(54) Title: GAS WIPING APPARATUS

(57) Abstract: A gas wiping apparatus is a type of equipment for coating a molten metal such as molten zinc onto a steel strip. In the gas wiping apparatus, a lip defines a gas outlet for ejecting a high-pressure gas to adjust a coating amount on a steel strip. A metal chip removing unit includes a metal chip remover disposed inside the lip to remove metal chips from the gas outlet and a drive unit associated with the metal chip remover to drive the metal chip remover along the gas outlet. A metal deposition prevention layer is formed on a surface of the lip around the gas outlet, the metal deposition prevention layer having a surface roughness up to 0.5D. Thus, the gas wiping apparatus including the metal chip removing unit and the metal deposition prevention layer prevents the steel strip from defective coating caused by the metal chip. The gas wiping apparatus effectively removes zinc chips (metal chips) which are splashed from the surface of the steel strip and deposited on a gas outlet. Also, the gas wiping apparatus has a metal chip removing unit installed therein and prevents a lip around the gas outlet from contamination by metal chips. This eventually prevents non-uniform coating of the steel strip and shortening in useful life of the apparatus due to the metal chips.

Published:
— with international search report

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.
Description

GAS WIPING APPARATUS

Technical Field

[1] The present invention relates to a gas wiping apparatus used in a molten metal coating line such as molten zinc onto a steel strip.

[2] More particularly, the present invention relates to a gas wiping apparatus in a molten metal coating line, which can effectively remove zinc chips or zinc fumes (hereinafter 'metal chips'), splashed from the surface of the steel strip and deposited on a gas outlet, during gas wiping. The gas wiping apparatus also has a metal chip removing unit installed inside the apparatus unlike the prior art and is configured to prevent a lip around the gas outlet from contamination by metal chips, thereby eventually preventing non-uniform coating of the steel strip and shortening in useful life of the apparatus due to the metal chips.

[3]

Background Art

[4] A coated steel strip obtained by coating a specific molten metal, e.g., molten zinc onto a cold-rolled steel strip or a hot-rolled steel strip, is highly corrosion-resistant and has aesthetic appearance.

[5] For example, the steel strip coated with molten zinc has a greater zinc coating amount than an electrically plated steel strip. Thus the coated steel strip is highly corrosion-resistant and low in manufacturing costs. Also, lately the coated steel strip has been widely utilized for inner and outer panels and internal structural panels of automobiles due to superior coating cohesion.

[6]

[7] FIG. 1 illustrates a conventional continuous galvanizing line, which is representative of a molten metal coating line.

[8] As shown in FIG. 1, a coil steel strip S uncoiled from a pay off reel is thermally treated in a furnace through a welder and an entry looper. Then the coil steel strip S passes through a hot dipping bath 210 filled with molten zinc 212 through a snout 214 to be coated.

[9] Next, the steel sheet passes through a gas wiping apparatus or an air knife 220 disposed over a molten level of the hot dipping bath. In this case, the molten metal solution (zinc) of the steel strip S is adequately worn from the surfaces thereof by a high-pressure air or a non-active gas such as nitrogen, which will be hereinafter referred to as 'gas', blown onto the steel strip. This allows the steel strip to be adjusted in its coating thickness as shown in A of FIG. 1.
Afterwards, a gauge 230 measures whether the steel strip is coated to an appropriate coating thickness. The measured value is fed back to adjust a gas ejection pressure of the gas wiping apparatus 220 and an interval between the steel strip S and the gas wiping apparatus 220, thereby continuously controlling a coating amount of the steel strip.

Here, reference signs 216 and 218 in FIG. 1, which are not described, indicate a sink roll for guiding the steel strip into the hot dipping bath and a stabilizing roll for suppressing vibration of the steel strip.

As described above, the gas wiping apparatus (air knife) 220 is the important equipment for determining a coating thickness of the steel strip to meet consumer's demand.

FIG. 2 illustrates splashing of a molten metal solution (molten zinc) which occurs in a gas wiping apparatus 220.

As shown in FIG. 2, a high-speed high-pressure gas is ejected through gas outlets 122, e.g., slits formed between upper and lower lip members, of the gas wiping apparatus 120, to collide against surfaces of the steel strip. Here, molten metal particles, e.g., molten zinc particles, (which will be hereinafter referred to as 'zinc chips') deposited on the steel strip are splashed due to gas moving upward and downward at a high speed.

For example, in FIG. 2, the gas ejected from the gas outlets at a high pressure and a high speed causes a negative pressure area to be formed around the outlets owing to the gas traveling fast so that the zinc chips d are splashed from the surfaces of the coated steel strip.

The metal chips d splashed as described above are deposited on the gas outlet 222 and surfaces of lips therearound and stuck with time passing.

This accordingly reduces pressure of an injected gas passing through a metal chip deposited on the gas outlet 222 of the gas wiping apparatus.

In contrast, gas vortex is increased, thereby preventing gas from being ejected uniformly along a width direction of the steel strip. This leads to coating defects of the steel strip, e.g., a strip mark thereon.

This necessitates regular removal of the metal chip d from the gas outlet 222 of the gas wiping apparatus 220 and the lip formed therearound.

For example, in the conventional gas wiping apparatus 220, the metal chips were manually removed from the gas outlet 220 by a device such as a thin plate.

However, in manually removing or cleaning the metal chips deposited on the gas outlet or the lip therearound, a worker has always risked a safety accident due to the
relative high-temperature of an ambient atmosphere, e.g., 460℃ of molten zinc in a hot
dipping bath, small work space and steel strip with sharp edges moving continuously.

