J
	Attorney Docket Number	20631.1028CON5

	13							

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NON-PATENT LITERATURE DOCUMENTS Remove

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
	1	Stahl und Eisen 120 (2000) Nr. 8, Seiten 51 bis 56, "Die neue Verzinkungsanlage 2 bei Eko Stahl", "The new No. 2 hot-dip galvanizing line at Eko Stahl", Autoren: Karl Döring, Jürgen Nathow, Dietrich Kern, Michael Breiter und Dietmar Lowenberg.	
	2	Andrews, K.W. Empirical Formulae for the Calculation of Some Transformation Temperatures. Journal of the Iron and Steel Institute, 203, Part 7, July 1965, 721-727.	
	3	Enlarged Fig. 7 of U.S. 16413825 (present application)	
	4	Low Carbon, Heat-Treatable Boron Steel - Uncoated or Aluminized PreCoated, GM Worldwide Engineering Standards, GMW14400.	
	5	Patent Trial and Appeal Board Final Decision in IPR2019-01275, US 9708683, dated January 5, 2021	
	6	Gokhale, Arun M., "Report on quantitative characterization of the microstructure of Aluminium alloy surface coating on hot-stamped US BOR 1500 steel blanks" School of Materials Science and Engineering, Georgia Institute of Technology, 13 May 2019	
	7	Fan, Dong Wei et al., "Formation of an Aluminide Coating on Hot Stamped Steel" ISIJ International, Vol. 50, No. 11, 2010, pp 1713-1718	
	8	Summons in EP proceeding for EP 09701846, dated 11/18/2016	

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	Application Number	16413799
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	First Named Inventor	Pascal DRILLET
	Art Unit	
	Examiner Name	SCHLEIS, DANIEL J
	Attorney Docket Number	20631.1028CON5

	9	Bourouga, Brahim, "Report on the heating of coated steel blanks for hot stamping" Laboratoire de therminque et enqerie de Nantes, 30 Aprill 2019	
	10	Imose, Masayuki, "Heating and Cooling Technology in the Continuous Annealing" Transactions ISIJ, Vol. 25, 1985, 911-932	
	11	Kolleck, R. et al., "Investigation on induction heating for hot stamping of boron alloyed steel" CIRP Annals - Manufacturing Technology 58, (2009), 275-278	
	12	Kahl, Martin, "Some like it hot" Technology focus - Hot stamping, September/October 2004 AMS	
	13	Self-study programme 339, The Passat 2006	

If you wish to add additional non-patent literature document citation information please click the Add button Add

EXAMINER SIGNATURE

Examiner Signature		Date Considered	

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

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Posco Co. LTD. v. ArcelorMittal
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	16413799
Filing Date	2019-05-16
First Named Inventor	Pascal DRILLET
Art Unit	
Examiner Name	SCHLEIS, DANIEL J
Attorney Docket Number	20631.1028CON5

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

See attached certification statement.

The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/William C. Gehris/	Date (YYYY-MM-DD)	2021-01-07
Name/Print	William C. Gehris	Registration Number	38,156

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these record s.

2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).

5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.

6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

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IN THE UNITED STATES PATENT & TRADEMARK OFFICE

Application of:	ARCELORMITTAL
Inventor(s):	Drillet et al.
Application No.:	16/413,799
Filed:	May 16, 2019
Attorney Docket No.:	20631.1028CON5
Confirmation No.:	7637
Examiner:	Daniel J. Schleis
Title:	Coated Steel Strips, Coated Stamped Products and Methods

Submitted electronically via EFS-WEB January 8, 2021

RCE AND RESPONSE TO FINAL OFFICE ACTION

Dear Sir or Madam:

In response to the Final Office Action dated July 10, 2020, please re-consider the above-identified patent application based on the following:

IN THE CLAIMS

This listing of claims will replace all prior versions, and listings, of claims in the application:

Listing of Claims:

Claims 1 to 47 (canceled).

Claim 48 (previously presented): A precoated steel product comprising:

a strip of base steel having a first side and a second side; and

a coating on at least one of the first side of the strip of base steel and the second side of the strip of base steel, wherein the coating results from interdiffusion between the base steel, and an aluminum or aluminum alloy pre-coating, and wherein the coating includes, proceeding from the base steel outwards:

(a) an interdiffusion layer having a first mean iron composition,

(b) an intermediate layer having a second mean iron composition different from the first mean iron composition,

(c) an intermetallic layer having a third mean iron composition different from the first and second mean iron compositions, the third mean iron composition being higher than the second mean iron composition; and

(d) a superficial layer having a fourth mean iron composition different from the third mean iron composition,

wherein the coating has a thickness greater than 30 micrometers.

