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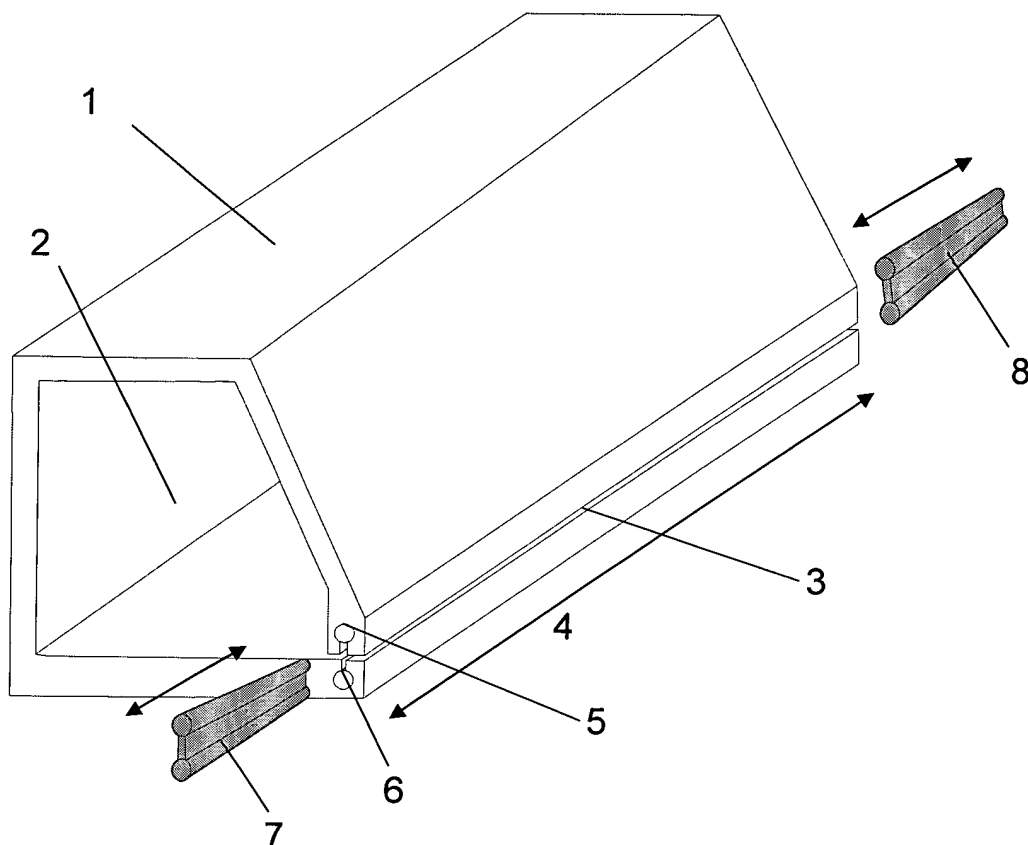
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(54) **Adjustable baffles for gas wiping**

(57) The invention relates to a method and an apparatus for wiping molten coating off a metal product by a

sheet-like gas flow. The width of said sheet-like gas flow is adjusted depending on the width of said metal product. (Figure)

Fig.



Description

[0001] The invention relates to a method for coating a metal product wherein a molten coating is applied to a surface of said metal product and wherein said metal product is passed through a control section where a sheet-like gas flow is directed to said metal product in order to wipe part of said molten coating off said metal product. Further, the invention relates to a gas wiping apparatus for wiping off a molten coating from a metal product comprising at least one gas outlet for providing a sheet-like gas jet.

[0002] Continuous hot-dip galvanizing of metal sheets is a well-known technique. This method involves the application of a molten coating onto the surface of a metal sheet in a continuous process. The metal sheet is passed through a bath of a molten metal. In the bath the surface of the metal sheet reacts with the molten metal to bond the coating onto the sheet surface. When the metal sheets emerge from the metal bath excess liquid metal is bond to the surface, too.

[0003] In a subsequent control section the coating thickness is controlled. This thickness control is achieved by a gas wiping process. Gas nozzles deliver low-pressure, high-volume air streams on the surface of the metal sheet to wipe off surplus molten metal pulled from the molten metal bath. Since the gas nozzles "cut off" excess coating material they are often referred to as "gas knives".

[0004] In the following the term "gas knife" shall mean a device for delivering a gas onto or along a surface, in order to wipe off surplus coating material. The terms "air knife" and "nitrogen knife" accordingly refer to devices for delivering air or nitrogen for gas wiping purposes.

