

Aug. 10, 1954

J. E. BUTLER

2,686,135

HOT DIP PLATING METHOD AND APPARATUS

Filed Jan. 24, 1949

2 Sheets-Sheet 1

Fig. 1.

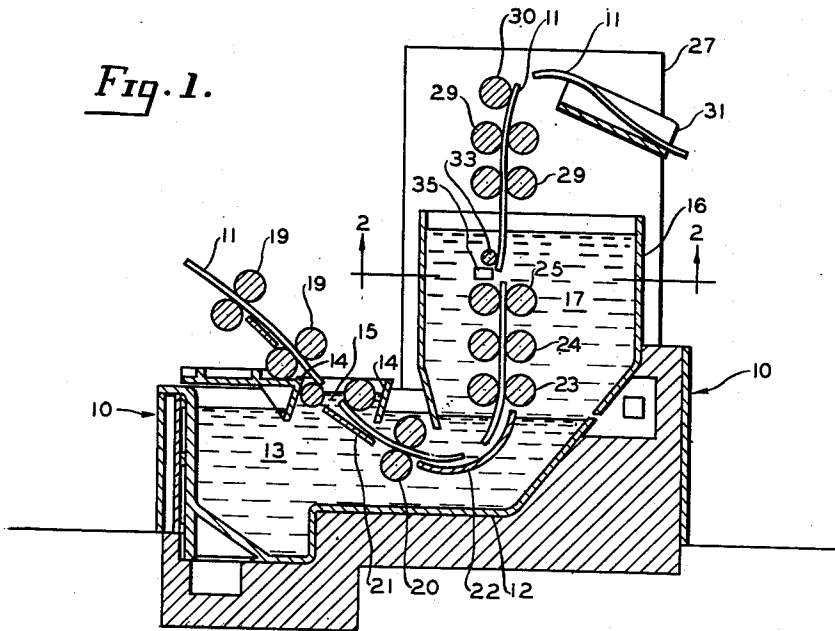
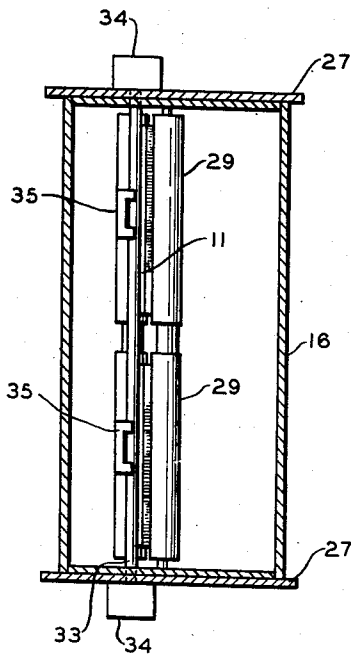


Fig. 2.

INVENTOR.
JOHN E. BUTLER

BY
James J. Slattery

Aug. 10, 1954

J. E. BUTLER

2,686,135

HOT DIP PLATING METHOD AND APPARATUS

Filed Jan. 24, 1949

2 Sheets-Sheet 2

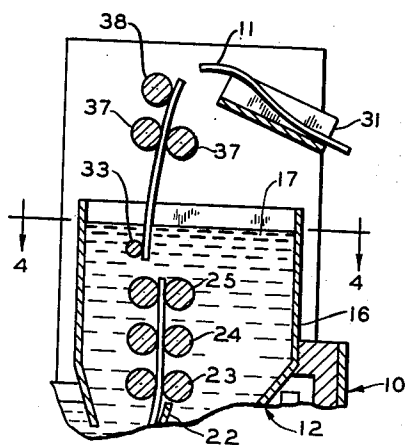


Fig. 3.