Claim 49 (previously presented): The precoated steel product as recited in claim 48 wherein the layers (c) and (d) are quasi continuous by occupying at least 90% of a level corresponding to each of the layers (c) and (d) and wherein less than 10% of layer (c) is present at an extreme surface of the product.

Claim 50 (previously presented): The precoated steel product as recited in claim 48 wherein the base steel includes the following components by weight based on total weight:

0.15%<carbon<0.5%;

0.5%<manganese<3%;

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0.1%<silicon<0.5%;

0.01%<chromium<1%;

titanium<0.2%;

aluminum<0.1%;

phosphorus<0.1%;

sulfur<0.05%;

0.0005%<boron<0.08%;

and further comprises iron and impurities inherent in processing.

Claim 51 (previously presented): The precoated steel product as recited in claim 48 wherein the base steel comprises the following components by weight based on total weight:

0.20%<carbon<0.5%;

0.8%<manganese<1.5%;

0.1%<silicon<0.35%;

0.01%<chromium<1%;

titanium<0.1%;

aluminum<0.1%;

phosphorus<0.05%;

sulfur<0.03%;

0.0005%<boron<0.01%;

and further comprises iron and impurities inherent in processing.

Claim 52 (previously presented): The precoated steel product as recited in claim 48 wherein the base steel comprises 20 ppm or less of sulfur.

Claim 53 (previously presented): The precoated steel product as recited in claim 49 wherein the base steel comprises 20 ppm or less of sulfur.

Claim 54 (previously presented): The precoated steel product as recited in claim 48 wherein a ratio of titanium to nitrogen in the base steel in weight % is in excess of 3.42.

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Claim 55 (previously presented): The precoated steel product as recited in claim 49 wherein a ratio of titanium to nitrogen in the base steel in weight % is in excess of 3.42.

Claim 56 (previously presented): The precoated steel product as recited in claim 48 wherein the layer (a) has a thickness less than 15 micrometers.

Claim 57 (previously presented): The precoated steel product as recited in claim 48 wherein the layer (a) has a thickness less than 10 micrometers.

Claim 58 (previously presented): The precoated steel product as recited in claim 48 wherein the interdiffusion layer comprises the following components by weight based on total weight: 86 to 95% Fe, 4 to10% Al, and 0 to 5% Si.

Claim 59 (previously presented): The precoated steel product as recited in claim 48 wherein the intermediate layer comprises the following components by weight based on total weight: 39 to 47% Fe, 53 to 61% Al, and 0 to 2% Si.

Claim 60 (previously presented): The precoated steel product as recited in claim 48 wherein the intermetallic layer comprises the following components by weight based on total weight: 62 to 67% Fe, 30 to 34% Al, and 2 to 6% Si.

Claim 61 (previously presented): The precoated steel product as recited in claim 48 wherein the superficial layer comprises the following components by weight based on total weight: 39 to 47% Fe, 53 to 61% Al, and 0 to 2% Si.

Claim 62 (previously presented): The precoated steel product as recited in claim 58 wherein the intermediate layer comprises the following components by weight based on total weight: 39 to 47% Fe, 53 to 61% Al, and 0 to 2% Si.

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Claim 63 (previously presented): The precoated steel product as recited in claim 62 wherein the intermetallic layer comprises the following components by weight based on total weight: 62 to 67% Fe, 30 to 34% Al, and 2 to 6% Si.

Claim 64 (previously presented): The precoated steel product as recited in claim 63 wherein the superficial layer comprises the following components by weight based on total weight: 39 to 47% Fe, 53 to 61% Al, and 0 to 2% Si.

Claim 65 (previously presented): The precoated steel product as recited in claim 48 wherein the interdiffusion layer has a thickness of from 1 micron to 15 microns.

Claim 66 (previously presented): The precoated steel product as recited in claim 48 wherein the first mean iron composition is 90 percent, the second mean iron composition is 43 percent, the third mean iron composition is 63 percent and the fourth mean iron composition is 45 percent.

Claim 67 (previously presented): The precoated steel product as recited in claim 48 wherein the fourth mean iron composition is lower than the third mean iron composition.

