

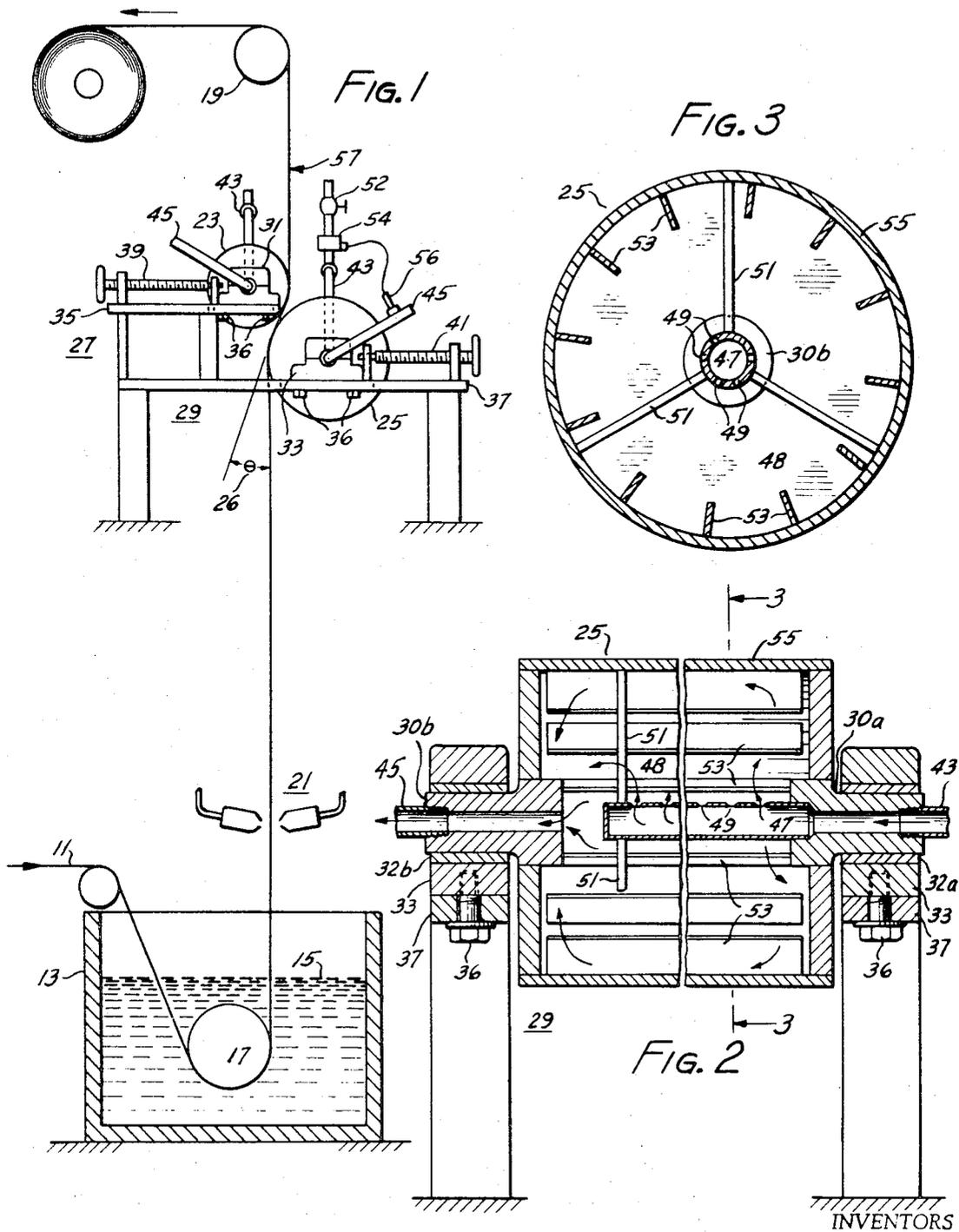
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L. B. CALDWELL ET AL

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METHOD OF FORMING MINIMIZED SPANGLE COATED STRIP

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INVENTORS

Laurence B. Caldwell
Robert W. Helman

BY

Joseph J. O'Keefe

ATTORNEY

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3,717,501

**METHOD OF FORMING MINIMIZED SPANGLE
COATED STRIP**

Laurence B. Caldwell and Robert W. Helman, Bethlehem, Pa., assignors to Bethlehem Steel Corporation
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5 Claims

ABSTRACT OF THE DISCLOSURE

Molten zinc coated material is wrap contacted with unequal sized internally cooled chromium plated rolls prior to solidification to inhibit the formation of undesirable spangling of the zinc coated surface.