[24]
[25] Conventional technologies have been proposed to solve the problems arising when
the gas outlet and its surrounding area are cleaned manually.
[26] For example, in other conventional technique for solving the metal chip problem,
the zinc chips are removed mechanically from the gas outlet or therearound without
manual work. Alternatively, a duct is installed around the gas outlet to inhale the metal
chips.
[27] However, such mechanical equipment or other conventional equipment such as
inhalation devices is installed outside the gas wiping apparatus. Thus, with coating of
the steel strip proceeding, splashed metal chips are deposited on a remover or a
cleaner, thereby causing the apparatus to malfunction or break down.
[28]
[29] This has called for a novel gas wiping apparatus in which a metal chip removing
unit is disposed internally to prevent a flow disturbance of gas caused by interference
with flow of a gas jet, and a zinc deposition prevention layer is formed to prevent zinc
chips from depositing on the gas outlet and therearound, thereby preventing the
splashing zinc chips from degrading coating quality of the steel strip.

[30]

**Disclosure of Invention**

**Technical Problem**

[31] The present invention has been made to solve the foregoing problems of the prior
art and therefore an aspect of the present invention is to provide a gas wiping apparatus
in which zinc chips (metal chips) deposited on a gas outlet is effectively removed, a
metal chip removing unit is internally installed, a lip around the gas outlet is prevented
from contamination by the metal chips, and eventually defective coating of the steel
strip or shorter useful life of the apparatus due to the metal chips is prevented.

[32]

**Technical Solution**

[33] According to an aspect of the invention, the invention provides a gas wiping
apparatus including a lip defining a gas outlet for ejecting a high-pressure gas to adjust
a coating amount on a steel strip; a metal chip removing unit including a metal chip
remover disposed inside the lip to remove metal chips from the gas outlet and a drive
unit associated with the metal chip remover to drive the metal chip remover along the
gas outlet; and a metal deposition prevention layer formed on a surface of the lip
around the gas outlet, the metal deposition prevention layer having a surface roughness
up to 0.5\%, whereby the steel strip is prevented from defective coating caused by the metal chip.

[34] According to another aspect of the invention, the invention provides a gas wiping apparatus including a lip defining a gas outlet for ejecting a high-pressure gas to adjust a coating amount on a steel strip; and a metal chip removing unit including a metal chip remover disposed inside the lip to remove metal chips from the gas outlet and a drive unit associated with the metal chip remover to drive the metal chip remover along the gas outlet, whereby the steel strip is prevented from defective coating caused by the metal chips.

[36] Preferably, the gas wiping apparatus further includes a metal deposition prevention layer formed on a surface of the lip around the gas outlet, the metal deposition prevention layer having a surface roughness up to 0.5\%.

[37] According to further another aspect of the invention, the invention provides a gas wiping apparatus including a lip defining a gas outlet for ejecting a high-pressure gas to adjust a coating amount on a steel strip; and a metal deposition prevention layer formed on a surface of the lip around the gas outlet, the metal deposition prevention layer having a surface roughness up to 0.5\%, whereby the steel strip is prevented from defective coating caused by the metal chip.

[38] Preferably, the gas wiping apparatus further includes a metal chip removing unit including a metal chip remover disposed inside the lip to remove metal chips from the gas outlet; and a drive unit associated with the metal chip remover to drive the metal chip remover along the gas outlet.

[40] In the gas wiping apparatus, the metal chip remover of the metal chip removing unit comprises one member inserted into the gas outlet, selected from a group consisting of a plate with a predetermined width, a needle with a predetermined width and a brush, the metal chip remover fixedly connected to the drive unit.

[42] Preferably, the plate of the metal chip remover includes a corrosion resistance layer formed on an area of the gas outlet which contacts the lip.

[43] Preferably, the drive unit is seated in a seat of the lip, which defines the gas outlet, and located out of a flow path of the high-pressure gas inside the apparatus.

[44] The lip includes upper and lower lip members which define the gas outlet, and the seat for seating the drive unit comprises a recess formed on the lower lip along a length direction thereof.

[46] The drive unit includes a mover seated on a rail disposed inside the seat in the lower
lip member and fixedly connected to the metal chip remover; and a driving force transmission associated with the mover to transmit a driving force from outside the apparatus to the mover.

Preferably, the driving force transmission includes a driven wire supported by driven pulleys installed at both sides of the seat to be driven along an endless track, the mover connected to the driven wire; and a driving wire wound around a connector pulley, connected to one of the driven pulleys and fixed to a driving shaft extending through the lip, and a driving pulley of a driving motor installed in a chamber or a frame of the apparatus.

Also, the driving force transmission may include a driven wire supported by driven pulleys installed at both sides of the seat to be driven along an endless track, the mover connected to the driven wire; and a gear box connecting a driving shaft, connected to one of the driven pulleys and extending through the lip, and a driving motor installed in a chamber or a frame of an air knife; and joints connected to the gear box.

Further, preferably, the driving force transmission may include a rotatable screw bar screwed into the mover and extending along the seat; and a gear box connecting the screw bar with a driving motor in a chamber or in a frame of the apparatus; and joints connected to the gear box.

More preferably, the gas wiping apparatus further includes a cover placed over the seat to prevent a flow disturbance of the high-pressure gas.

The lip may include upper and lower lip members which define the gas outlet, the upper and lower lip members fixed to a frame of the apparatus and associated with a chamber of the apparatus to which the high-pressure gas is fed.

The lip may include upper and lower lip members which define the gas outlet, the upper and lower lip members installed in a chamber of the apparatus and fixedly connected to a lip support unit through which the high-pressure gas flows.