Claim 68 (previously presented): A precoated steel product comprising:

a strip of base steel having a first side and a second side; and

a coating on at least one of the first side of the strip of base steel and the second side of the strip of base steel, wherein the coating results from interdiffusion between the base steel, and an aluminum or aluminum alloy pre-coating, and wherein the coating includes, proceeding from the base steel outwards:

(a) an interdiffusion layer having a first mean iron composition,

(b) an intermediate layer having a second mean iron composition different from the first mean iron composition,

(c) an intermetallic layer having a third mean iron composition different from the first and second mean iron compositions, the third mean iron concentration being higher than the second mean iron composition, and

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(d) a superficial layer having a fourth mean iron composition different from the first, second and third mean iron compositions,

wherein the coating has a thickness greater than 30 micrometers.

Claim 69 (previously presented): The precoated steel product as recited in claim 68 wherein the fourth mean iron composition is lower than the third mean iron composition.

Claim 70 (previously presented): The precoated steel product as recited in claim 69 wherein the fourth mean iron composition is higher than the second mean iron composition.

Claim 71 (previously presented): A precoated steel product comprising:

a strip of base steel having a first side and a second side; and

a coating on at least one of the first side of the strip of base steel and the second side of the strip of base steel, wherein the coating results from interdiffusion between the base steel, and an aluminum or aluminum alloy pre-coating, and wherein the coating includes, proceeding from the base steel outwards:

(a) an interdiffusion layer having a first mean aluminum composition,

(b) an intermediate layer having a second mean aluminum composition different from the first mean aluminum composition,

(c) an intermetallic layer having a third mean aluminum composition different from the first and second mean aluminum compositions, and

(d) a superficial layer having a fourth mean aluminum composition different from the first, second and third mean aluminum compositions, the second mean aluminum composition being greater than the third mean aluminum composition;

wherein the coating has a thickness greater than 30 micrometers.

Claim 72 (previously presented): The precoated steel product as recited in claim 71 wherein the fourth mean aluminum composition is less than the second mean aluminum composition.

Claim 73 (previously presented): The precoated steel product as recited in claim 71 wherein the layer (a) has a thickness less than 15 micrometers.

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Claim 74 (previously presented): The precoated steel product as recited in claim 71 wherein the interdiffusion layer comprises the following components by weight based on total weight: 86 to 95% Fe, 4 to10% Al, and 0 to 5% Si.

Claim 75 (previously presented): The precoated steel product as recited in claim 71 wherein the intermediate layer comprises the following components by weight based on total weight: 39 to 47% Fe, 53 to 61% Al, and 0 to 2% Si.

Claim 76 (previously presented): The precoated steel product as recited in claim 71 wherein the intermetallic layer comprises the following components by weight based on total weight: 62 to 67% Fe, 30 to 34% Al, and 2 to 6% Si.

Claim 77 (previously presented): The precoated steel product as recited in claim 71 wherein the superficial layer comprises the following components by weight based on total weight: 39 to 47% Fe, 53 to 61% Al, and 0 to 2% Si.

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REMARKS

This paper is submitted in response to the Final Office Action dated July 10, 2020. Claims 48 to 77 are pending.

Claims 48-50 and 54-77 stand rejected under 35 U.S.C. 102(b) as anticipated by or, in the alternative, under 35 U.S.C. 103(a) as obvious over U.S. Patent Number 6,296,805 (Laurent); and claims 51-53 stand rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over Laurent.

Claims 48, 68, and 71 are independent claims. Each of the independent recites a strip of based steel having a coating on one or both sides where " the coating results from interdiffusion between the base steel, and an aluminum or aluminum alloy pre-coating." Each claim also specifies that the coating has a thickness greater than 30 micrometers. The claims differ in the claimed layers in the coating, where:

In claim 48: "the coating includes, proceeding from the base steel outwards:
(a) an ***interdiffusion layer*** having ***a first mean iron*** composition,
(b) ***an intermediate layer*** having a ***second mean iron*** composition ***different from*** the ***first mean iron*** composition,
(c) ***an intermetallic layer*** having a ***third mean iron*** composition ***different from*** the ***first and second mean iron*** compositions, the ***third mean iron*** composition ***being higher than*** the ***second mean iron*** composition; and
(d) ***a superficial layer*** having a ***fourth mean iron*** composition ***different from*** the ***third mean*** iron composition"