CROSS REFERENCES TO RELATED APPLICATIONS

This application is a division of U.S. application Ser. No. 857,515 filed Sept. 12, 1969, now Pat. No. 3,608,520, by the present inventors.

BACKGROUND OF THE INVENTION

This invention relates to molten metal coating and particularly to the attainment of a minimized spangle surface on a molten metal type galvanized coating.

The spangling of molten zinc coated sheet and strip can be inhibited to form so-called minimized spangle material by contacting the molten zinc surface just prior to solidification after it leaves a molten coating bath with internally cooled rolls as shown in U.S. Pat. 1,933,401 to Ward. The cooled rolls accelerate the solidification of the molten coating and smooth the surface of the coating inhibiting the formation of spangles and providing a final coating having a very uniform thickness without the relief and inequalities usually apparent between the various spangles of the coating.

While the process disclosed by Ward is attractive in theory it has not proved reliable enough in actual practice to be widely used due to non-uniformity of the final coated surface, particularly at accelerated coating line speeds. Alternative methods of making minimized spangle material such as contacting the molten zinc surface just prior to solidification with various crystallization nucleating substances such as water sprays with or without included salts to enhance nucleation or with dry or preferably wet steam have, therefore, been widely adopted. Such expedients are in themselves objectionable for various reasons including excessive corrosion of the line apparatus resulting from the corrosive atmospheric conditions induced in the vicinity of the application of such nucleating substances.

SUMMARY OF THE INVENTION

The present inventors have discovered that the disadvantages of the cooled roll process of U.S. Pat. 1,933,401 to Ward can be overcome by providing a pair of unequal sized cooled rolls about which the strip is partially wrapped and the provision preferably of a chromium or other corrosion resistant surface on the rolls, internal baffles within the rolls to accelerate heat transfer and impart stiffness and a roll surface temperature of between 130 and 200 and preferably between 140 and 160 degrees Fahrenheit.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an elevation of a molten metal coating apparatus according to the present invention.

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FIG. 2 is a longitudinal cross section of a cooling roll illustrating the internal baffle cooling arrangement.

FIG. 3 is a transverse cross section of the cooling roll of FIG. 2 along line 3—3 of FIG. 2.

DESCRIPTION OF THE PREFERRED EMBODIMENT

In FIG. 1 a strip 11 is shown passing through a molten metal coating pot 13 filled with a bath 15 of molten zinc. The strip 11 passes downwardly into the molten bath 15 of zinc, passes around sinker roll 17 and then upwardly from the surface of the bath to a guide roll 19 and thence out of the apparatus. As the strip 11 leaves the bath 15 it accumulates a heavy coating of molten zinc picked up in the bath. Within a short distance above the bath both sides of the strip are contacted with planar jets of high pressure steam or other gas from gas or jet wipers 21 positioned on both sides of the strip. The jet wipers 21 wipe excess coating from the surface of the strip and determine the thickness of the final coating. As is well understood in the art, if differential coating thicknesses are desired on the two sides of the strip the jet wipers will be adjusted to wipe more molten coating from one side of the strip than the other.

After passing between jet wipers 21 the strip passes between two unequal sized rolls 23 and 25 of the minimized spangle apparatus 27 mounted approximately 20 feet above the surface of bath 15. Small roll 23 and large roll 25 are adjustably positioned for lateral movement upon a supporting structure 29. The rolls 23 and 25 are journaled in bearing supports 31 and 33 respectively which are slidably engaged with slotted tracks 35 and 37 respectively by large machine screws 36. The position of the rolls 23 and 25 with respect to mounting surfaces 35 and 37 and strip 11 is determined by respective adjusting screws 39 and 41. Cooling water of such temperature as will maintain the roll surfaces at a temperature of substantially 130 to 200 degrees Fahrenheit and preferably 140 and 160 degrees Fahrenheit is passed into the rolls through water access pipes 43 and out through discharge pipes 45.