The lip support unit includes a baffle wall provided with passage holes for allowing the high-pressure gas supplied from the chamber to pass therethrough to produce uniform gas injection, the baffle wall supporting the apparatus against load; and lip supports disposed in upper and lower parts of the baffle wall, respectively, each of the lip supports fixed, at one end, to a corresponding one of the upper and lower members and, at the other end, to the chamber.

The metal deposition prevention layer may be a zinc deposition prevention layer for preventing zinc chips from depositing on the lip.

Preferably, the zinc deposition prevention layer includes a coat made of a material selected from a nitride or a carbide high-hardness ceramic material, or a coat made of nitride and carbide high-hardness ceramic material layers alternating with each other.
Preferably, the nitride high-hardness ceramic material layer is made of one selected from a group consisting of TiN, TiAlN and CrN.

More preferably, the carbide high-hardness ceramic material layer is made of a material selected from WC and DLC.

The gas wiping apparatus further includes baffle plate and edge roll pairs disposed, respectively, at both edges of a steel strip, which is adjusted in the coating amount by the high-pressure gas ejected from the gas outlet of the lip. Preferably, the zinc deposition prevention layer is additionally formed on at least one of surfaces of the baffle plates and the edge rolls.

At least one of the lip and the baffle plate and edge roll pairs comprises stainless.

The zinc deposition prevention layer includes a hard chrome layer formed on the metal deposition prevention layer having a surface roughness up to 0.5µ; and a metal layer formed on the hard chrome layer and containing the high hardness ceramic material.

**Advantageous Effects**

In the gas wiping device in a molten metal coating line according to the invention, metal chips (zinc chips) deposited on the gas outlet are stably removed.

That is, a remover unit for removing metal chips from the gas outlet is internally installed in the apparatus in an area where the metal chips are not splashed, thereby stably operating the remover unit during a longer period.

Also, surface treatment is carried out to form a metal deposition prevention layer on the surface of the lip around the gas outlet or accessory equipment such as the baffle plates, thereby preventing contamination caused by the metal chips and thus extending useful life of the apparatus.

Therefore, the gas wiping apparatus prevents defective coating or contamination when the steel strip is coated with a molten metal.

**Brief Description of the Drawings**

The above and other objects, features and other advantages of the present invention will be more clearly understood from the following detailed description taken in conjunction with the accompanying drawings, in which:

FIG. 1 is a perspective view illustrating a continuous galvanizing line which is an example of a process for coating a steel strip with a molten metal;

FIG. 2 is a schematic view illustrating splashing of zinc chips around a gas outlet;

FIG. 3 is a configuration view illustrating a gas wiping apparatus including a metal
chip removing unit of the invention;

FIG. 4 is a plan view of FIG. 3;

FIG. 5 is an exploded perspective view of FIG. 3;

FIG. 6(a) to 6(d) are views illustrating several embodiments of a metal chip removing unit of the invention;

FIG. 7 is an exploded perspective view illustrating another embodiment of a gas wiping apparatus of the invention;

FIG. 8 is a perspective view illustrating further another embodiment of a gas wiping apparatus of the invention; and

FIG. 9 is a schematic perspective view illustrating a metal deposition prevention layer (zinc deposition prevention layer) formed on a lip around a gas outlet, and baffle plate and edge roll pairs which are accessory equipment of a gas wiping apparatus.

**Best Mode for Carrying Out the Invention**

Exemplary embodiments of the present invention will now be described in detail with reference to the accompanying drawings.

Components of a gas wiping apparatus 100 are designated with reference numerals in 10X. Meanwhile, components of a remover unit 1 for removing metal chips (zinc chips) from a gas outlet are denoted by reference numerals in 1X.

First, FIGs. 3 to 5 illustrate a gas wiping apparatus 100 including a metal chip removing unit 1 of a gas outlet.

That is, as shown in FIGs. 3 to 5, the gas wiping apparatus 100 of the invention includes a lip 130 composed of upper and lower lip members 130a and 130b which define a gas outlet 110 for ejecting a high-pressure gas to adjust a coating amount of a steel sheet (see S of FIG. 1).

Also, the gas wiping apparatus 100 of the invention includes a metal chip removing unit 1 including a metal chip remover 10 and a drive unit 30. The metal chip remover 10 is disposed inside the upper and lower lip members 130a and 130b to remove metal chips 120 from the gas outlet 110. The drive unit 30 is associated with the metal chip remover 10 to drive the metal chip remover along the gas outlet.

Especially, the drive unit 30 of the metal chip removing unit 1 is located out of a flow path P of a high-pressure gas flowing inside the lip 130 of the gas wiping apparatus.

That is, in the metal chip removing unit 1 of the invention, the drive unit 30 reciprocally drives the metal chip removing unit 10 along the gas outlet 110, and is located out of a flow path P of the high-pressure gas inside the apparatus as described
above. This prevents a flow disturbance of the ejected gas due to the drive unit 30, thereby having no effect on the gas.

Therefore, the metal chip remover unit 1 of the invention overcomes an operational problem caused by the splashed metal chips, which arises from conventional cleaners of the gas outlet installed outside the apparatus.

Meanwhile, as will be described in greater detail with reference to FIG. 6, the metal chip remover 10 may be formed of one selected from a thin metal plate, a needle or a brush (not illustrated) having a thickness (or diameter in case of needle) corresponding to the gas outlet 110 which is defined by distal ends of the upper and lower lip members 130a and 130b.

In whatever shape, the metal chip remover 10 should be strong enough to remove the metal chips (120 of FIG. 3) deposited or, if serious, stuck to the gas outlet.