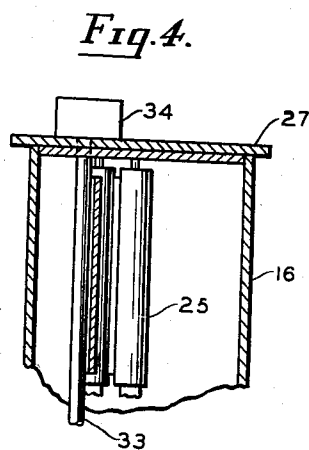


Fig. 4.

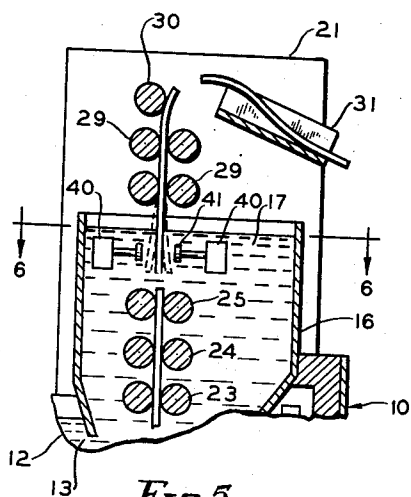


Fig. 5.

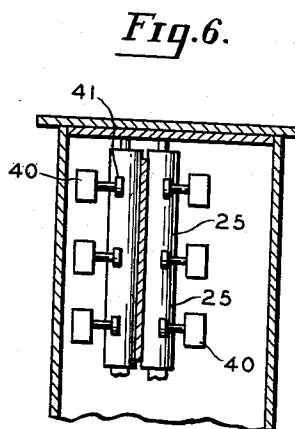


Fig. 6.

INVENTOR
JOHN E. BUTLER

BY
James J. Healey

UNITED STATES PATENT OFFICE

2,686,135

HOT DIP PLATING METHOD AND APPARATUS

John E. Butler, Weirton, W. Va., assignor to National Steel Corporation, a corporation of Delaware

Application January 24, 1949, Serial No. 72,471

15 Claims. (Cl. 117-102)

1

This invention relates to an improved method of and apparatus for hot dip plating sheets of base metal with a coating of protective metal and more particularly relates to the removal of excess molten metal from the trailing edges of the plated sheets.

The present invention will be described in connection with the hot dip plating of sheets of base metal, such as sheets of blackplate, with a protective coating of tin. In the production of tin plate by the hot dip process, the sheets of blackplate are passed through a bath of molten tin and then up through a body of hot grease, such as palm oil, floating on the surface of the molten tin. Finishing rolls are mounted in the layer of palm oil for regulating the thickness of the tin coating. The hot palm oil serves as a medium in which to keep the tin coating molten on the sheet so as to produce better tin distribution. The palm oil also aids in protecting the tin from oxidation. The oil or grease is at an elevated temperature, and the tin coating is not solidified in the palm oil. It is to be understood that the present invention is not limited to blackplate for the sheets of base metal or to tin as the protective coating metal or to palm oil or grease as the protective liquid. Other metals which have a melting temperature below that of the base metal may be used, and other hot liquids may be used in place of the palm oil depending on the type of metal and other factors. The protective liquid should not dissolve the coating metal.

In the hot dip process of plating or coating sheets with a layer of protective tin, the sheets are passed through a bath of molten tin. The coated sheets are withdrawn from the bath and have thereon a uniform coating of tin except for the trailing edge which is last to leave the bath. The trailing edge portion has a relatively thicker coating and is commonly known as the "list edge." The formation of this list edge is a waste of relatively expensive coating metal and results in sheets that are non-uniform. While various procedures have been proposed for preventing the formation of this list edge, these prior art procedures have had various drawbacks, and, insofar as is known, none has been used commercially, and all commercially produced hot dip plate, such as tin plate, galvanized sheets, terne plate, and sheets coated with aluminum have this relatively thicker list edge.

Accordingly, it is an object of the present invention to provide a novel method of and apparatus for producing hot dip coated sheets having on the edge portions a coating which has the

2

same or more nearly the same thickness as the coating on the remaining, major portions of the sheets.