In claim 68: "the coating includes, proceeding from the base steel outwards:
(a) ***an interdiffusion layer*** having a ***first mean iron*** composition,
(b) ***an intermediate layer*** having a ***second mean*** iron composition ***different from*** the ***first mean iron*** composition,
(c) ***an intermetallic layer*** having ***a third mean iron*** composition ***different from*** the ***first and second mean iron*** compositions, the ***third mean iron*** concentration being ***higher than*** the ***second mean iron*** composition, and
(d) ***a superficial layer*** having a ***fourth mean iron*** composition ***different from*** the ***first, second and third mean iron*** compositions,

In claim 71: " the coating includes, proceeding from the base steel outwards:
(a***) an interdiffusion layer*** having a ***first mean aluminum*** composition,
(b) ***an intermediate layer*** having a ***second mean aluminum*** composition ***different from*** the ***first mean aluminum*** composition,

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> (c) ***an intermetallic layer*** having ***a third mean aluminum*** composition ***different from*** the ***first and second mean aluminum*** compositions, and
> (d) ***a superficial layer*** having a ***fourth mean aluminum*** composition ***different from*** the ***first, second and third mean aluminum*** compositions, the ***second mean aluminum*** composition being ***greater than*** the ***third mean aluminum*** composition"

The Examiner concedes that Laurent does not disclose a coating resulting "from interdiffusion between the base steel, and an aluminum or aluminum alloy pre-coating" that has four layers in the claimed arrangement (interdiffusion, intermediate, intermetallic, superficial), or that such layers would have the specifically claimed mean iron or mean aluminum compositions. Indeed, at best, Laurent discloses a two layered coating. (col. 3, lines 15-23).

Instead, at pages 4-5 of the Final Office Action the Examiner contends that the Laurent "process appears to be identical or substantially identical to the process set forth in the specification of the instant application, which produces the claimed product," citing Laurent at col. 1, lines 6-8 and 47-64, col. 2, lines 37-45, col. 3, lines 26-44 and 61-65, and col. 4, lines 4-9. The Examiner alleges that "[w]here the claimed and prior art products are identical or substantially identical, or are produced by identical or substantially identical processes, the Office can require an applicant to prove that the prior art products do not necessarily or inherently possess the characteristics of the claimed product." Final Office Action, p. 6. In making this assertion, the Examiner relies, inter alia, on the discussion of an " increase in temperature to an excess of 5° C/second" (col. 3, lines 26-29) and heat treatment of a 1 mm thick coated sheet at "900 C for 5 min" (column 4, lines 8-9), which the Examiner alleges is substantially the same as the process disclosed in the present application, citing to paragraph [0059] thereof..

Applicant respectfully traverses. First, the process of Laurent is not "identical or substantially identical to the process set forth in the specification of the instant application."

The process of Laurent comprises:

- Shaping the coated steel sheet to form a “casting” (col.3, line 26, claims 4 and 11);
- Then heating the coating at a heating rate of 5-600°C/s (col.2, lines 23-25, col.3, lines 26-31, claims 4 and 11) to a temperature higher than 750°C (col. 2, line 28, claim 12), for example 900°C for 5 min for a 1 mm thick sheet (col. 4, lines 4-9); and

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- Cooling with a cooling rate of at least 27°C/s. (col. 4, lines 2-9).

For the reasons detailed below, this process of Laurent is not "identical or substantially identical to the process set forth in the specification of the instant application," at least because:

(i) no hot-stamping is performed after heating to the temperature higher than 750° C, for example 900° C;

(ii) no hot-stamping is performed after the heating rate of 5-600° C/s is applied;

(iii) the heating rate is not Vc according to the cited passages of the present application because the heating rate of 5-600 C/s is from room temperature to the final heating temperature (e.g. a temperature higher than 750°C (col. 2, line 28, claim 12), for example 900°C), and not between 20-700°C/s as in the process described in the present application; and

(iv) the cited heating of 900°C for 5 min for a 1 mm thick sheet is not according to the limits of diagram "ABCD" at least because the referenced 5 minutes refers not to the dwell time of diagram "ABCD", but rather to the total time in the furnace.

This process is therefore not according to the process described in the present application.

First, applicant points out that although Laurent discloses that hot-shaping may be performed on the sheet of Laurent (col.1, lines 44-46, col. 2, lines 49-52, col. 3, lines 56-59), Laurent does not provide any detail regarding the hot-shaping process, and this process is not performed after the heating rates cited by the Examiner.

