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[54] **METHOD FOR PREVENTING DESTRUCTION OF STRIP METAL IN ANNEALING FURNACE CONNECTED WITH DIRECT HEATING FURNACE**

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[56] **References Cited**

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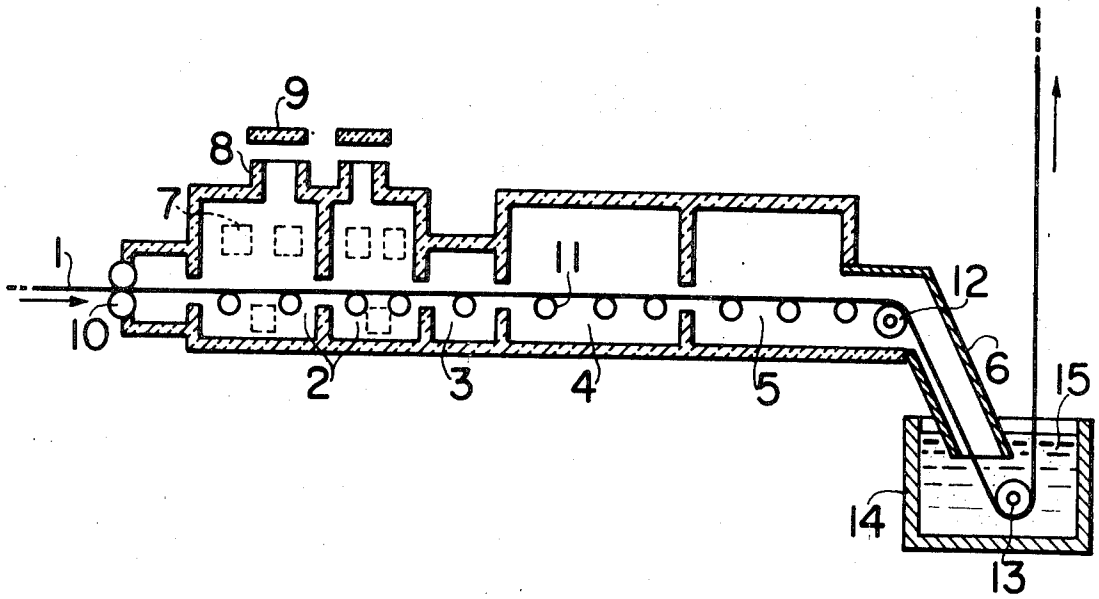
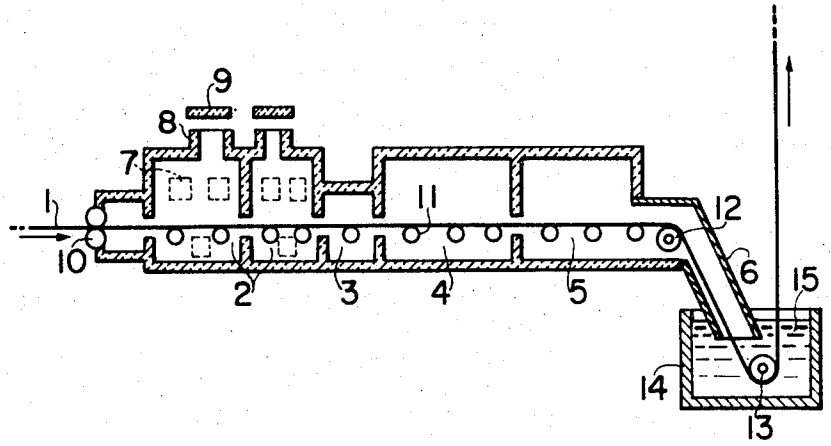
[57] **ABSTRACT**

Method for preventing destruction of a strip of metal moving in treatment line containing a continuous annealing furnace connected with a direct-heating furnace due to over-oxidation during longer than normal residence in the direct heating furnace, that is, before re-starting from an exigent stoppage of the line, which method is so carried out that at the same time with such stoppage, the opening for air outside of said direct heating furnace is closed, and combustion continues at limited operation rate of the burner, hardly reducing the temperature inside the furnace but maintaining the atmosphere inside the furnace non-oxidant.

6 Claims, 1 Drawing Figure





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METHOD FOR PREVENTING DESTRUCTION OF STRIP METAL IN ANNEALING FURNACE CONNECTED WITH DIRECT HEATING FURNACE

The present invention relates in general to a method for continuously annealing strip metal, and more particularly to a method for preventing destruction of a strip of metal moving in a treatment line containing a continuous annealing furnace connected with a direct heating furnace, for example, in a continuous hot dip zinc plating apparatus, due to over-oxidation during longer than normal residence in the line before restart from an exigent stoppage of the line.

