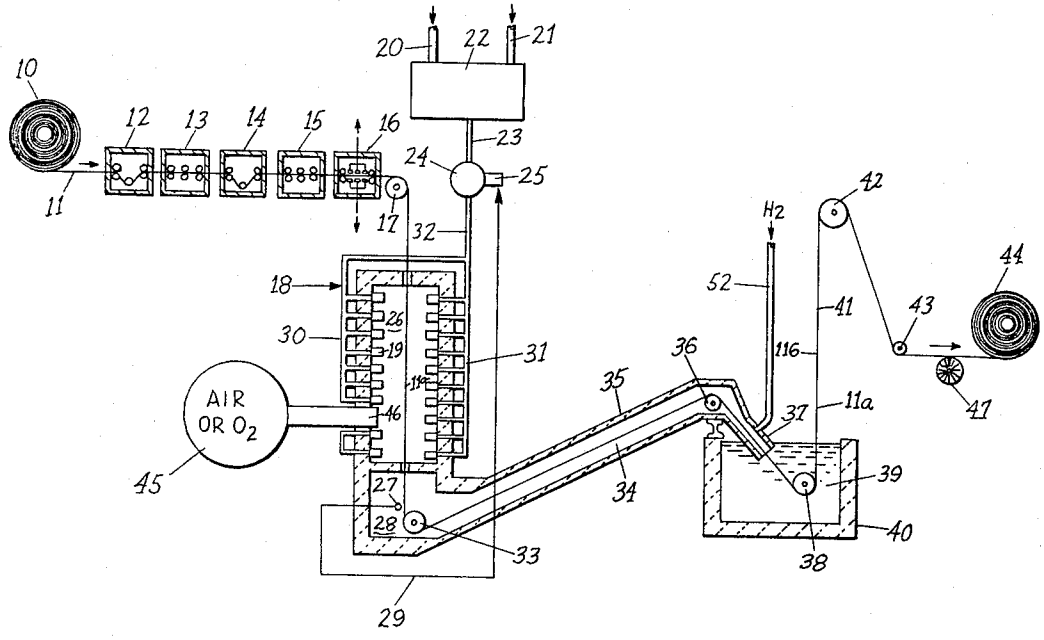
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METHOD FOR PRODUCING ONE SIDE METALLIC COATED STRIP

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METHOD FOR PRODUCING ONE SIDE METALLIC COATED STRIP

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ABSTRACT OF THE DISCLOSURE

A method of producing a strip of metal having a metal coating on only one side thereof. Both sides of the metal strip are first cleaned. The metal strip is brought to coating temperature and one side only of the metal strip is then oxidized. This metal strip is maintained in a protective atmosphere at coating temperature as it is then moved into the coating bath. The coating metal adheres to the clean side of the metal strip but not to the oxidized side.

This invention resides in a method for applying an adherent metal coating to steel strip on one side only. The invention may readily be incorporated as a modification of conventional continuous coating processes. It may also be accomplished in conjunction with a vertical open flame strip heating furnace as will be further described below. Coating of the strip will normally be accomplished by dipping it in a molten metal coating bath. The invention embraces the use of zinc, aluminum or lead, or any hot dip coating metal.

In recent years there has been a growing demand for steel strip which has been galvanized on one side only. Such a product is quite useful because the uncoated side can be welded by spot welding techniques more easily, and has better painting characteristics than untreated galvanized surfaces. Methods which have been tried by others for the production of single side coatings have used the application of stop-off materials to one side of the strip to prevent wetting by the coating metal. And some methods have attempted simply to use the inking roll process, rather than dipping, to apply the coating to one side only.

The best prior art known to the inventors includes three patents and a knowledge of certain undesirable results which have occurred during other processes by which it was intended that steel would be coated. The Greene et al. Patent No. 2,894,850 shows the coating of one side of a steel sheet or strip with an alkali metal aluminate solution. The Siebert et al. Patent No. 3,104,993 teaches providing on only one side of a ferrous metal sheet a thin, continuous coating of a refractory metal oxide composition prepared in the form of an aqueous colloidal solution or suspension having an oxy-mineral acid dissolved therein. The Blay Patent No. 3,121,019 discloses coating one side of the strip that is to be dipped in molten zinc with a solution of one of the alkaline earth hydroxides which includes calcium, magnesium, strontium and barium.