The drive unit 30 drives the metal chip remover 10 along a length direction of the gas outlet even in operating the gas wiping apparatus 1 as described above. Then, as shown in FIGs. 3 to 5, the drive unit 30 is seated in a seat 132 formed on one of the upper lip 130a and the lower lip 130b which define the gas outlet 110, preferably, the upper lip 130b.

That is, the drive unit 30 is seated in the seat 132 so that the drive unit 30 of the metal chip removing unit is located out of a flow path P of the high-pressure gas inside the apparatus.

As shown in FIGs. 3 and 5, the seat 132 may be configured as a linear recess formed on the lower lip member 130b adjacent to the gas outlet along a length direction of the lower lip member 130b.

Although not illustrated in a separate drawing, alternatively, the seat 132 can be formed in the upper lip member 130a to have the drive unit 30 disposed therein and the metal chip remover 10 can be bent to be inserted into the gas outlet 110.

In the meantime, as shown in FIGs. 3 to 5, the drive unit 30 of the metal chip removing unit 1 includes a carriage 34 and a driving force transmission 36. The carriage 34 is seated on a rail 32 disposed inside the seat 132 in the lower lip 130b and fixedly connected to the metal chip remover 10. The driving force transmission 36 is associated with the carriage 34 to transmit a driving force from outside the apparatus.

That is, the metal chip remover 10 for practically removing the metal chips (zinc chips) 120 from the gas outlet 110 is fixedly connected to the carriage 34 of the drive unit 30. The carriage 34 is associated with the driving force transmission 36 to reciprocally move in a length direction of the gas outlet along the rail 32 on a bottom of the seat.

In this fashion, the metal chip remover 10 made of a thin plate moves along the gas
outlet to remove the deposited metal chips 120, i.e., zinc chips therefrom.

[99] Here, as shown in FIG. 4, the metal chip remover 10 has a small width, and thus stays waiting in an extra space of both sides of the lip having a substantially greater length than a width of steel strip until it moves. Accordingly, the metal chip remover 10 does not disturb a flow of the high-pressure gas inside the gas wiping apparatus.

[100] The driving force transmission 36 of the invention may be configured variously.

[101] For example, FIGs. 3 and 5 illustrate the driving force transmission 36 according to a first embodiment of the invention.

[102] That is, as shown in FIGs. 4 and 5, the driving force transmission 36 includes a driven wire 38 and a driving wire 50. The driven wire 38 is supported by driven pulleys 40 installed at both sides of the seat 36 to be driven along an endless track, and connected to the carriage 34. The driving wire 50 is wound around a connector pulley 44, connected to one of the driven pulleys and fixed to a driving shaft 42 extending through the lip, and a driving pulley 48 of a driving motor 46 installed in a chamber 150 or a frame 140 of the apparatus.

[103] Therefore, when an apparatus control panel (not illustrated) drives the driving motor 46 installed in a rear part of the chamber or the frame to be less affected by heat, the driving wire 50 and the driven wire 38 are driven in association with the driving pulley 48 and a connector pulley 44, and the driving pulleys 40.

[104] The carriage 34 has upper and back sides fixedly connected to the driven pulleys 48 which are driven along an endless track. That is, the carriage 34 is configured as a square block and provided with a rail seat 34a at a lower part thereof. Accordingly, the carriage 34 reciprocally moves in a length direction of the gas outlet 110 of the gas wiping apparatus 100 in response to driving of the driven wire.

[105] Here, the driving shaft 42, where the connector pulley 44 and the driven pulley 40 are installed, extends through the seat of the lower lip member 130b and is assembled hermetically and rotatably through a bearing 42a.

[106] Meanwhile, as shown in FIGs. 3 and 5, a cover 60 of a thin plate is placed over the seat 132, in which the metal chip remover 1 is disposed, in a length direction of the lower lip member to entirely cover the seat.

[107] Therefore, the high-pressure gas fed to the chamber 150 of the gas wiping apparatus 1 flows along the cover 60 uninterrupted and is injected uniformly in a length direction of the gas outlet while the metal chips 120 deposited on the gas outlet are removed by the metal chip remover 10.

[108] This as a result allows the steel strip to be coated with uniform coating amount along a width direction of the steel strip, thereby enhancing coating quality and preventing waste in costs due to excessive coating.
Then FIG. 6 illustrates the metal chip remover 10 of the metal chip removing unit 1 according to various embodiments of the invention.

That is, as shown in FIG. 6a, the metal chip remover 10 is configured as a member inserted into the gas outlet 110, selected from a needle (stick) 10' with a predetermined diameter or a panel 10 with a predetermined width as shown in FIGs. 6b and 6c.

Here, as shown in FIG. 6c, a corrosion resistance layer 10a is formed on front portions of both surfaces of the panel. The corrosion resistance layer 10a, in contact with the lip, removes metal chips. For example, the corrosion resistance layer 10a is preferably made of a high heat-resistant material such as ceramic, tungsten or titan to ensure more metal chips to be removed and increase useful life of the apparatus.

Also, as shown in FIG. 6d, the metal chip remover 10" may have a front end 10b fixed to an outer edge of the gas outlet to remove the metal chips from gas outlet of the lip.

FIG. 6a illustrates a driving force transmission 36' according to a second embodiment of the invention.

That is, as shown in FIG. 6a, the driving force transmission 36' includes a driven wire 38, multiple joints 49 and a gear box 49a. The driven wire 38 is supported by driven pulleys 40 installed at both sides of the seat of the lip 130b to be driven along an endless track, and connected to the carriage 34. The gear box 49a connects the driving shaft 42, connected to one of the driven pulleys 40 and extending through the lip, to a driving motor installed in the chamber 150 or the frame 140. The joints 49 are connected to the gear box 49a.