[0005] Some of the steel manufacturers use nitrogen instead of air as the wiping gas in the steel galvanizing process. The use of nitrogen has the advantage that a coating with improved surface quality is achieved due to the inertness of nitrogen.

[0006] The gas nozzles or gas knives are at least as long as the maximum width of the product to be processed. When a product of lesser width is processed the gas knives extend beyond the edges of the product.

[0007] In the following the term "width of the product" shall mean the dimension of the metal product in a direction perpendicular to its transport direction and parallel to the surface which has been coated. The term "width of the sheet-like gas flow" shall mean the dimension of the gas flow in a direction perpendicular to the transport direction of the metal product and parallel to the surface which has been coated. In general, the term "width" relates to the dimension of an object in a direction perpendicular to the transport direction of the metal product and parallel to the surface which has been coated.

[0008] PCT application WO 00/01861 A1 proposes baffles adjacent the edges of the processed strip and disposed between that part of the gas nozzles which extend beyond the strip edges, that is between the counter-flowing gas streams beyond the strip edges. The baffles

are provided with gas collection means for redirecting gas in order to avoid turbulence and hence to protect the strip edges.

[0009] However, the baffles do not influence the gas output from the knives. The gas flow rate is not changed and at least part of the gas flowing beyond the strip edges is wasted. This may not be an issue for air knives but for knives using nitrogen as wiping medium.

[0010] Hence it is an object to provide an apparatus and a method for reducing the gas consumption in a gas wiping process when products of lesser width are processed.

[0011] This object is achieved by a method for coating a metal product wherein a molten coating is applied to a surface of said metal product and wherein said metal product is passed through a control section where a sheet-like gas flow is directed to said metal product in order to wipe part of said molten coating off said metal product, and which is **characterized in that** the dimension of said sheet-like gas flow in a direction perpendicular to the transport direction of said passing metal product is adjusted depending on the dimension of said metal product in said direction perpendicular to the transport direction of said passing metal product.

[0012] The inventive gas wiping apparatus for wiping off a molten coating from a metal product comprises at least one gas outlet for providing a sheet-like gas jet, and is **characterized in that** means for reducing the opening cross section of said gas outlet are provided.

[0013] According to the invention the width of the sheet-like gas flow which is used for wiping purposes is set depending on the width of the product to be processed.

[0014] The gas knife is preferably provided with at least one elongated gas outlet extending over a major part of the width of the gas knife. Instead of one elongated gas outlet it is also possible to provide the gas knife with a number of smaller gas outlets which are arranged in line. Further it is possible to have two or more rows of gas outlets, either elongated gas outlets or a number of smaller gas outlets or a combination of both.

[0015] By reducing the opening cross section, for example by closing part of the elongated gas outlet or by closing some of the gas outlets, the total gas flow out of the gas knife is reduced. Thereby, the gas consumption can be reduced by 30% to 60% compared to the existing prior art systems when narrower metal strips are produced.

[0016] The invention is preferably aimed at coating elongated metal products, in particular metal strips, metal sheets or metal wires, for example steel sheets or steel strips, which are continuously passed through a coating section where a molten coating is applied to a surface of the metal product.

[0017] The metal strip or metal sheet or in general the elongated metal product is transported through a coating bath where coating material from the coating bath is bond to the surface of the metal product. When the elongated

metal product exits the bath it drags out more coating material than needed for the coating. The excess coating material is then wiped off the surface by the inventive wiping process.

[0018] Preferably a metal coating is applied to said metal product. Preferably the coating which is applied to the metal product comprises one or more metals or composites of the group of zinc, aluminium, silicon.

[0019] In particular, the invention is directed to galvanizing a metal product, and even more preferred to galvanizing metal sheets or metal strips, in particular steel sheets or steel strips. However, the inventive method can also be used for the application of other coating materials to a metal product by hot-dip coating, that is by dipping the metal product into a bath of coating material.

[0020] When coating an elongated product as described above the amount of excess coating material which is dragged out of the coating bath depends on the speed the metal product exits the bath. The higher the speed, the more coating material is dragged out of the bath. The inventive method works well at speeds of the metal product between 1 m/min and 300 m/min that is it fits quite well into the speed range of standard hot-dip coating systems.

[0021] It is advantageous to pass the coated elongated metal product continuously along a gas knife which blows a gas flow onto or along the surface of the passing metal product. In that case two gas knives are disposed on either side of the passing metal product with the gas outlets of each gas knife directed to respective sides of the passing surface. The gas outlets, for example elongated gas outlets or lines of small gas outlets, preferably extend in a direction parallel to the surface of the passing metal product and perpendicular to the transport direction of the metal product.