And, as has been indicated above, there has been a phenomenon which has occurred during prior coating operations and which has heretofore resulted in poor coatings. It has been observed for some time that when oxygen has accidentally found its way into the coating system, as might occur when leaks develop in the furnace snout, or when furnace combustion tubes perforate or crack, oxide patches have formed on the strip to which the coating material did not adhere, in this manner producing an undesirable product.

It is, therefore, an important object of this invention to

provide a method for coating steel strip on one side only by providing on the opposite side a continuous oxide layer throughout, prior to the time the strip is passed through the hot dip coating metal.

Another important object of the invention is to provide a method for coating one side only for a steel strip, which means and method may be readily incorporated in steel coating lines.

Briefly stated, one method of practicing the invention is to mask that side of the steel strip which is not to be coated by oxidizing that side of the very edge without oxidizing the other side, which other side is to be coated by the hot dip coating metal.

One way in which the benefits of this invention may be achieved is in conjunction with a vertical open flame strip heating furnace such as that shown in the Klein et al. Patent No. 3,010,844 in which high intensity radiant heat is produced by open, cup-shaped burners of the Selas type. The gas and air fed to these burners are precisely regulated and completely pre-mixed so that the products of combustion contain excess combustibles to the extent that the atmosphere is chemically reducing to steel strip at normal processing temperatures. In the present invention jets of air or oxygen are directed against one side of the heated strip near the bottom of the combustion zone. Oxygen contacting the hot strip oxidizes the strip surface on that side but any excess oxygen is engulfed in the relatively large volumes of reducing combustion gases of the furnace and is rendered reducing by combustion before it can contact and oxidize the opposite side of the strip. In the Klein et al. process, the strip is precleaned chemically so that the function of the open flame radiant heater primarily to rapidly heat the strip to coating temperature, or slightly above (in the neighborhood of about 1000° F.) in a protective atmosphere. This relatively low strip temperature is adequate because furnace treatment is not normally required for strip surface preparation and metallurgical treatment for strip mechanical properties is accomplished as a separate prior operation.

Following passage of the strip through the open flame heater, the strip travels through a closed connecting transfer chamber to the coating bath with the end of the chamber sealed in the molten coating metal. The chamber maintains proper strip temperature for coating and the chemically cleaned strip surface is protected with a low hydrogen content protective atmosphere. After leaving the strip heater the strip with one side oxidized and one side clean is not exposed to potent reducing conditions by virtue of the low hydrogen content atmosphere of the transfer chamber and the low strip temperature. This condition is essential in the present invention. If the strip were exposed to potent reducing conditions (high hydrogen and high strip temperature) the oxidized surface would be reduced at least enough for a quasi-adherent coating to be applied to the oxidized surface which would be impractical to remove. With the oxidized surface reaching the bath essentially unreduced the coating metal will not adhere at all, or only superficially adhere. Any coating metal that superficially adheres may be easily removed by wire brushing or the like, there is no true bonding of the coating to the steel strip on that side which has been processed as described.

These objects and statements regarding this invention will be amplified with reference to the accompanying drawing and the description to follow, which drawing consists of the single figure depicted:

The figure is a schematic illustration of the technique for oxidizing one side of strip in conjunction with a continuous galvanizing line such as shown in the Klein et al. Patent No. 3,010,844.

Referring now to the figure there is diagrammatically illustrated a continuous galvanizing line to which this invention has been applied. A coil **10** of strip steel material to be coated is located at the input of the line. The strip **11** may then pass from the coil **10** through a series of compartments **12**, **13**, **14**, **15** and **16** in which the strip may successively be exposed to an alkali, a rinse, an acid, a rinse, and a drying means respectively. From the drying means **16** the strip **11** passes over a deflector roll **17** and then passes vertically downwardly through a furnace generally designated at **18**. This furnace **18** is a vertical open flame strip heating furnace in which high intensity radiant heat is produced by open, cupshaped burners of the Selas type as generally indicated at **19**.