In particular, the heat treatment at 900 C for 5 mins in Laurent is not followed by hot stamping, as in the process described in the present application. Further, and independently, the process of Laurent lacks the **heating rate Vc** during the heat treatment, which applicant's specification explains at paragraph [0059] is critical to obtaining the layer disposition in combination to furnace temperature and dwell time:

> [0059] For sheets of total thicknesses greater or equal to 0.7 mm, and less than or equal to 1.5 mm, the preferred treatment conditions: (furnace temperature, total dwell time in the furnace) are illustrated in FIG. 7 by conditions lying within the limits of diagram "ABCD" For sheets of total thicknesses greater than 1. 5 mm, and less than or equal to 3 mm, the preferred treatment conditions: (furnace temperature, total dwell time in the furnace) are illustrated in FIG. 7 by diagram "EFGH". **The heating rate Vc is comprised between 4 and 12° C./s for producing a favorable alloyed layer disposition. In this**

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> **regard, this "heating rate" reflects the temperature rise which is experienced by the pre-coated steel upon being located in the preheated furnace. Vc is defined as the mean heating rate between 20 and 700° C.** The inventors have discovered that the control of Vc in this precise range is a key factor, because it controls directly the nature and the morphology of the alloyed layers which are formed**. It is here underlined that the heating rate Vc is different from the mean heating rate, which is the heating rate between room temperature and furnace temperature**.

In alleging that Laurent includes the heating rate Vc, the Examiner cites to col 3, lines 26-29 as describing that "[a]fter the shaping of a casting the coating is subjected to an increase in temperature to an excess of 5° C/second, which may exceed 600 C/second." However, the referenced heating cannot be compared to Vc for a number of reasons.

First, the cited passage of Laurent at col 3, lines 26-29 is discussing a heating rate increase in "excess of 5° C/second, which may exceed 600 C/second" in reference to heating after a forming operation:

> The first alloy layer may crack when the sheet is shaped for the manufacture of castings.
>
> According to the invention, after the shaping of the casting, the coating is subjected to an increase in temperature at a speed in excess of 5° C./second, which may exceed 600° C./second. This rise in temperature makes possible a rapid remelting of the aluminum which fills in the cracks generated by the operation of shaping of the casting.

Thus, the heating rate of 5-600° C/s disclosed by Laurent expressly does not apply to the hot-shaping process described in the present application, and thus this heating rate in Laurent is not part of a process that is "identical or substantially identical to the process set forth in the specification of the instant application, which produces the claimed product," as alleged by the Examiner. (Office Action, p. 5).

Rather, Laurent discloses on column 3, lines 26-29, as well as in claims 4, 6, 8, 10 and 11 that the increase in temperature at a rate of at least 5°C/s, preferably at least 600°C/s is performed after the shaping.

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And indeed, Laurent stresses that this heating rate is especially designed to allow remelting the aluminum coating which fills the cracks which were generated during the shaping operation, see col.3, l.26-31:

> According to the invention, after the shaping of the casting, the coating is subjected to an increase in temperature at a speed in excess of 5.degree. C./second, which may exceed 600.degree. C./second. This rise in temperature makes possible a rapid remelting of the aluminum which fills in the cracks generated by the operation of shaping of the casting

Therefore, the heating rate of 5 to 600°C/s disclosed by Laurent is not the heating rate before hot-stamping and is not transposable to the hot-shaping process.

There is no indication that this process forms to claimed four layer structure, or that the referenced 4 ° C /second has any relation to the Vc used in the completely different process for obtaining the claimed four layer structure is the heat treatment discussed at paragraph [0059] quoted above. Thus, the heating rate in Laurent is not part of a process that is "identical or substantially identical to the process set forth in the specification of the instant application, which produces the claimed product," as alleged by the Examiner. (Office Action, p. 5).

Second, and independently, even if Laurent had disclosed a heating rate prior to hot-stamping of at least 5°C/s, Laurent would still not disclose nor even suggest a process implementing a specific heating rate in the temperature range 20-700°C comprised between 4 and 12°C/s.

In particular, the heating rate mentioned in Laurent, after shaping, is the mean heating rate between room temperature and the final heating temperature. The present specification is express in stating that this is not Vc:

> **The heating rate Vc is comprised between 4 and 12° C./s for producing a favorable alloyed layer disposition. In this regard, this "heating rate" reflects the temperature rise which is experienced by the pre-coated steel upon being located in the preheated furnace. Vc is defined as the mean heating rate between 20 and 700° C.** The inventors have discovered that the control of Vc in this precise range is a key factor, because it controls directly the nature and the morphology of the alloyed layers which are formed. **It is here underlined that the heating rate Vc is different from the mean heating rate, which is the heating rate between room temperature and furnace temperature.**

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It is therefore clear that the heating rate in Laurent does not correspond Vc, which is the mean heating rate between 20°C and 700°C. Accordingly, having a mean heating rate to the final heating temperature of at least 5°C/s cannot lead to any conclusion as to Vc. For this reason as well, the heating rate in Laurent is not part of a process that is "identical or substantially identical to the process set forth in the specification of the instant application, which produces the claimed product," as alleged by the Examiner. (Office Action, p. 5).

