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METAL COATING PROCESS AND APPARATUS

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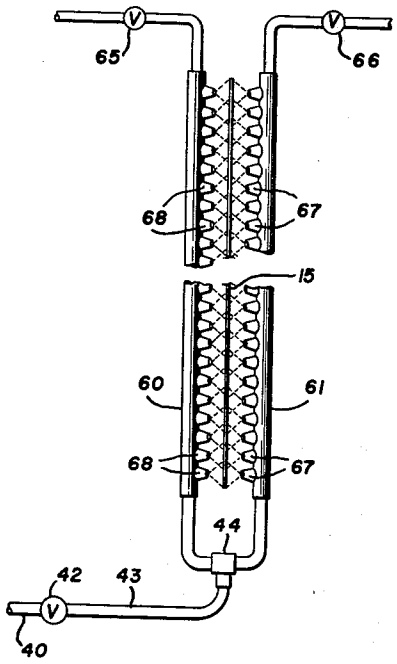


FIG. 2

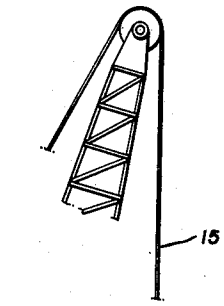
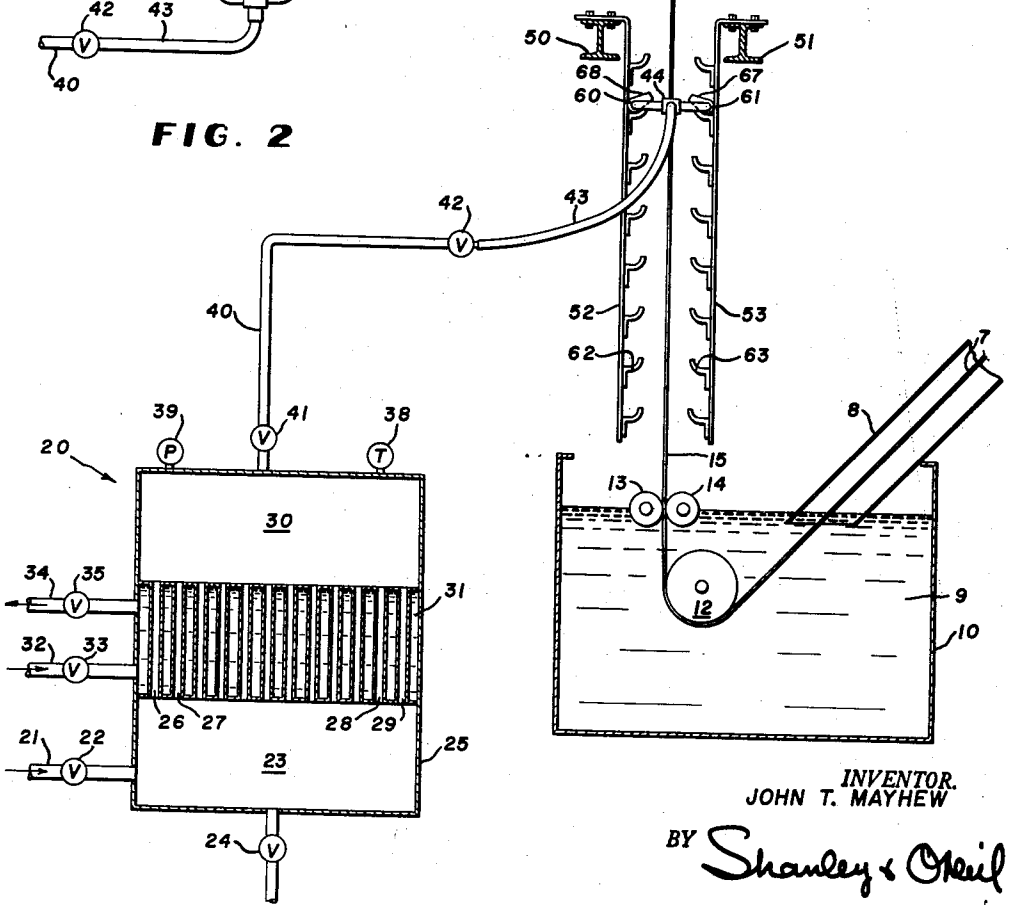


FIG. 1



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METAL COATING PROCESS AND APPARATUS

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This invention relates generally to improvements in the galvanizing of metal products and, more particularly to novel methods and apparatus for treating galvanized coatings.

Galvanized coatings are widely used for protective coating of metal products especially in the steel industry. In the galvanizing of steel products, the tightness of the coat, the adherence of the coat during subsequent working operations, and the finish of the coating surface itself are important factors to be considered. The invention departs from the prior art in improving all these factors in a single operation. (See "Making, Shaping, and Treating of Steel," 6th Edition, Section XIII, "Special Finishing Operations," pages 958–9.)