Another object of the present invention is to provide a method of and apparatus for removing the excess metal from the sheets without damaging or marring the sheets.

Another object of the present invention is to provide a method of and apparatus for removing excess metal from the trailing edge portion of hot dip plated sheets while the trailing edge portion is submerged in the layer of hot protective liquid, palm oil, floating on the bath of molten metal and before the coating metal solidifies and then utilizing the removed molten metal in the metal bath.

Another object of the present invention is to remove the excess molten metal from the list edge without exposing the molten metal to the atmosphere and thereby reducing oxidation of the molten metal and to effect such removal while the molten metal is relatively fluid before the metal is solidified or unduly thickened so that the molten metal will readily flow and smooth out any surface irregularities.

In accordance with the present invention, a sheet of base metal such as blackplate is passed through a bath of molten tin and then up through a layer of hot palm oil floating on the surface of the tin bath. The sheet coated with molten tin is withdrawn from the hot palm oil, and the molten tin then quickly solidifies. Before the trailing edge leaves the palm oil and while the tin is in a fluid condition, the excess molten metal is removed. Removing the excess tin in the palm oil has a number of advantages. The tin coating while in the hot palm oil is more fluid than after the sheet is withdrawn, and any imperfections or surface irregularities quickly disappear as a result of the ability of the fluid tin to smooth itself out into a film having a level surface. As soon as the coated sheet is withdrawn from the palm oil, the tin thickens and quickly solidifies, and any disturbance in the surface of the tin at that time tends to remain permanently. The removed molten metal sinks under the influence of gravity down through the palm oil and returns directly to the bath of molten tin. The removed molten tin is not exposed to the atmosphere and oxidized, and there is no handling loss. By forming a coating on the trailing edge that is the same or more nearly the same thickness as on the remainder of the sheet, the amount of tin required per sheet is reduced,

and the coated sheet has a more uniform thickness.

These and other objects and advantages will become more readily apparent from the following detailed description, taken with the accompanying drawings, in which:

Figure 1 is a vertical sectional view of hot dip, tin plating apparatus embodying the principles of the present invention;

Figure 2 is a horizontal sectional view taken along line 2—2 of Fig. 1;

Figure 3 is a fragmentary sectional view similar to Figure 1 illustrating another embodiment of the present invention;

Figure 4 is a fragmentary sectional view taken along line 4—4 of Figure 3;

Figure 5 is a fragmentary sectional view similar to Figure 1 illustrating another embodiment of the present invention; and

Figure 6 is a fragmentary sectional view taken along line 6—6 of Figure 5.

Referring more particularly to Figures 1 and 2 of the drawings and the embodiment of the present invention shown therein, this hot dip tin plating apparatus includes a tank 10 through which a series of similar sheets 11 are successively passed and coated with molten tin. Sheets 11 are flat sheets of ferrous metal containing a low percentage of carbon commonly termed "black-plate."

The tank 10 includes a relatively lower tin pot 12 in which there is maintained a pool or bath of molten tin 13. A pair of upper plates 14 extend across the tank and form a flux pot which confines a pool of flux 15 on the surface of the bath 13 of molten tin. The sidewalls of a relatively higher grease pot 16 are arranged to confine a layer of grease, such as palm oil, on the bath of molten tin 13 in the tin pot 12. Two pairs of power-actuated feed rolls 18 are provided for feeding the sheets 11 one by one down through the body of flux 15 and into the bath 13 of molten tin. A pair of power-actuated feed rolls or tin pot rolls 20 are mounted in the tin pot 12 along with guides 21 and 22 all arranged to move the sheets 11 through the molten tin and then up into the grease pot. Three pairs of power-actuated rolls 23, 24 and 25 are mounted in the grease pot 16 and in the layer of palm oil. These last-mentioned pairs of rolls move the sheets from the tin pot up through the grease pot. The pairs of rolls 23, 24 and 25 are also finishing rolls, and the pressure of the rolls on the coated sheets determines, at least to a certain extent, the thickness of the tin coating on the finished sheets by removing or wiping of the excess molten metal. These finishing rolls do not prevent the formation of the relative thicker list edge.