Finally, Laurent also fails to disclose the combination of heating temperature and time disclosed in the present application. Indeed, Laurent discloses, as an example, an austenitizing at 900°C for 5 min for a 1 mm thick sheet (col.4, line 8). First, Laurent does not disclose that this austenitizing is performed in a hot stamping process. Rather, the paragraph in which this austenitization is disclosed does not mention any hot stamping step, and rather seems to relate to the embodiment of Laurent wherein the heating is performed after stamping. This is confirmed by col.2, lines 27-28 which stress that the heating above 750°C, which corresponds to the heating above 750°C disclosed in the paragraph bridging columns 3 and 4, is performed on the "casting" therefore after shaping. In any event, Laurent does not disclose any dwell time, but merely discloses a holding time of 5 min. Therefore, Laurent does not disclose the temperature/time diagram of the process of the application, and for this reason as well, does not describe a process that is "identical or substantially identical to the process set forth in the specification of the instant application, which produces the claimed product," as alleged by the Examiner. (Office Action, p. 5).

Accordingly, in view of the fact that the process described in Laurent is not substantially the same as the process described in the present specification for the created the claimed four layer arrangement, and that there is no indication whatsoever that Laurent provides the claimed four layer arrangement, and in fact, discusses at most two layers (col. 3, lines 15-31), withdrawal of the Examiners rejections under 35 U.S.C. §§ 102 and 103 is respectfully requested.

Information Disclosure Statement

An information disclosure statement is submitted herewith.

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It is respectfully submitted that the application is in condition for allowance and applicants respectfully request such action

If any fees are deemed to be due at this time, the Assistant Commissioner is authorized to charge payment of the same to Deposit Account No. 50-0552.

Respectfully submitted,
DAVIDSON, DAVIDSON & KAPPEL, LLC

By: /Cary Kappel/
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PETITION FOR EXTENSION OF TIME UNDER 37 CFR 1.136(a)

Docket Number (Optional): 20631.1028CON5

Application Number: 16413799

Filed: 05-16-2019

For: Coated Steel Strips, Coated Stamped Products and Methods

Art Unit: 7637

Examiner: SCHLEIS, DANIEL J

This is a request under the provisions of 37 CFR 1.136(a) to extend the period for filing a reply in the above-identified application.

The requested extension and fee are as follows (check time period desired and enter the appropriate fee below):

	Fee	Small Entity Fee	Micro Entity Fee	
☐ One month (37 CFR 1.17(a)(1))	$220	$110	$55	$
☐ Two months (37 CFR 1.17(a)(2))	$640	$320	$160	$
☑ Three months (37 CFR 1.17(a)(3))	$1,480	$740	$370	$ 1480
☐ Four months (37 CFR 1.17(a)(4))	$2,320	$1,160	$580	$
☐ Five months (37 CFR 1.17(a)(5))	$3,160	$1,580	$790	$

☐ Applicant asserts small entity status. See 37 CFR 1.27.

☐ Applicant certifies micro entity status. See 37 CFR 1.29.
Form PTO/SB/15A or B or equivalent must either be enclosed or have been submitted previously.

☐ A check in the amount of the fee is enclosed.

☐ Payment by credit card. Form PTO-2038 is attached.

☑ The Director has already been authorized to charge fees in this application to a Deposit Account.

☑ The Director is hereby authorized to charge any fees which may be required, or credit any overpayment, to Deposit Account Number 500552.

☑ Payment made via EFS-Web.

WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.

I am the

☐ applicant.

☑ attorney or agent of record. Registration number 38156.

☐ attorney or agent acting under 37 CFR 1.34. Registration number _____.

/williamcgehris/ — Signature

January 8, 2021 — Date

William C. Gehris — Typed or printed name

212 736 1940 — Telephone Number

NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications. Submit multiple forms if more than one signature is required, see below*.

☐ * Total of _____ forms are submitted.

This collection of information is required by 37 CFR 1.136(a). The information is required to obtain or retain a benefit by the public, which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 6 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Mail Stop PCT, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

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The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (*i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.