Therefore, in response to driving of the driving motor in the chamber or in the frame, the gear box and joints are driven to move the driven wire 38 along an endless track. Accordingly the carriage 34 moves on the rail and the metal chip remover 10 removes the metal chips from the gas outlet.

FIG. 7 illustrates a driving force transmission 36" of the metal chip remover unit 1 of the gas wiping apparatus 100 according to a third embodiment of the invention.

The driving force transmission 36" of this embodiment includes a screw bar 54, multiple joints 56 and a gear box 56a. The screw bar 54 is screwed into the carriage 34 and supported by bearing blocks 53 at both sides of the seat. The gear box 56a connects the screw bar with a driving motor in the chamber or in the frame. The joints 56 are connected to the gear box 56a.
As a result, in response to driving of the driving motor (46 of FIG. 4) installed in the chamber or in the frame, the joints 56 are driven and the screw bar 54 is rotatably driven through the gear box 56a to drive the carriage 34 along the rail 32.

In this fashion, the metal chip removing unit 1 of the invention may employ the driving force transmission of various configurations 36, 36', and 36".

Next, a description will be given of a structure of a gas wiping apparatus 100 employing the metal chip removing unit 1 described so far. FIGs. 3 to 5 illustrate the gas wiping apparatus having upper and lower lip members 130a and 130b connected to a chamber 140 and FIG. 8 illustrates the gas wiping apparatus having a lip support unit 160 disposed separately.

As shown in FIGs. 3 to 5, the gas wiping apparatus 100 of the invention, which adopts the metal chip removing unit 1, includes the upper and lower lip members 130a and 130b defining the gas outlet 110, and the chamber 150 associated with the upper and lower lip members 130 and 130b and fixed to the frame 140.

Therefore, the high-pressure gas fed through a high-pressure feed pipe (not illustrated) connected to the chamber 150 is ejected onto the steel strip through the gas outlet 110 defined by the chamber and the upper and lower lip members.

Here, the metal chip remover 10, e.g., a panel of the metal chip removing unit according to the invention removes metal chips, i.e., zinc chips (120 of FIG. 3) from the gas outlet even during operation of the gas wiping apparatus.

FIG. 8 illustrates the gas wiping apparatus 100 according to another embodiment of the invention. The gas wiping apparatus 100 of this embodiment basically adopts the metal chip removing unit 1 described above. The gas wiping apparatus 100 of this embodiment also includes upper and lower lip members 130a and 130b which define a gas outlet 110 and a lip support unit 160 through which the high-pressure gas flows from inside the apparatus to the gas outlet. Here, the lip support unit 160 is arranged between the upper and lower lip members 130a and 130b and defining a part of the chamber 150 to support the gas wiping apparatus against load, thereby allowing the gas wiping apparatus to maintain its strength.

The lip support unit 160 includes a baffle wall 162 and lip support units 164 and 166. The baffle wall 162 is provided with passage holes 162a for allowing the high-pressure gas to pass therethrough to produce uniform gas injection. The baffle wall 162 has a predetermined thickness to remain strong. The lip supports 164 and 166 are disposed in upper and lower parts of the baffle wall 162, respectively. Each of the lip supports 164 and 166 is fixed, at one end, to a corresponding one of the upper and lower lip members and, at the other end, to the chamber.

Therefore, the lip support unit 160 in the gas wiping apparatus of this embodiment of the invention, assures less difficulty in manufacturing or operating the gas wiping
apparatus, in which the chamber needs to maintain the strength since the upper and lower lip members are connected to the chamber 150 as shown in FIG. 4.

Also, the baffle wall 162 of the lip support unit 160 is provided with the passage holes 162a arranged in a predetermined pattern so that air or a high-pressure gas supplied through the chamber can be ejected through the gas outlet 110 as uniformly as possible.

Here, in the gas wiping apparatus 100 of the invention, the lower lip member 130b should be provided with a seat 132 for seating a drive unit and also securely fixed to the chamber or the lip support unit with its thickness or strength adjusted to prevent any vibration from occurring when a coating amount is changed.

Then, FIG. 9 illustrates a gas wiping apparatus 100 according to further another embodiment of the invention.

The characteristic of this embodiment is that the gas wiping apparatus 100 has a metal deposition prevention layer, i.e., a zinc deposition prevention layer 180 formed on a surface of the lip 130 around the gas outlet 100, i.e., the upper and lower lip members 130a and 130b. Here, the gas wiping apparatus 100 of FIG. 9 adopts the metal chip removing unit 1 of the invention as described above with reference to FIGs. 3 to 8. Alternatively, the gas wiping apparatus 100 of FIG. 9 may be configured without the metal chip removing unit 1.

As a result, in the gas wiping apparatus 100 of this embodiment, the metal chips deposited on the gas outlet are removed by mechanical mechanism via the metal chip removing unit 1 of the invention. In addition, the zinc deposition prevention layer 180 is formed on the lip around the gas outlet, thereby fundamentally preventing zinc fumes (zinc chips) from depositing around the gas outlet of the lip due to gas vortex.

Here, as shown in FIG. 9, the zinc deposition prevention layer 180 has a surface roughness up to 5μ and preferably up to 3μ so that zinches are not easily deposited.

Also, preferably, the zinc deposition prevention layer 180 is preferably a coat made of a material selected from a nitride or a carbide high-hardness ceramic material, which has no reaction with molten zinc.

According to further another embodiment of the invention, the zinc deposition prevention layer 180 may be a coat made of nitride and carbide high-hardness ceramic material layers alternating with each other. Here, the invention is not limited to a specific coating sequence, but either the nitride high-hardness ceramic material layer or the carbide high-hardness ceramic material layer may be disposed.