The tin plating apparatus includes a pair of upwardly extending side plates 27 mounted on the tank 10. Power-actuated catcher rolls 29 are rotatably mounted in plates 27 in position to receive the upper leading edge of each sheet as it is fed upwardly out of the grease pot 16 by the finishing rolls. The tin coating usually is sufficiently solidified by the time the sheets reach the catcher rolls so that the catcher rolls 29 do not mar the surfaces of the sheet. A roll 30 is provided for guiding the sheets 11 from the catcher rolls 29 to a guide chute 31 from which the sheets pass to other units in the processing line or to sorting and inspection stations.

The apparatus shown and described in the drawings is of the type intended to simultaneously

pass two series of sheets 11 through the tin pot and grease pot to the catcher rolls. As described so far, the apparatus is of conventional type and will be described as though only one series of sheets were plated, it being understood that the second series of sheets are simultaneously plated in the same manner. Insofar as the present invention is concerned, it is immaterial whether one or more than one series of sheets are simultaneously plated.

The sheets 11 passing up through the grease pot have thereon a coating of molten tin. The hot protective liquid, palm oil, maintains the tin molten but cools the molten tin without solidifying the tin so that as the sheet leaves the grease pot the molten tin will quickly solidify and will not be as readily oxidized by the atmosphere. At times, it is conventional practice to direct streams of cooling air against the sheets passing from the grease pot rolls to the catcher rolls as an aid in cooling the tin.

Sheets of tin plate produced as described have relative thicker list edges on which there is a heavier coating of tin. In the grease pot 16, there is mounted a rod 33 connected at each end to a vibrator means 34. The vibrators 34 may be of the customary type available on the market for vibrating members or may be of special design. The vibrators 34 vibrate the rod 33 quite rapidly. Below the rod 33 and above the rolls 25, there is mounted an electromagnet 35. The rod 33 and magnet 35 are positioned closely adjacent to the path of the sheets passing from the rolls 25 to the catcher rolls 29. The rod 33 and magnet 35 are spaced slightly from this path so that unless the sheet 11 moves from this path the sheet will not touch rod 33. The magnet 35 is connected to a source of electric current and sets up a magnetic field tending to attract the passing sheet toward the rod 33. Although the sheet 11 is flexible and the magnet is positioned close to the rolls 25, the magnet does not exert sufficient magnetic force to move the leading edge portion laterally from the normal path of sheet movement against the rod 33. The rolls 25 preferably support the leading edge portion sufficiently to prevent contact between sheet 11 and the rod 33. As the sheet moves upwardly, the leading edge passes between the catcher rolls. When the trailing edge leaves the finishing rolls, the sheet is supported by and depends from the catcher rolls 29. A relatively long portion of the sheet is not supported against lateral movement, and the magnet 35 draws the trailing edge of the sheet against the vibrating rod 33 substantially as shown in the drawings. The rapidly vibrating rod 33 in turn vibrates the trailing edge of the sheet and removes the excess molten tin. The removed tin sinks through the hot palm oil and returns to the tin pot 12. The sheets 11 are moved quite rapidly by the power actuated rolls so that the period of contact between the trailing edge portion and the vibrating rod 33 is brief but sufficient to remove excess molten metal.

The coating of tin on the trailing edge of the sheet at the time of contact with rod 33 is more fluid than after the sheet leaves the layer of palm oil 17. If there is any surface disturbance on the coating in the palm oil, the coating is sufficiently fluid to flow and smooth itself. In addition, the removed tin is not oxidized by exposure to the atmospheric air and returns directly to the tin pot so that there is complete recovery of the removed tin. The finished sheet has a relatively more uniform thickness and a given

5

amount of tin will coat a greater surface area.