[0022] It is preferred to use air and/or nitrogen as the wiping gas. The air and / or nitrogen flow can further be pre-heated and then directed to the metal product for wiping off excess molten coating. It is especially preferred to use nitrogen as wiping gas. Among the benefits of using nitrogen instead of air are reduced dross formation and improved surface quality. According to a preferred embodiment an air flow and a nitrogen flow are directed to the metal product one after the other.

[0023] It is in particular preferred to first use an air flow for wiping off excess molten coating and to subsequently direct a nitrogen flow to said metal product. The idea is to first reduce the coating with an air flow to a particular level and then complete the wiping with nitrogen. Due to its inertness the nitrogen is used to finish the final molten metal coating in order to achieve the desired surface quality. Thus, without any loss of surface quality this method reduces the required nitrogen volume and the related gas consumption costs compared to the use of pure nitrogen knives.

[0024] In order to achieve a specific surface roughness or a specific surface quality or to change the surface solidification behaviour it is advantageous to use the air

flow first and then the nitrogen flow. Further, to achieve a maximum flexibility to change the surface properties of the coating it might also be helpful to apply the air flow and the nitrogen flow at the same time.

[0025] As already described the invention can be used with air knives as well as with nitrogen knives or gas knives which are supplied with any other gas, fluid or steam. The invention is in particular advantageous when gas wiping systems are used which are provided with two or more gas knives arranged in series. With such systems the gas consumption can be substantially reduced.

[0026] A gas wiping apparatus with an elongated gas outlet is preferably provided with means for reducing the width of the elongated gas outlet. By reducing the width of the gas outlet the width of the sheet-like gas stream leaving the gas outlet can be adjusted to the width of the passing metal product.

[0027] According to another preferred embodiment the gas wiping apparatus is provided with at least one baffle which is slidably arranged in the longitudinal direction of the elongated gas outlet such that at least a part of the gas outlet can be closed by the baffle. In an even more preferred embodiment there are two baffles which can be moved from each end of the elongated gas outlet along the width of the gas outlet.

[0028] The adjustment of the baffles or of any other means for reducing the opening cross section of the gas outlet is preferably carried out automatically. For that reason the baffles are connected to a motorized control system which adjusts the position of the baffles in terms of the width requirements. The automatic control allows optimisation of the position of the baffles with respect to the gas consumption and the quality requirements.

[0029] It is further preferred to have means, for example an optical sensor, for detecting the width of the metal product to be coated. Depending on the detected width of the metal product the motor is activated to move the baffles to the optimum position such that on the one hand excess liquid coating is sufficiently wiped off the metal product to achieve the desired product quality, and on the other hand the gas consumption is reduced as far as possible.

[0030] The invention as well as further details of the invention will now be described with reference to the attached drawing. The figure schematically shows the inventive gas knife for wiping off excess molten zinc from a steel sheet.

[0031] A steel strip is transported at a high speed of for example about 150 m/min through a coating or galvanizing bath where a molten metal or metal alloy, for example zinc, is bond to the steel surface. When leaving the coating bath the steel strip is covered with an over thick layer of molten zinc. The steel strip exits the coating bath in a vertical direction.

[0032] Two gas knives are disposed on either side of the passing steel strip. In the figure only one gas knife 1 is shown. The second gas knife is identically to gas knife

1 but arranged mirror-inverted with the passing steel strip being the mirror plane.

[0033] Gas knife 1 comprises a chamber 2 with an elongated gas outlet 3. Chamber 2 is connected to a supply of pressurised gas such as air or nitrogen. Chamber 2 with the elongated gas outlet 3 extends transversely to the steel strip at a right angle to the direction of steel strip transport, that is the elongated gas outlet 3 is oriented in an essentially horizontal direction.

[0034] Through elongated gas outlets 3 each gas knife 1 directs a sheet-like gas jet against the respective side of the passing steel strip. Thereby, any excess zinc which has been dragged off the coating bath is blown off the steel strip.

[0035] The width 4 of the elongated gas outlets 3 defines the maximum width of the steel strip to be processed by the gas knives 1. When a steel strip of lesser width than the maximum width shall be processed the width 4 of the elongated gas outlets 3 is adjusted in terms of the width requirements.

[0036] For that reason the end faces which restrict the elongated gas outlet 3 over its width 4 are furnished with longitudinal slits 5, 6 extending along the width 4 of the gas outlet 3.