Also, according to the invention, the nitride high-hardness ceramic material layer is preferably made of a material selected from a group consisting of TiN, TiAlN and
CrN. The carbide high-hardness ceramic material layer is preferably selected from WC and DLC.

The zinc deposition prevention layer 180 has a thickness of preferably 1 µ to 5 µ, more preferably 2 µ.

Therefore, the zinc deposition prevention layer 180 is formed on a surface of the lip around the gas outlet, thereby preventing zinc deposition.

Moreover, the zinc deposition prevention layer 180 should have a surface roughness that is required according to the invention, and thus preferably formed by dry coating such as physical vapor deposition (PVD) and chemical vapor deposition (CVD).

With this dry coating, the nitride and carbide ceramic material layers can be effectively formed, and rarely deformed even at a high temperature (about at least 450°C) in the molten zinc equipment.

Then, as shown in FIG. 9, the zinc deposition layer 180 of the invention is preferably applied to a baffle system which is accessory equipment of the gas wiping apparatus 100.

For example, the baffle system which is the accessory equipment of the gas wiping apparatus in the coating equipment includes baffle plate pairs 190 and edge roll pairs 192 disposed, respectively, at both edges of a steel strip at a predetermined interval from the steel strip.

The baffle plates 190 and the edge rolls 192 located adjacent to the steel strip S may lead to less prevention of excessive coating caused by zinc deposition as in the case of the lip and the gas outlet of the gas wiping apparatus 1.

Therefore, the zinc deposition layer 180 of the invention, when adopted in the baffle system can relieve a problem of zinc deposition.

Furthermore, to form the zinc deposition layer of the invention, preferably, the nitride or carbide high-hardness ceramic material layer is formed by dry coating on a material having a surface roughness up to 0.5 µ.

The zinc deposition prevention layer formed in this fashion can effectively maintain a surface roughness up to 0.5 µ.

Moreover, the zinc deposition prevention layer 180 made of a ceramic material by dry coating has no reaction with molten zinc, and is superior in surface hardness, friction coefficient and corrosion resistance. Especially, this prevents the gas outlet from being blocked in the gas wiping apparatus contaminated with splashed zinc chips.

Meanwhile, in a case where the zinc deposition prevention layer 180 is to be formed in a device, e.g., lip made of stainless, a ceramic material layer can be formed easily. However, in a case where the zinc deposition prevention layer 180 is to be formed in a
device of steel, preferably, additional means for enhancing cohesion with the ceramic material should be employed.

For example, in a case where the lip of the gas wiping apparatus, and the plate and edge roll pairs of the baffle system are made of steel, a surface of the metal deposition prevention layer is polished to have a surface roughness up to 0.5, and then a hard chrome layer is formed thereon by wet coating.

Preferably, the hard chrome layer is uniformly formed to a thickness of 100. Chrome is selected for wet coating in order to prevent oxidation of steel and impart similar features to surfaces of the high-hardness ceramic material and the base material, thereby ensuring them to be highly cohesive.

Thereafter, a metal layer is formed on the hard chrome layer. The metal layer is made of a ceramic material selected from a group consisting of titanium (Ti), tungsten (W), titan aluminum (TiAl) and alloys thereof. Preferably, the metal layer has a thickness of about 20.

Example

In a gas wiping apparatus of the invention, surfaces of a lip around a gas outlet, baffle plate and edge roll pairs were polished to have a surface roughness of 0.3, respectively. Also, hard chrome layers were formed to about a thickness of about 100 by wet coating.

Titanium (Ti) layers were formed to a thickness of about 20 on the hard chrome layers and nitride titanium (TiN) layers made of a hard ceramic material were formed to a thickness of about 20.

Under these conditions, the gas wiping apparatus of the invention exhibited longer useful life than a conventional gas wiping apparatus in hostile environments where only a small number of cleaning is carried out. The results are shown in Tables 1 to 3 below.

Table 1

<table>
<thead>
<tr>
<th></th>
<th>Gas outlet of conventional gas wiping apparatus</th>
<th>Gas outlet of inventive gas wiping apparatus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of cleanings</td>
<td>10/day</td>
<td>Less than 2/day</td>
</tr>
<tr>
<td>Useful life</td>
<td>Four months</td>
<td>2 years or more</td>
</tr>
<tr>
<td>Coating amount of molten zinc</td>
<td>Great</td>
<td>Small</td>
</tr>
</tbody>
</table>
Table 2

<table>
<thead>
<tr>
<th></th>
<th>Conventional baffle plate</th>
<th>Inventive baffle plate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of cleanings</td>
<td>1/week</td>
<td>Less than 1/week</td>
</tr>
<tr>
<td>Useful life</td>
<td>3 months</td>
<td>2 years or more</td>
</tr>
<tr>
<td>Coating amount of molten zinc</td>
<td>Great</td>
<td>Small</td>
</tr>
</tbody>
</table>

Table 3

<table>
<thead>
<tr>
<th></th>
<th>Conventional edge roll</th>
<th>Inventive edge roll</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of cleanings</td>
<td>None</td>
<td>3/year</td>
</tr>
<tr>
<td>Useful life</td>
<td>4 months</td>
<td>4 years or more</td>
</tr>
<tr>
<td>Coating amount of molten zinc</td>
<td>Great</td>
<td>Small</td>
</tr>
</tbody>
</table>

As seen from Tables 1 to 3, the gas wiping apparatus with the zinc deposition prevention layer according to the invention exhibited useful life 5 times greater than the conventional one despite decrease in the number of cleanings for the deposited zinc chips.