In general, galvanized coatings have a large crystalline structure which is commonly described as "frost flower" or "spangled." There are many applications for galvanized products where this spangled surface is objectionable. It is especially objectionable when some additional decorative coating, such as paint or plastic, is to be added to galvanized products. Paint, for example, will not spread readily but rather will form into droplets on the bright crystals. Even when the decorative coating can be spread, the surface is not smooth because of the unevenness of large spangles.

One practice in the art to acquire a smooth galvanized coating involves temper rolling with grit rolls. A smooth or satin finish is produced by such rolling to which paint will adhere. However, the finish has been found to be temporary in nature and, with exposure to weather, the normal spangles return. Another special treatment to acquire a smooth coat is "bonderizing," a process well known in the art.

The general purpose of the invention is to provide a permanent, smooth-surface, galvanized product, without the necessity of rolling or special treatment having improved adherence properties.

It is an object of the invention to provide methods and apparatus for improving the tightness of the galvanized coating.

It is another object of the invention to provide methods and apparatus for improving the adherence of the galvanized coating.

It is an additional object of the invention to provide methods and apparatus for producing a smooth-finish galvanized coating.

It is a further object of the invention to provide methods and apparatus for producing a minimized-spangle galvanized coating.

The invention will be described in connection with continuous galvanizing operations. However, it is understood that the invention is not to be limited to such operations. In its broader aspects the invention includes a metal coating process comprising the steps of hot dipping a product in a molten galvanizing bath and cooling the coated product sufficiently to solidify the coating during a short time

interval by contacting the coated product after emergence from the molten bath while the coating is substantially entirely molten with wet steam.

In continuous hot dip galvanizing a strip material is commonly cleaned, rinsed and dried, annealed, cooled to slightly above galvanizing pot temperature, and introduced into the molten bath through a chute containing a special atmosphere to prevent oxidation of the base metal. The strip travels through the molten metal bath and exits through coating rolls with a molten coating adhering to the base metal. The novel features of the invention which result in an improved coating come into play during a short interval after the strip has passed through the molten galvanizing bath.

The molten galvanizing bath temperature may vary from approximately 800° F. to 875° F. dependent on the galvanizing alloy, the gauge of the strip material being coated, and other factors well known in the art. Ordinarily this temperature is about 850° F. The coated strip is approximately at bath temperature as it exits through the coating rolls. Conveniently, forced air blasts are directed against the strip as it travels upwardly through the cooling tower to, among other things, assist in solidifying the coating before it reaches the roll at the top of the cooling tower. The temperature of the coated strip when it reaches the top of the cooling tower is normally around 600° F. The distance between the galvanizing bath and the top of the cooling tower is generally in excess of 50 feet.

By the novel method of the invention the forced air drafts may be eliminated. The coated strip is treated within a short distance, approximately 8 to 12 feet, after emergence from the galvanizing bath. The coated strip is cooled rapidly through a change in temperature of approximately 75 to 100° F. The temperature change occurs within a short time interval during which the coating is solidified. A smooth surface, minimized spangle, galvanized strip is immediately apparent after treatment.

The treating agent is wet steam, no additives or chemical agents are necessary. Wet steam is blown onto the coated strip after emergence from the bath while the coating is still substantially molten. As termed in the art, the coating is "wet." However the coating must not only be "wet" but the pattern for crystallization must not have started to form within the coating. A relatively rapid cooling of the strip takes place when contacted by the wet steam. If the temperature of the strip, prior to cooling, has been properly selected, the coating will immediately go dull. If the temperature is low, even though the coating still appears "wet," the wet steam will hasten the freezing of the coating but the normal, bright, large spangles will form.

The timing and temperatures involved are critical. Slight variations in the optimum values of these factors will cause the product to go bright rather than dull. Normally, one would expect that the optimum temperature of the strip for treatment would vary with the gauge of the strip, but it has been found that the optimum temperature for treatment is the same for practically all commercial gauges of strip. This holds true even though the temperature of the bath and the coated strip may vary with the gauge; the optimum treatment temperature of

the product remains constant. Measurements during production verify this as brought out in the following table:

Strip Width (inches)	Coating Thickness (inches)	Bath Temperature, ° F.	Speed of the Line, ft./min.	Steam Contact, Distance above Bath, inches	Steam Temperature, ° F.	Steam Pressure (gauge), lbs.	Temperature of Strip Measured by Radiation Pyrometer	
							Before Steam Contact, ° F.	After Steam Contact, ° F.
41½	.0217 (26 gage)	860	130	116	275	35	625 to 650	550 to 575
44⅜	.032	840	100	134	305	85	625 to 650	550 to 575
40 1/16	.062	850	60	146	310	80	625 to 650	550 to 575