Streams of air and combustible gas, from sources not shown, are conducted through conduits **20** and **21** to a gas-air ratio regulator **22**, and the output from the regulator **22** is conducted through a conduit **23** to the inlet of the valve **24**. The valve **24** is provided with an operating mechanism **25** which may be adjusted to establish a desired temperature in the chamber **26** of the furnace **18** and which functions responsively to the temperature of the strip material passing from the heating chamber of the furnace. For this latter purpose a radiation pyrometer or proximity thermocouple type of temperature sensing means **27** is located in the chamber **28** adjacent the path of the strip material coming from the furnace **18** and is connected to the valve operating mechanism **25** through a conductor **29**. The burners **19** receive the carefully regulated mixture of gas and air from manifolds **30** and **31** through the valve **24** and feed conduit **32**. The regulator **22** is adjusted to feed to the conduit **23** a composite stream of air and combustible gas of the proper ratio so that the gaseous products of combustion of the heating units or burners **19** are nonoxidizing to the strip.

The strip **11** passes through the heating chamber **26** and chamber **28** whereupon it passes around a deflector roll **33** and into the chamber **34** of the closed connecting transfer member **35**. A roll **36** is located in the upper end of the transfer member **35** for directing the strip **11** downwardly through the snout or delivery chute **37** into the bath of molten metal and around a sinker roll **38**. The end of the chute **37** extends into the bath of molten metal **39** contained within the pot **40**. The strip **11** then passes upwardly through a cooling section diagrammatically illustrated at **41**, around a deflector roll **42**, downwardly and around a roll **43**, and then formed into a coil **44** at the exit end of the line. The cooling section **41** may comprise a conventional cooling tower not shown, and coiling devices may be located at the exit end of the line upon which the coil is formed.

The furnace **18** permits extremely close and accurate control of the fuel-air ratio so that one may get from it either a reducing potential or an oxidizing potential relative to steel strip. The burning of natural gas (CH_4) and oxygen, for example, results in heat plus combustion products, which products are carbon monoxide (CO), plus carbon dioxide (CO_2), plus water (H_2O), plus hydrogen (H_2), and perhaps some excess CH_4. If enough oxygen is utilized, then more CO_2 and H_2O and excess O_2 result, thus producing an oxidizing atmosphere. If less oxygen is used, then more CO and H_2 result thus producing a reducing atmosphere. In the arrangement of this invention the furnace **18** and burners **19** within the chamber **26** are controlled to produce products of combustion containing excess combustibles which are reducing to steel strip.

The apparatus heretofore described with specific reference to the figure is conventional. The crux of the invention with respect to this arrangement lies in the position of means generally indicated at **45** for providing jets of air or oxygen directed against one side of the heated strip near the bottom of the combustion zone **26**. The delivery end **46** of the means **45** may take the place of one or more of the cupshaped burner units **19**. The air, oxygen or

oxidizing flame delivered from the member **46** can be directed more or less on the center portion of the strip **11** with complete coverage of the strip obtained by washing action of the deflected oxidizing gases.

The oxygen which contacts the hot strip via the member **46** near the exit end of the chamber **26** oxidizes the strip surface on the side contacted but such oxygen is engulfed in the relatively large volumes of reducing combustion gases emanating from the burners **19** with the result that the resulting atmosphere is rendered reducing by combustion before the injected oxygen can contact and oxidize the opposite side of the strip **11**.

The furnace **18** may be operated to produce relatively low strip temperatures, that is, in the neighborhood of 800° F. to 1000° F. And, although normal operation of the furnace **18** might tend to prevent the formation of oxides, in this invention the formation of an oxide layer on the side **11***a* of the strip **11** is positively insured by specifically directing an oxidizing gas from the source **45** and conduit **46** against such side **11***a*. The low hydrogen protective gas supplied at **52** is insufficient to reduce the oxide on side **11***a*.

After the strip **11** has had its one side **11***a* oxidized to the edges as just described, the strip passes through the closed connecting transfer chamber **35** and through the delivery chute or snout **37** into the molten coating metal **39** contained in the pot **40**. Although this coating metal will generally be zinc, it may also be aluminum, lead or other suitable coating materials. This coating metal will bond to the clean side of the strip **11** but it will not bond to the side **11***a* which has been oxidized as described. It is possible, however, to the extent that the oxide layer may have become very slightly reduced between the time it left the furnace **18** and entered the bath **39**, that there may be some superficial adherence of the coating metal to such slightly reduced oxide layer; this, however, is not a true bonding of the coating metal to the oxidized side **11***a*. Any such adherence of the coating metal to the oxidized layer may easily be removed by a simple rotary brush or the like such as is shown at **47**.