That is, as shown in FIG. 9, the zinc deposition prevention layer 180 of the invention prevents the zinc chips from depositing on the surface of the gas wiping apparatus, which is thus rendered minimally affected by zinc fumes (zinc chips).

**Industrial Applicability**

As set forth above, according to exemplary embodiments of the invention, the gas wiping apparatus of the invention easily removes metal chips, i.e., zinc chips deposited on a gas outlet which ejects a gas to adjust a coating amount of a steel strip.

Moreover, a zinc deposition prevention layer is formed on an area where zinc chips are easily deposited. This ensures the zinc chips to be removed from the gas outlet and prevents decrease in useful life resulting from the zinc chips.

While the present invention has been shown and described in connection with the preferred embodiments, it will be apparent to those skilled in the art that modifications and variations can be made without departing from the spirit and scope of the invention as defined by the appended claims.
Claims

[1] A gas wiping apparatus comprising:
a lip defining a gas outlet for ejecting a high-pressure gas to adjust a coating
amount on a steel strip; and
a metal chip removing unit including a metal chip remover disposed inside the
lip to remove metal chips from the gas outlet and a drive unit associated with the
metal chip remover to drive the metal chip remover along the gas outlet,
whereby the steel strip is prevented from defective coating caused by the metal
chips.

[2] The gas wiping apparatus according to claim 1, further comprising a metal
deposition prevention layer formed on a surface of the lip around the gas outlet,
the metal deposition prevention layer having a surface roughness up to 0.5μ.

[3] A gas wiping apparatus comprising:
a lip defining a gas outlet for ejecting a high-pressure gas to adjust a coating
amount on a steel strip; and
a metal deposition prevention layer formed on a surface of the lip around the gas
outlet, the metal deposition prevention layer having a surface roughness up to
0.5μ,
whereby the steel strip is prevented from defective coating caused by the metal
chip.

[4] The gas wiping apparatus according to claim 3, further comprising a metal chip
removing unit including:
a metal chip remover disposed inside the lip to remove metal chips from the gas
outlet; and
a drive unit associated with the metal chip remover to drive the metal chip
remover along the gas outlet.

[5] A gas wiping apparatus comprising:
a lip defining a gas outlet for ejecting a high-pressure gas to adjust a coating
amount on a steel strip;
a metal chip removing unit including a metal chip remover disposed inside the
lip to remove metal chips from the gas outlet and a drive unit associated with the
metal chip remover to drive the metal chip remover along the gas outlet; and
a metal deposition prevention layer formed on a surface of the lip around the gas
outlet, the metal deposition prevention layer having a surface roughness up to
0.5μ,
whereby the steel strip is prevented from defective coating caused by the metal
chip.
The gas wiping apparatus according any one of claims 1, 4 and 5, the metal chip remover of the metal chip removing unit comprises one member inserted into the gas outlet, selected from a group consisting of a plate with a predetermined width, a needle with a predetermined width and a brush, the metal chip remover fixedly connected to the drive unit.

The gas wiping apparatus according to claim 6, wherein the plate of the metal chip remover comprises a corrosion resistance layer formed on an area of the gas outlet which contacts the lip.

The gas wiping apparatus according to any one of claims 1, 4 and 5, wherein the drive unit is seated in a seat of the lip, which defines the gas outlet, and located out of a flow path of the high-pressure gas inside the apparatus.

The gas wiping apparatus according to claim 8, wherein the lip comprises upper and lower lip members which define the gas outlet, and the seat for seating the drive unit comprises a recess formed on the lower lip along a length direction thereof.

The gas wiping apparatus according to claim 8, wherein the drive unit comprise: a mover seated on a rail disposed inside the seat in the lower lip member and fixedly connected to the metal chip remover; and a driving force transmission associated with the mover to transmit a driving force from outside the apparatus to the mover.

The gas wiping apparatus according to claim 10, wherein the driving force transmission comprises:

- a driven wire supported by driven pulleys installed at both sides of the seat to be driven along an endless track, the mover connected to the driven wire; and
- a driving wire wound around a connector pulley, connected to one of the driven pulleys and fixed to a driving shaft extending through the lip, and a driving pulley of a driving motor installed in a chamber or a frame of the apparatus.

The gas wiping apparatus according to claim 10, wherein the driving force transmission comprises:

- a driven wire supported by driven pulleys installed at both sides of the seat to be driven along an endless track, the mover connected to the driven wire; and
- a gear box connecting a driving shaft, connected to one of the driven pulleys and extending through the lip, and a driving motor installed in a chamber or a frame of an air knife; and
- joints connected to the gear box.

The gas wiping apparatus according to claim 10, wherein the driving force transmission comprises:

- a rotatable screw bar screwed into the mover and extending along the seat; and
a gear box connecting the screw bar with a driving motor in a chamber or in a frame of the apparatus; and joints connected to the gear box.

[14] The gas wiping apparatus according to claim 8, further comprising a cover placed over the seat to prevent a flow disturbance of the high-pressure gas.

[15] The gas wiping apparatus according to any one of claims 1 to 5, wherein the lip comprises upper and lower lip members which define the gas outlet, the upper and lower lip members fixed to a frame of the apparatus and associated with a chamber of the apparatus to which the high-pressure gas is fed.

[16] The gas wiping apparatus according to any one of claims 1 to 5, the lip comprises upper and lower lip members which define the gas outlet, the upper and lower lip members installed in a chamber of the apparatus and fixedly connected to a lip support unit through which the high-pressure gas flows.