The wet steam blown onto the product freezes the coating immediately on the lighter gauges and within a short interval on the heavy gauges, for example, on the 26 gage strip the coating is solidified within 3 inches of strip travel or about .1 second. The rapid freezing of the coating prevents the sensible heat of the base metal from causing additional alloying between the coating and the base metal. The reduction in alloying results in excellent adherence properties and in turn improved forming and bending qualities with the practical elimination of flaking. Also the sudden chilling of the galvanized coating (especially the zinc portion of the galvanizing alloy) increases the hardness of the coating so that the product can be skin rolled without pickup of coating by the rolls.

The invention also includes a novel combination of hot dip galvanizing structure, condenser type heat exchange means for delivering wet steam to the area of the galvanizing structure, and means for spraying the wet steam onto the coated product while the coating is still substantially molten. A specific embodiment of the novel combination will be described in relation to the accompanying drawings in which:

FIGURE 1 is a schematic diagram of a specific embodiment of the invention; and

FIGURE 2 is a top plan view of a portion of FIGURE 1.

In FIGURE 1 an uncoated strip 7 passes through a controlled atmosphere chute 8 into the molten bath 9 within the galvanizing pot 10. The strip 7 passes through the molten bath 9 around the sinker roll 12 and exits from the molten bath through the coating rolls 13 and 14 as coated strip 15. The coating on the strip 15 is molten as it leaves the bath and remains molten for a considerable distance during its upward travel.

A condenser means, designated generally at 20, is provided for delivering wet steam at the desired temperature, pressure and "wetness" to the area of the galvanizing operation. Steam is supplied to the condenser through a steam input line 21 with a valve 22 controlling the flow of steam into the inlet steam chamber 23, valve 24 is provided for removal of excess condensation, if any. The condenser shown is of the surface type, that is the cooling agent remains separated from the steam during the heat exchange. Above chamber 23 is a series of steam tubes 26–29, etc. which communicate with the steam chamber 23 at the lower end of the condenser casing 25, and communicate with an outlet steam chamber 30 at the upper end of the casing 25. Surrounding the steam tubes 26–29, etc. is a water chest 31 in heat exchange communication with the steam tubes. Water is supplied to chest 31 through injection line 32 under control of valve 33. Discharge is through line 34 through control valve 35. In actual practice, whether a water tube condenser or a steam tube condenser is used makes no difference. In effect, the coolant flow control means controls the temperature, pressure, and "wetness" or "moisture" of the steam.

The temperature and pressure of the steam in chamber 30 are measured by gauges 38 and 39 respectively. The wet steam output conduit 40 has a pressure control valve 41 and a cutoff valve 42 located in the conduit between the condenser means 20 and the galvanizing structure.

In the area above the exit side of the molten bath, beams 50 and 51 support braces 52 and 53 on opposite sides of the coated strip 15. Braces 52 and 53 have steam pipe supporting brackets designated generally at 62 and 63. The steam pipes are connected to the condenser 20 by the wet steam conduit 40 and the flexible conduit 43. The coupler 44 distributes the steam to either or both of the steam pipes 60 and 61 dependent on whether either or both surfaces of the strip are to be treated. Each of the steam pipes has a drain valve at 65 and 66.

In the embodiment shown the supporting brackets 62 and 63 permit the level of the steam pipes 60 and 61 above the coating bath to be adjusted. In this way the optimum treatment temperature for the product can be selected by adjusting the level of the steam pipes above the coating bath (see tabulation supra). It is obvious that other adjustment means for the steam pipe level could be used without departing from the spirit of the invention.

Referring to FIGURE 2, the wet steam is discharged from numerous V jets such as 67 and 68 with a generally conical configuration. The boundaries of the steam contacting the strip overlap slightly to insure complete coverage of the surface being treated. Of import, is the angle of the V jets in relation to the strip. The V jets should be inclined at an angle above the horizontal to prevent steam from descending along the strip, and cooling the strip before contact with the main body of the jetted steam. The angle above the horizontal should not be increased to such a degree that ambient air is drawn into the area between the steam pipes and the strip; the ambient air tends to cool the strip before contact with the main body of the jetted steam. Also the ambient air tends to present an insulating layer of air along the strip which inhibits the desired impingement of the wet steam on the coating.