It has earlier been mentioned that difficulties formerly occured during operations wherein it was desired to effect a bonding between clean steel strip and the coating metal when portions of the clean strip became accidentally oxidized. It was observed that these accidentally oxidized portions would prohibit correct bonding of the coating metal to the strip. This at that time produced an inferior strip. Broadly considered, therefore, a feature of this invention resides in the conversion of these prior, accidental and objectionable occurrences into a controlled process producing desirable, improved results.

After the strip **11** emerges from the coating pot **40**, with the coating metal bonded to the side **11***b* of the strip **11**, but not to the side **11***a*, it may or may not be necessary to remove the oxide layer from the side **11***a*. Ordinarily it is desirable to remove such oxide layer and this may easily be accomplished by conventional (chemical and mechanical) practices.

The invention resides in having the oxide layer on side **11***a* extend from edge to edge without any oxidizing of the opposite side, said oxide layer to be intact as the strip enters the coating pot. Direct impingement of air or oxygen from the arrangement **45**, **46** on the very edges of the strip **11** is not required. It is sufficient that the oxidizing media be directed more or less on the center portion of the strip with complete coverage of the strip being obtained by the washing action of the deflected oxidizing gases. This removes the possible hazard of oxidizing the edges on the opposite side of the strip, that is, the side which is to be coated. The trick is to keep an excess of reducing gases washing over the opposite side so that it will immediately combine with any oxygen which might overflow from the side **11***a* so that said oxide layer is restricted to the side **11***a*.

It should be understood that in the broad application

of the principles of this invention it does not matter how the strip to be oxidized on the one side is prepared for coating. Thus, for example, gases may sometimes be employed to oxidize and/or vaporize surface contaminants and to reduce the strip in order to prepare it for bonding, while at other times chemical preparations may be employed for this purpose. It is important only that the strip be properly cleaned and then, more or less at the last moment, one side thereof be oxidized without oxidizing any of the other side.

With respect to the oxide layer provided at **11***a* by the means and methods of this invention, it is pointed out that only a light oxide is required, one which may be described as blue to straw color.

It is believed that the foregoing constitutes a complete description of this invention. It will be understood that modifications of this invention may be made by those skilled in the art without departing from the scope and spirit of the invention. Also, while the invention has been described in terms of particular methods and means, the invention is not to be restricted specifically to such methods and means except in so far as they are specifically set forth in the claims to follow.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A method of producing a steel strip having single side coating which includes the steps of preparing one side of said strip to receive said coating, applying a large volume of reducing gases to said one side of said strip while simultaneously applying relatively small amounts of oxidizing gases to the other side of said strip while said strip is at a reactive temperature for oxidation whereby to form an oxide layer thereon without forming any oxide on said one side, bringing said strip to coating temperature and transferring said strip to a bath of molten metal under such conditions as to maintain said oxide layer, and dipping said strip in said bath of molten metal whereby to form a coating thereof on said one side only.

2. A method of producing a coated steel strip having one side to which another metal adheres well when the strip is passed into a coating pot containing such metal in molten condition, and an opposite side to which said metal does not adhere, which method comprises:

(a) preparing the strip so that a metal coating will adhere thereto;

(b) applying an oxidizing gas to one side of the strip while said strip is at a reactive temperature for oxidation so as to form an oxide thereon and simultaneously providing sufficient reducing gas on the opposite side of said strip to prevent any oxidizing of said opposite side of said strip even after any excess of said oxidizing gas combines with the said reducing gas whereby to produce an intermediate product comprising steel strip having an oxide on said one side and a reduced surface on said opposite side; and

(c) bringing said strip to coating temperature and passing said intermediate product (the oxidized-reduced steel strip) into a coating pot containing molten metal before any substantial alterations in the characteristics of said intermediate product occur, whereby the molten metal adheres to the reduced opposite side and not to the oxidized one side, thus achieving a single side coating of said steel strip.

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