Though the following describes specifically an embodiment of the present invention in continuous hot dip zinc plating, the application of the method of the present invention is not limited to this use, but to any such cases where the line for treating strip metal stops operating suddenly for some reason, so that there is a possibility of the strip being destructed.

Generally in case of continuous hot dip zinc plating, the temperature inside the direct heating furnace connected with the reduction furnace, which form the continuous annealing line, is heated by the burner to a temperature from about 1,000° to 1,200°C, in order to reach the annealing temperature of strip steel which is usually from 500° to 700°C. If the line stops operating in that case, and the burner continues working, the temperature inside the furnace will rise beyond 1,200°C, raising the temperature of the strip steel residing in the furnace nearly to the temperature of the furnace itself possibly causing melting and destruction of the strip metal.

Usually in such case, the operation of the burner is stopped, which method, however, is also destructive to the strip steel due to the oxidation and scaling of the strip steel due to air coming into the furnace and the drop of temperature and pressure inside the furnace when operation has been stopped for a long time before re-start, finally resulting in destruction of the strip steel. Particularly this is true of a thin strip of steel, for example, less than 0.4 mm thick.

In order to prevent such oxidation-destruction of strip steel, such methods are used as to withdraw the direct heating furnace which is heated to high temperature, from the operation line, or to blow into the furnace a non-oxidant gas, to purge the furnace gas and clean the atmosphere inside the furnace, while stopping supply of fuel gas and air for combustion at the same time with the stoppage of the strip pass, so as to prevent oxidation of the strip steel.

However, the former method requires a great construction cost, and the latter requires great quantities of fuel gas to warm up the furnace for restart, as the temperature inside the furnace has dropped, and also great quantities of cleaning gas; moreover, such process for restart is very complicated.

The inventors of the present invention noticed that strip steel is not destroyed even when its temperature is maintained as high as that in normal operation during its longer than normal residence, unless it is scaled by air coming in from outside; so they utilize this finding in improving the conventional methods, in such way that the combustion is continued to the extent of maintaining the temperature of the furnace, thereby preventing induction of air from outside due to pressure drop (negative pressure) which is caused by temperature drop.

Concretely speaking about the method of the present invention, even when the operation line stops, the burner of the direct heating furnace continues operating, but at such reduced rate sufficient merely for maintaining the temperature of the furnace, that is, without a drop of the temperature inside the furnace from that in normal operation, thereby preventing pressure drop inside the furnace, which is caused by temperature drop; and, at the same time, to prevent the temperature drop which is unavoidably caused by such reduced operation rate of the burner as mentioned above, the damper of the chimney and other openings are closed to maintain pressure positive at several mm H_2O, thereby preventing air coming in from outside and maintaining the atmosphere inside the furnace non-oxidant. Thus, it is possible to obtain the same effect as is obtainable by the known methods using raw gas blown into the furnace to raise the pressure therein, that is, the atmosphere inside the furnace is maintained non-oxidant without using raw gas. Therefore, by the method of the present invention, when the operation line stops, strip steel residing in the furnace is heated up to the same temperature as the furnace, but, as it is oxidized hardly at all, it is not destroyed when operation restarts even in several hours.

An object of the present invention is to provide a method for preventing destruction of strip metal due to over-oxidation during longer than normal residence in the continuous annealing furnace, that is, before restart from an exigent stoppage of the operation of the line for the treatment of strip metal.

Another object of the present invention is to provide a method for preventing destruction of strip metal in a continuous annealing furnace, in the case of an exigent stoppage or slowdown as dangerous as that, which furnace does not require additional equipment requiring large amounts of construction costs and which is easily handled in maintaining the temperature inside, and therefore, is very economical.

Other objects than mentioned above are self-evident from the following description and attached drawings. The FIGURE shows the skeltonized cross-section of a continuous hot dip zinc plating apparatus containing a continuous annealing furnace, as an embodiment of the present invention.

The following is a detailed description of an embodiment of the present invention in reference to the drawing.

In the shown continuous hot dip zinc plating apparatus, the strip steel **1** is introduced into the furnace to be annealed, through the seal rolls **10** which seal the atmospheric gas inside the furnace from outside. The strip steel **1** is heated to the prescribed temperature in the direct heating furnace **2** which has been preheated by the burner **7** mounted on the wall of the furnace, and, at the same time, it is cleaned of foul matters such as pressure oil on the surface of the strip steel. The direct heating furnace is equipped, at its upper part, with the chimney **8** and damper **9** which is capable of opening and closing. Then, the strip steel **1** is led into the reduction furnace **4** through the connection part **3**, as it is held by the hearth rolls **11** in the catenary state. In the reduction furnace which has been heated indirectly by a radiant tube, etc., the strip steel is completely annealed, and activated by the hydrogen-containing atmospheric gas inside the furnace which