FIG. 2 shows the internal structure of the larger roll 25. It will be understood that the internal structure of roll 23 is similar or identical. In roll 25 the cooling water passes from water access pipe 43 into the hollow journal 30a of the roll 25 which journal 30a is rotatably supported in bearing 32a on bearing support 33. The cooling water passes from hollow journal 30a into internal water supply pipe 47 positioned along the axis of roll 25 and then passes out water exit orifices 49 spaced at appropriate intervals along supply pipe 47 into the internal cooling cavity 48 of the roll 25. Orifices 49 in supply pipe 47 distribute the cooling water uniformly along the length of the roll. Pipe 47 is appropriately supported in a central position by water pipe supports 51. A series of baffle plates 53 are secured in any suitable manner against the inside surface of the thin outer wall 55 of the roll 25 to strengthen the wall 55, provide increased cooling surface and to agitate the water in the internal cooling cavity 48. The cooling water ultimately passes from the internal cooling cavity 48 through the hollow roll journal 30b supported in bearing 32b and is exhausted through discharge pipe 45.

The temperature of the cooling water entering the roll 25 may be controlled by any suitable flow control valve 52 and temperature regulator 54 located in the water access pipe 43. When the surface of the rolls is 130 to 160 degrees Fahrenheit the discharge water temperature will normally be about 100 to 140 degrees Fahrenheit at a flow rate of from 15 to 30 gallons of water per minute. Normally higher flow rates and lower tempera-

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tures are desirable. Control of the entering water temperature may thus be conveniently accomplished by measuring the discharge water temperature by a temperature sensing device 56, such as a thermocouple, suitably arranged in the discharge pipe 45 to effect control of temperature regulator 54. Temperature regulator 54 may conveniently comprise any suitable industrial mixing means. The actual regulation of the water temperature may be conveniently accomplished in an industrial environment by mixing steam with water or hot and cold water through the action of said mixing means.

The outside surface of the walls 55 of the rolls 23 and 25 preferably have a dull matte industrial chrome surface deposited over a 40 to 80 grit surface finish on the roll. The chrome coating provides a very hard wear and corrosion resistant surface. It has been found necessary for best operation for the surface to be slightly rough and preferably close to 80 grit to provide a final even coating to the material being coated. A suitable surface may be prepared by blasting the surface of the roll with 40 to 80 grit sand or shot and applying an electroplated chromium finish. If the surface is too smooth, small solid impurities such as dross particles which are almost universally present in molten coating baths and drawn out with the strip will cause visible defects on the coating. It is believed that with the slightly rough surface these small solid impurities are accommodated within the low points of the roll surface preventing marring of the final coated strip surface. Other hard wear and corrosion resistant surfaces may also be used, such as high chrome stainless steel or tungsten alloy surfaces, but a chrome surface is preferred.

The strip 11 first contacts the surface of the large bottom roll 25, passes around this roll for a short distance determined by the so-called wrap angle θ designated as 26 and then passes a short distance about the surface of the small roll 23 before being directed upwardly over the guide roll 19. The strip 11 will normally have the same wrap angle about the surface of the small roll 23 as about the large roll 25. The molten coating solidifies in the so-called freeze line 57 a short distance beyond the small roll 23. The freeze line 57 is readily detectable when observing the operation. The amount of cooling water flow must be adjusted until the temperature of the roll surface is from 130 to 200 degrees Fahrenheit and preferably from 140 to 160 degrees Fahrenheit to prevent a mottling of the coating surface. The cooling rate of the minimized spangle operation is determined and adjusted as made necessary by the coating of strip of various gages and various coating speeds by adjusting the wrap angle of the strip about the rolls 23 and 25 by adjusting the position of the rolls by means of the adjusting screws 39 and 41 respectively. The amount of wrap of the strip about the rolls determines the length of time the strip is exposed to the cooling effect of the roll. A wrap angle of from 17 to 30 degrees has been found to be suitable and necessary for normal operations. The wrap angle will be adjusted so that the strip is cooled sufficiently to bring the freeze line within a distance of a few inches to 4 to 6 feet above the small roll 23. Preferably the freeze line will be brought as close to the small roll as possible. A distance of 4 to 6 inches has been found very satisfactory but the freeze or solidification line can be less than 1 inch above the contact line of roll 23 with strip 11. Some adjustment of the cooling water flow may be necessary to achieve this, but the roll surface temperature should not be significantly lower than 130 degrees Fahrenheit in order to avoid condensation on the roll and consequent mottling. On a humid day the temperature required may be slightly higher. Likewise the roll surface temperature should not be significantly greater than 200 degrees Fahrenheit else pockets of internal steam may occur in the roll destroying the even cooling of the roll and causing mottling of the strip sur-

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face. Higher temperatures will also result in metal pick-up by the rolls.