[0037] Baffles 7, 8 are slidably arranged within the slits 5, 6. The upper part of each baffle 7, 8 runs within the upper slit 5, the lower part of each baffle 7, 8 runs within the lower slit 6.

[0038] Depending on the position of the baffles 7, 8 part of the elongated gas outlet 3 is closed. Hence, the position of the gas baffles 7, 8 defines the width of the sheet-like gas jet stream which exits gas knife 1 through the elongated gas outlet 3.

[0039] The baffles 7, 8 are connected to a computer controlled motor drive (not shown). The computer controlled system allows to automatically set the position of the baffles 7, 8 when different steel strip gauges are produced. Hence, the inventive system gives flexibility to set the gas streams such that on the one hand the gas consumption is reduced, and on the other hand the required surface quality of the edges of the steel strip is achieved.

[0040] Pressure and volume of the gas supplied to the gas knives 1 are also controlled depending on the speed of the steel strip, the desired thickness and quality of the coating, and/or the type of coating material. Further parameters which might be used to control pressure and volume of the gas and/or the position of the baffles 9, 10 are the height of the gas knife 1 above the coating bath, the distance of the gas knife 1 from the passing steel strip, the angle at which the gas jets impinge on the passing steel strip, or the dimensions of the elongated gas outlets 3.

and wherein said metal product is passed through a control section where a sheet-like gas flow is directed to said metal product in order to wipe part of said molten coating off said metal product, **characterized in that** the dimension of said sheet-like gas flow in a direction perpendicular to the transport direction of said passing metal product is adjusted depending on the dimension of said metal product in said direction perpendicular to the transport direction of said passing metal product.

2. Method according to claim 1 **characterized in that** said metal product is an elongated product, in particular a metal strip, metal sheet or metal wire, which is continuously passed through a coating section where a molten coating, in particular a metal coating, is applied to a surface of said metal product.

3. Method according to claim 2 **characterized in that** said elongated product is continuously passed through a bath of a molten coating material.

4. Method according to any of claims 1 to 3 **characterized in that** said metal product is galvanized.

5. Method according to any of claims 1 to 4 **characterized in that** said metal product is passed through said coating section at a speed between 1 m/min and 300 m/min.

6. Gas wiping apparatus for wiping off a molten coating from a metal product comprising at least one gas outlet for providing a sheet-like gas jet, **characterized in that** means for reducing the opening cross section of said gas outlet are provided.

7. Gas wiping apparatus for wiping off a molten coating from a metal product comprising an elongated gas outlet, **characterized in that** means for reducing the width of the elongated gas outlet are provided.

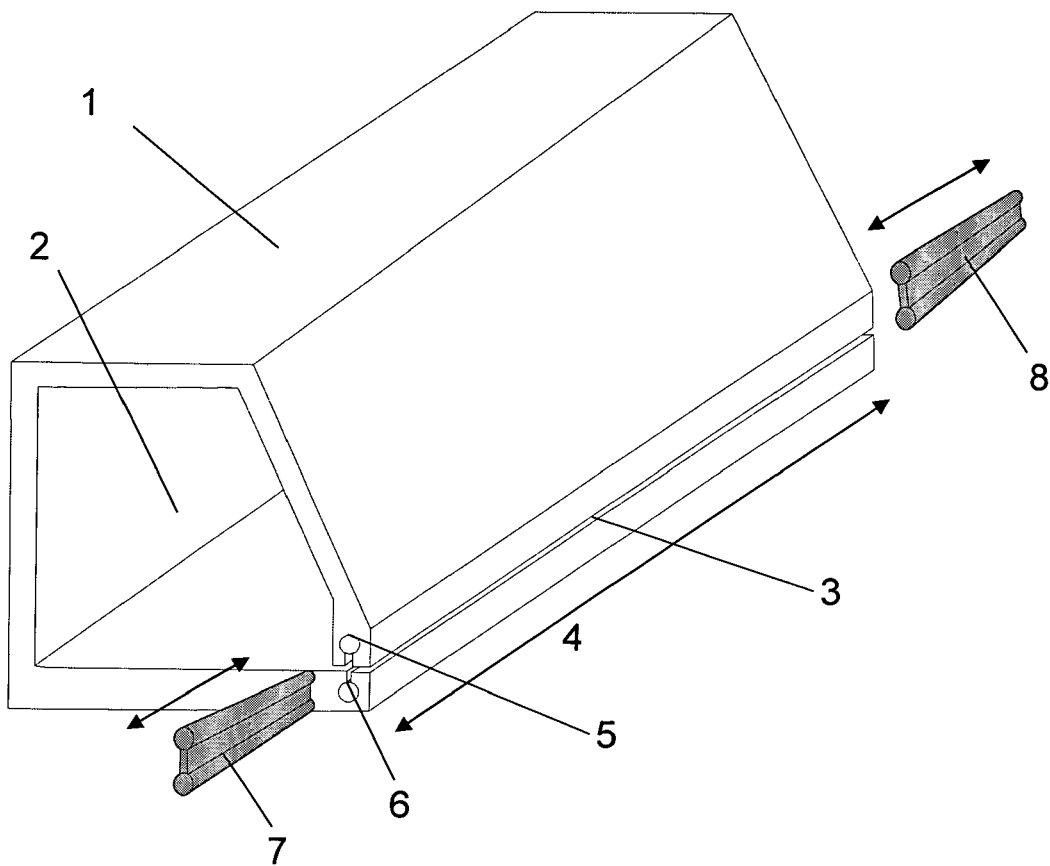
8. Gas wiping apparatus according to claim 7, **characterized in that** said elongated gas outlet is provided with at least one baffle which is slidably arranged in the longitudinal direction of said gas outlet so that at least part of said gas outlet can be closed by said baffle.