The wet steam contacts the coating while the coating is still substantially entirely molten, that is before spangles have started to form. It is believed that in contacting the molten coating the moisture particles in wet steam form nuclei for the crystallization of the galvanized coating. With proper contact the coating will go dull immediately with a crystal structure which can be described as spangle-free or minimized spangle. The finish is smooth and matte. The normal spangle boundaries are eliminated and better die performance and roll forming qualities result. Paint will adhere without bonderizing. If bonderizing is performed, the "dust" encountered in bonderizing normal spangled products is eliminated.

Obviously modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood, that within the scope of the appended claims, the invention may be practiced otherwise than as specifically described.

What is claimed is:

1. Process for producing minimized-spangle galvanized strip comprising the steps of moving a continuous steel strip through a molten galvanizing bath in which strip temperature approaches galvanizing bath temperature, delivering galvanized strip from the molten galvanizing bath at about bath temperature, controlling the mois-

ture content of a steam supply to provide wet steam, moving the galvanized strip beyond the galvanizing bath to permit a gradual cooling of the strip below galvanizing bath temperature and near the crystallization temperature of the galvanize coating, and then impinging wet steam on the strip before a crystallization pattern has started to appear to suddenly freeze the coating producing a minimized-spangle finish.

2. Continuous process for producing minimized-spangle galvanized strip comprising the steps of moving continuous steel strip through a molten galvanizing bath in which strip temperature approaches galvanizing bath temperature, delivering coated strip at about galvanizing bath temperature from the bath, moving the strip beyond the galvanizing bath to cool the strip below galvanizing bath temperature, controlling the moisture content of a steam supply to provide wet steam and moving a stream of the wet steam so as to have a component of motion in the direction of movement of the strip, and directing the moving wet steam onto the galvanized strip to rapidly freeze the galvanize coating before a crystallization pattern has started to appear.

3. Continuous strip galvanizing apparatus for producing minimized-spangle galvanized strip comprising continuous galvanizing means including a coating zone for providing a molten galvanize coating on the strip, means for passing strip to be coated into and through the coating zone and delivering strip from the coating zone with a molten galvanize coating; steam supply means; steam control means connected to the steam supply means to provide wet steam; means for blowing the wet steam onto the molten galvanize coating; and adjustable support means for positioning the means for blowing wet steam onto the molten galvanize coating in a desired relation to the galvanized strip and to the coating zone.

4. Apparatus for improving the galvanized coating of metal products comprising in combination hot-dip galvanizing means for applying a molten coating to a metallic product including a molten metal bath; spray means for blowing wet steam of predetermined temperature and pressure onto the molten coating after emergence from the molten bath; and steam temperature and pressure control means, including a confined steam flow path and a coolant path in heat exchange relationship with the steam flow path, for delivering wet steam to the spraying means.

5. In combination with continuous strip hot-dip galvanizing equipment including a hot-dip galvanizing bath, apparatus for improving the galvanized coating including a steam supply, steam temperature and pressure control means including condenser means for delivering wet steam, spray means for blowing the wet steam onto the galvanized surface after emergence from the hot-dip galvanizing bath while the coating is still substantially entirely molten and means for positioning the spray means to direct the wet steam so as to impinge on the strip at an angle beyond the normal to the strip in the direction of strip movement.

6. Apparatus for producing minimized-spangle galvanized products comprising hot-dip galvanizing structure including a molten bath and means for delivering a product from the bath with a molten coating thereon; spray means for blowing wet steam onto the coated surface while the coating is still substantially molten; and steam temture control means connected to the spray means for delivery of wet steam including condenser structure having a closed steam flow path, a coolant flow path in heat exchange relationship with the steam flow path, and coolant flow control means.

7. Apparatus for producing smooth-finish, minimized-spangle galvanized steel products comprising hot-dip galvanizing apparatus including a molten metal bath and means for delivering the product from the bath with a molten coating thereon, spraying apparatus adjacent to the means for delivering the product for blowing wet steam onto the product while the coating is substantially entirely molten, and steam temperature control means including condenser means for delivering wet steam to the spraying apparatus, and adjustment means for the spraying apparatus to control the time between delivery of the product from the bath and the blowing of wet steam on the product.

8. Continuous strip galvanizing apparatus for producing minimized-spangle galvanized strip comprising continuous galvanizing means including a hot-dip galvanizing bath, means for passing strip to be coated into and through the galvanizing bath and delivering coated strip from the bath through exit control means; a steam supply means; steam control means, connected to the steam supply means, including a condenser means for controlling the temperature and pressure of steam from the steam supply means so as to deliver wet steam; conduit means, for the wet steam, connected to the condenser means; sprayer means for blowing wet steam delivered from the condenser means onto the galvanized strip after it emerges from the galvanizing bath while the coating is still substantially molten; support means for the spraying means to support the spraying means in close proximity to the galvanized strip as it is delivered from the galvanizing bath, the support means including means for adjusting the level of the spraying means above the exit control means.

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