It has been found absolutely essential in order to obtain uniform and comparable coated surfaces on both sides of the strip to have the cooling rolls unequal in size. If the rolls are not unequal in size and the largest roll is not located below the small roll the degree of spangling on the two sides of the strip will be unequal. The freeze line on the two sides of the strip will, in such case, also not be located at the same height on both sides of the strip. Strangely it has been found that the freeze lines and the spangling on the two sides of the strip cannot be equalized by any adjustment of the amount of cooling water used in the respective rolls or variation even of the wrap angles of the strip about the rolls. The top roll 23 in the specific embodiment illustrated is preferably 10 inches in diameter while the bottom roll 25 is 14 inches in diameter. The small roll 23 should be 20 to 40 percent smaller than the large roll 25. If the size of the rolls is varied the relative ratio in size between the rolls should remain substantially the same. We have found, however, that the roll sizes given are about the optimum for almost any line speed or gage of strip passing through the coating apparatus.

We prefer to position our minimized spangling apparatus 27 approximately 75 to substantially 100 percent of the distance of the freeze line from the surface of the coating bath. The distance of the freeze line from the surface of the bath varies significantly, of course, depending upon the heat content of the coated strip as determined by the gage of the strip, the speed of the line and to some extent the temperature of the coating bath. Ordinarily the minimized spangling apparatus can be positioned initially approximately 80 percent of the distance between the surface of the bath and the freeze line and then the freeze line can be brought closer to the apparatus, if desired, by increasing the wrap angle to increase the cooling rate of the strip. Some variation of the position of the minimized spangling apparatus with respect to the freeze line and the surface of the bath can thus be had and the cooling of the strip varies by altering the wrap of the strip about the rolls. Any suitable adjusting means may be provided to adjust the height of the minimized spangling apparatus above the bath in order to aid in maintaining the freeze line 57 a uniform distance above the minimized spangling apparatus as desired. If the coating line normally operates on fairly standard material and at regular speeds and temperatures, however, such adjusting means will not normally be required.

We claim:

1. A method of producing minimized spangled sheet material comprising:
 - (a) passing sheet material through a molten zinc bath,
 - (b) passing said sheet material through gas wiping means to determine a coating thickness,
 - (c) contacting one side of said sheet material with a first large cooled roll above said gas wiping means, and
 - (d) contacting the opposite side of said sheet material with a second smaller cooled roll 20 to 40 percent smaller than said first cooled roll and mounted above said first cooled roll and partially offset from said first cooled roll in order to effect a partial wrapping of said sheet material about said cooled rolls.
2. A method of producing minimized spangle sheet material according to claim 1 additionally comprising:
 - (e) maintaining the surface of said cooled rolls at approximately 130 to 200 degrees Fahrenheit.
3. A method of producing minimized spangle sheet material according to claim 1 additionally comprising:
 - (e) maintain the surface of said cooled rolls at approximately 140 to 160 degrees Fahrenheit.
4. A method of producing minimized spangle sheet material according to claim 2 additionally comprising:

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(f) maintaining a wrap angle of said sheet material about said first and second rolls of from 17 to 30 degrees.

5. A method of producing minimized spangle sheet material according to claim 1 additionally comprising:

(e) maintaining a wrap angle of said sheet material about said first and second rolls of from 17 to 30 degrees.

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3,083,120	3/1963	Paterson	-----	117-114	A X
3,148,080	9/1964	Mayhew	-----	117-114	A X
3,148,081	9/1964	Ross	-----	117-102	M X
3,322,560	5/1967	Monaco	-----	117-114	A X
3,379,557	4/1968	Hoover et al.	-----	117-114	A X
3,459,587	8/1969	Hunter et al.	-----	117-102	M
3,499,418	3/1970	Mayhew	-----	117-102	M X
3,523,036	8/1970	Hubert et al.	-----	117-114	A

References Cited

UNITED STATES PATENTS

1,933,401	10/1933	Ward	-----	117-119.2	X
2,095,718	10/1937	Simmons	-----	117-114	A
2,926,103	2/1960	Brick	-----	117-119.2	X

10 ALFRED L. LEAVITT, Primary Examiner

J. R. BATTEN, Jr., Assistant Examiner

U.S. Cl. X.R.

117-114 A, 119.2