Referring more particularly to Figures 3 and 4 of the drawings, the apparatus, shown in part, is similar to that of Figures 1 and 2 and identical parts have applied thereto the same reference numerals. The embodiment of Figures 3 and 4 does not include a magnet 35 as does the apparatus of Figures 1 and 2 but does include a vibrating rod 33 which is vibrated by vibrators 34 that may be of any suitable type. Above the tin pot 16, there is a pair of catcher rolls 37 positioned to receive the sheet 11 passing upwardly from the upper finishing rolls 25 and a guide roll 38 for guiding the sheet to guide chute 31. The catcher rolls 37 are arranged with their axes parallel to the axes of rolls 25 and the nip of rolls 37 is in alignment with the pass line of rolls 25. The roll 37 which is on the opposite side of the path of the sheets from rod 33 has its axis below that of the other roll 37. Thus, the pass line of the rolls 37 is at an angle to the path of the sheets so as to urge or tend to urge the portion of sheet 11 that is below the catcher rolls toward the vibrating rod 33. As the finishing rolls 25 move a sheet 11 upwardly, the leading edge enters the nip of rolls of 37 and then passes between the catcher rolls. As soon as the trailing edge leaves rolls 25, it moves toward the left and against rod 33. The rod 33 vibrates the trailing edge and removes the excess molten metal which passes down through the layer 17 of palm oil to the tin pot as described in connection with Figures 1 and 2.

The apparatus of Figures 5 and 6 is the same as the apparatus of Figures 1 and 2 except for the means for vibrating the trailing edge portions of the sheets 11 and the same reference numerals have been applied to the identical parts. In the apparatus of Figures 5 and 6, the means for vibrating the trailing edge of each sheet includes a plurality of vibrators 40 submerged in the body of palm oil 17. Each vibrator 40 has a plunger 41, the outer end of which is positioned closely adjacent to the path of the sheets between the finishing rolls and catcher rolls. The vibrators 40 are positioned on opposite sides of the sheet path, and the plungers 41 do not touch the sheet but vibrate the sheet, particularly the trailing edge, as a result of transmission of the vibrations of plungers 41 through an intervening layer of palm oil so that there is no direct contact between the vibrators and the sheet. The vibrators 40 may be suspended in the palm oil by any suitable means and are preferably operated by electrical power. The rate of vibration of the plungers 41 may be within the audible range or may be ultrasonic, depending in part on the space between the plungers and sheet and the area of the ends of the plungers and the thickness of the sheet.

In each of the embodiments shown and described, the trailing edge of the sheet is vibrated in the palm oil while the sheet is suspended by and depending from the catcher rolls so that the trailing edge is free to vibrate. While this construction is preferable, it is to be understood that the vibrating means, and particularly the vibrators of Figures 5 and 6, may be positioned below the lowest finishing rolls or between the grease pot rolls. For example, if desirable, the grease pot rolls could be spaced farther apart and the vibrating means placed between the rolls with the upper pair or pairs of grease pot rolls acting substantially the same as the catcher rolls.

In each embodiment of the present invention, 75

6

the trailing edge of the sheet is vibrated while in the palm oil to remove excess molten tin. The removed molten tin is not exposed to the air and is returned to the tin pot without being oxidized in whole or part. Further, when the excess tin is removed, the tin coating is relatively more fluid and the tin more readily flows to smooth out any variations in coating thickness.

In the drawings, the thickness of the sheets has been exaggerated to make a better showing. In addition, the sheets will engage the guide 22 and be bent and guided upwardly thereby, although for purposes of greater clarity, the sheets are shown as slightly spaced from this guide. The drive mechanism for the rolls has been omitted as this mechanism is of conventional construction of the same general design as used commercially on hot dip tin plating apparatus of the type shown and described.

I claim:

1. In the hot dip process of coating a metal sheet with a layer of metal, the steps comprising, passing such a sheet through a bath of molten metal to coat the sheet and then passing the coated sheet upwardly through a layer of liquid on the bath, the coating metal on the sheet in the layer of liquid being molten and the liquid being a nonsolvent for the molten metal, and rapidly vibrating the trailing edge of the sheet in the liquid layer to remove excess molten coating metal while the sheet is suspended with its trailing edge free to vibrate in the layer of liquid.