9. Gas wiping apparatus according to any of claims 6 to 8 further comprising a motor for adjusting said means for reducing the opening cross section of said gas outlet.

Claims

1. Method for coating a metal product wherein a molten coating is applied to a surface of said metal product

Fig.





EUROPEAN SEARCH REPORT

Application Number
EP 08 01 2051

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 3 941 086 A (RONCAN RICCARDO) 2 March 1976 (1976-03-02) * column 1, line 66 - column 2, line 5 * * column 2, lines 46-56 * * column 3, lines 11-18; figures * -----	1-9	INV. B05C11/06 C23C2/20
X	DE 42 08 558 C1 (DUMA KONSTRUKTIONSBUERO, 4100 DUISBURG, DE) 11 March 1993 (1993-03-11) * column 2, lines 18-64; figures * -----	1-9	
X	EP 0 278 373 A (UNITAS SA [LU]) 17 August 1988 (1988-08-17) * figures * -----	1,6,7	
X	US 5 683 514 A (COX TIMOTHY L [US] ET AL) 4 November 1997 (1997-11-04) * figure 6 * -----	1,6,7	
X	EP 0 249 234 A (DUMA KONSTRUKTIONSBURO [DE] DUMA KONSTRUKTIONSBUERO [DE]) 16 December 1987 (1987-12-16) * claim 1; figures * -----	1,6,7	TECHNICAL FIELDS SEARCHED (IPC) B05C C23C
X	WO 98/32890 A (IND AUTOMATION SERV PTY LTD [AU]; WALLACE GLEN [AU]) 30 July 1998 (1998-07-30) * page 15, paragraph 2; figure 4 * -----	1,6,7	
A	WO 03/018859 A (POSCO [KR]; RES INST IND SCIENCE & TECH [KR]; CHAE HONG-KOOK [KR]) 6 March 2003 (2003-03-06) * figures * -----	1,6,7	
A	EP 0 566 497 A (CLECIM SA [FR]) 20 October 1993 (1993-10-20) * figures * -----	1,6,7	
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 3 December 2008	Examiner Pöll, Andreas
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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**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 08 01 2051

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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03-12-2008

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
US 3941086	A	02-03-1976	NONE	
DE 4208558	C1	11-03-1993	NONE	
EP 0278373	A	17-08-1988	DE 3704199 A1	25-08-1988
			ES 2033945 T3	01-04-1993
			GR 3005694 T3	07-06-1993
US 5683514	A	04-11-1997	NONE	
EP 0249234	A	16-12-1987	ES 2009820 T5	16-10-1989
WO 9832890	A	30-07-1998	DE 19881989 T0	10-02-2000
			GB 2336377 A	20-10-1999
			JP 4020217 B2	12-12-2007
			JP 2001508358 T	26-06-2001
			US 6199301 B1	13-03-2001
WO 03018859	A	06-03-2003	CN 1610763 A	27-04-2005
			JP 2004522002 T	22-07-2004
EP 0566497	A	20-10-1993	AU 3700593 A	21-10-1993
			DE 69303316 D1	01-08-1996
			DE 69303316 T2	19-12-1996
			ES 2088647 T3	16-08-1996
			FR 2690170 A1	22-10-1993
			JP 6106500 A	19-04-1994
			US 5332437 A	26-07-1994

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- WO 0001861A1 A1 [0008]