has been introduced from the snout **6** or has been directly blown into the reduction furnace **4** or the cooling furnace **5**, so as to improve the plating capacity. And then, the strip steel **1** is cooled in the cooling furnace **5** to nearly the same temperature as the molten zinc bath **15**, and led into the molten zinc bath through the snout **6** which is sealed at one end in the molten zinc **15** in the molten zinc vessel **14**; after being plated, the strip steel is taken right up around the pot roll **13**. If operation stops due to an accident with the apparatus or by mishandling of the apparatus, the tension of the strip steel is slackened, and the chimney damper **9** is automatically closed, so as to shut out air from outside. In this case, if the seal roll parts can also be closed, the situation will become more effective. On the other hand, that is, with respect to combustion, the operation rate of the burner is reduced to one-fifth to one-tenth of that of normal operation, at which rate combustion is continued with the ratio between fuel and air balanced for perfect combustion.

Thus, the temperature inside the furnace can be maintained nearly the same as the in normal operation, even while the operation line stops, thereby preventing a pressure drop caused by temperature drop. Therefore, the pressure drop is limited to that caused by the reduced operation of the burner, making it possible to maintain it positive at several mm H_2O, say 1 to 2 mm H_2O.

Even though strip steel is kept in such conditions as long as 2 to 4 hours, and so its temperature rises to about 1,000°C close to that of the furnace in operation, the strip steel is protected from destruction, as the atmosphere inside the furnace is maintained non-oxidant.

When the operation line restarts, the strip steel is wound as the tension is slackened. While it is wound, the part of the strip steel having resided in the heating furnace, is checked; that is, as said part was subjected to a temperature of about 1,000°C for a long time, its structure is degraded, and this part must be cut away as off-specification product.

The following is a description of an embodiment of the present invention:

In the case of an exigent stoppage of the operation line for treating a strip of steel 0.27 mm thick and **917** mm wide in the direct heating furnace at the operation conditions of the furnace temperature of 1,100°C; the flow rate of COG as combustion gas of 900 m^3/H; the furnace pressure of 12 mm H_2O with the chimney damper open 80 percent for perfect combustion; and the velocity of strip steel of 120 m/min (therefore, the temperature of the strip steel at the outlet of the direct heating furnace is 650°C), the tension of the strip steel was reduced to nothing, and the flow rate of COG was also reduced to 100 m^3/H, so as to be perfectly burned, then, in 4 hours after the stoppage, the furnace temperature was 1,050°C, and the furnace pressure was 1.5 mm H_2O; no oxidation took place on the surface of the strip steel residing in the furnace for such a long time, therefore, there was no destruction of that part of the strip steel before restart of operation.

As mentioned in detail above, the method of the present invention is advantageous economically over the other processes, as no destruction of strip steel takes place during its longer than normal residence in the direct heating furnace; and nearly the same temperature as required for operation is maintained during stoppage, thereby saving time, fuel gas of great volume and an additional device for warming-up before restart from the stoppage, and raising operation efficiency. As for the method per se, it is carried out so simply that the damper of the direct heating furnace is closed and the operation of the burner is continued at reduced rate, requiring only simple systems for the piping of combustion gas and control of various adjusting valves.

What we claim is:

1. A method for preventing the breakage of steel strip which has stopped during treatment in which it is being passed through a continuous annealing furnace which is comprised of a direct heating furnace portion having a burner therein followed by a reduction furnace portion, the burner being operated during normal annealing at a normal burning rate for maintaining the temperature at a normal annealing temperature, said method comprising, at the time the strip is stopped, closing the portions of the annealing furnace open to the air while continuing the operation of the burner in the direct heating furnace portion at substantially complete combustion conditions and at a burning rate which is no more than one-fifth the normal burning rate and is such as to maintain the temperature of the furnace so that it does not drop below said normal annealing temperature, and maintaining the pressure inside the annealing furnace positive relative to atmospheric pressure and preventing air from coming into the annealing furnace from outside the annealing furnace to maintain the atmosphere inside the annealing furnace non-oxidizing so that the steel strip is prevented from breaking even though it must stay for a long time within the furnace at the annealing temperature or above due to the stoppage of the strip.

2. The method as claimed in claim **1**, wherein the rate of burning of said burner is reduced to one-fifth to one-tenth of the normal rate of burning.

3. The method as claimed in claim **1**, wherein the reduced burning rate of said burner is sufficient to make the pressure inside the furnace several mm H_2O positive.

4. The method as claimed in claim **1**, wherein said furnace has chimney means with damper means therein, and said step of closing of the portions of the annealing furnace open to the air comprises closing the damper means.

5. The method as claimed in claim **4** wherein said furnace further has seal rolls through which the strip enters the furnace, and said step of closing the portions of the annealing furnace open to the air further comprises closing said seal rolls.

6. The method as claimed in claim **1** which further comprises reducing the tension of the stopped strip within the furnace.

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