[17] The gas wiping apparatus according to claim 16, wherein the lip support unit comprises:

a baffle wall provided with passage holes for allowing the high-pressure gas supplied from the chamber to pass therethrough to produce uniform gas injection, the baffle wall supporting the apparatus against load; and lip supports disposed in upper and lower parts of the baffle wall, respectively, each of the lip supports fixed, at one end, to a corresponding one of the upper and lower members and, at the other end, to the chamber.

[18] The gas wiping apparatus according to any one of claims 2, 3 and 5, wherein the metal deposition prevention layer comprises a zinc deposition prevention layer for preventing zinc chips from depositing on the lip, wherein the zinc deposition prevention layer comprises a coat made of a material selected from a nitride or a carbide high-hardness ceramic material, or a coat made of nitride and carbide high-hardness ceramic material layers alternating with each other.

[19] The gas wiping apparatus according to claim 18, wherein the nitride high-hardness ceramic material layer comprises one selected from a group consisting of TiN, TiAlN and CrN.

[20] The gas wiping apparatus according to claim 18, wherein the carbide high-hardness ceramic material layer comprises a material selected from WC and DLC.

[21] The gas wiping apparatus according to claim 18, further comprising:

baffle plate and edge roll pairs disposed, respectively, at both edges of a steel strip, which is adjusted in the coating amount by the high-pressure gas ejected from the gas outlet of the lip,
wherein the zinc deposition prevention layer is additionally formed on at least one of surfaces of the baffle plates and the edge rolls.

[22] The gas wiping apparatus according to claim 21, wherein at least one of the lip and the baffle plate and edge roll pairs comprises stainless.

[23] The gas wiping apparatus according to claim 18, wherein the zinc deposition prevention layer comprises:
a hard chrome layer formed on the metal deposition prevention layer having a surface roughness up to 0.5; and
a metal layer formed on the hard chrome layer and containing the high hardness ceramic material.
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER

C23C 2/16(2006.01)\i

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)
IPC 8 C23C 2/16, C23C 2/18, C23C 2/20, C23C 4/06, B05D 1/04

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Korean Patents and applications for inventions since 1975
Korean Utility models and applications for Utility models since 1975
Japanese Utility models and applications for Utility models since 1975

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
eKIPASS (KIPO internal) & key words : wiper, air nife, coating, nozzle, lip cleaner

C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>KR 10-2006-0055923 A (HANDO ENGINEERING COMPANY, LTD.) 24 May 2006</td>
<td>1</td>
</tr>
<tr>
<td>Y</td>
<td>See page 3, line 48 - page 4, line 28, claims 1-6 and figures 4-8.</td>
<td>2, 4-6, 8-21, 23</td>
</tr>
<tr>
<td>X</td>
<td>KR 10-2003-0093586 A (POSCO) 11 December 2003</td>
<td>1</td>
</tr>
<tr>
<td>Y</td>
<td>See the abstract, page 4, lines 20-42, and figures 5-14.</td>
<td>2, 4-6, 8-21, 23</td>
</tr>
<tr>
<td>X</td>
<td>JP 08-027555 A (NIPPON STEEL CORP.) 30 January 1996</td>
<td>3</td>
</tr>
<tr>
<td>Y</td>
<td>See the abstract, page 2, paragraphs [0005]-[0010], and figures 1, 3.</td>
<td>2, 4-6, 8-21, 23</td>
</tr>
<tr>
<td></td>
<td>See the abstract and figures 4-6.</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>See the abstract claims 1-10 and figures 3-7.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>US 4,535,936 A (PAUL FONTAINE) 20 August 1985</td>
<td></td>
</tr>
<tr>
<td></td>
<td>See the abstract, claims 1-6 and figures 1-5.</td>
<td></td>
</tr>
</tbody>
</table>

☐ 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
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of citation or other special reason (as specified)
"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

"P" 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

26 MARCH 2007 (26.03.2007)

Date of mailing of the international search report

27 MARCH 2007 (27.03.2007)

Name and mailing address of the ISA/KR

Korean Intellectual Property Office
920 Dunsan-dong, Seo-gu, Daejeon 302-701, Republic of Korea
Facsimile No. 82-42-472-7140

Authorized officer

LEE, Han Uk
Telephone No. 82-42-481-8309

Form PCT/ISA/210 (second sheet) (April 2005)
<table>
<thead>
<tr>
<th>Patent document cited in search report</th>
<th>Publication date</th>
<th>Patent family member(s)</th>
<th>Publication date</th>
</tr>
</thead>
<tbody>
<tr>
<td>KR 10-2006-0055923 A</td>
<td>24.05.2006</td>
<td>NONE</td>
<td></td>
</tr>
<tr>
<td>JP 08-027555 A</td>
<td>30.01.1996</td>
<td>NONE</td>
<td></td>
</tr>
<tr>
<td>KR 10-2006-0003447 A</td>
<td>11.01.2006</td>
<td>NONE</td>
<td></td>
</tr>
<tr>
<td>US 4535936 A</td>
<td>20.08.1985</td>
<td>AT32839E</td>
<td>15.03.1988</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DE32339393A1</td>
<td>15.03.1984</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EP0103288A2</td>
<td>21.03.1984</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EP103288B1</td>
<td>09.03.1988</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EP103288A3</td>
<td>10.07.1988</td>
</tr>
<tr>
<td></td>
<td></td>
<td>JP2000097984</td>
<td>10.01.1990</td>
</tr>
<tr>
<td></td>
<td></td>
<td>JP59076567</td>
<td>01.05.1984</td>
</tr>
<tr>
<td></td>
<td></td>
<td>US4535936A</td>
<td>20.08.1985</td>
</tr>
</tbody>
</table>