2. In the hot dip process of coating a ferrous metal sheet with a layer of tin, the steps comprising, passing such a sheet through a bath of molten tin to coat the sheet and then passing the coated sheet upwardly through a layer of hot palm oil on the bath, the coating of tin on the sheet in the layer of palm oil being molten, and rapidly vibrating the trailing edge of the sheet in the layer of palm oil to remove excess molten tin from the trailing edge portion of the sheet.

3. In the hot dip process of coating a metal sheet with a layer of metal, the steps comprising, passing such a sheet through a bath of molten metal to coat the sheet and then passing the coated sheet upwardly through a layer of liquid on the bath along a predetermined path, the coating metal on the sheet in the layer of liquid being molten and the liquid being a nonsolvent for the molten metal, applying magnetic force against the trailing edge of the sheet as the trailing edge moves through the liquid layer and displacing the trailing edge laterally from said path, and rapidly vibrating the displaced trailing edge of sheet in the liquid layer to remove excess molten coating metal.

4. In the hot dip process of coating a metal sheet with a layer of metal, the steps comprising, passing such a sheet through a bath of molten metal to coat the sheet and then passing the coated sheet upwardly through a layer of liquid on the bath along a predetermined path, the coating metal on the sheet in the layer of liquid being molten and the liquid being a nonsolvent for the molten metal, changing the direction of travel of the leading edge sheet and displacing the trailing edge of the sheet laterally from the predetermined path while the trailing edge is in the layer of liquid, and rapidly vibrating the trailing edge of the sheet in the liquid layer to remove excess molten coating metal.

5. In the hot dip process of coating a metal sheet with a layer of metal, the steps compris-

ing, passing such a sheet through a bath of molten metal to coat the sheet and then passing the coated sheet upwardly through a layer of liquid on the bath, the coating metal on the sheet in the layer of liquid being molten and the liquid being a nonsolvent for the molten metal, and rapidly vibrating the trailing edge of the sheet in the liquid layer to remove excess molten coating by setting up a source of vibrations in the liquid layer and imparting vibrations to the trailing edge through an intervening layer of liquid.

6. In the hot dip process of coating a sheet of base metal with a layer of protective metal, the steps comprising, passing such a sheet through a bath of molten protective metal to coat the sheet and then passing the coated sheet upwardly through a layer of liquid on the bath and between and in engagement with pairs of finishing rolls located in the layer of liquid, the coating metal on the sheet in the layer of liquid being molten and the liquid being a non-solvent for the molten protective metal, and rapidly vibrating the trailing edge of the sheet while in the liquid layer above the finishing rolls to remove excess molten metal from the trailing edge while the sheet is suspended with its trailing edge free to vibrate in the layer of liquid.

7. In apparatus for coating a metal sheet with a layer of protective metal, the combination comprising, tank means including relatively lower pot means arranged to confine a bath of molten protective metal and relatively higher walls arranged to confine a layer of protective liquid on top of the bath of molten metal, means for moving the sheet through the bath of molten metal and then upwardly through the layer of liquid along a predetermined path, sheet vibrating means adjacent but spaced from said path below the top of the liquid-confining walls, and magnetic means positioned adjacent the path for urging the trailing edge of the sheet against the sheet vibrating means upon energization to rapidly vibrate the trailing edge portion of the sheet in the layer of liquid and remove excess molten coating metal.

8. In apparatus for coating a metal sheet with a layer of protective metal, the combination comprising, means for moving the sheet through the bath of molten metal and then upwardly through the layer of liquid along a predetermined path, sheet vibrating means adjacent but spaced from said path below the top of the liquid-confining walls, and a pair of rolls disposed above the tank means in position to receive the upwardly moving sheet, said rolls being rotatable about parallel axes and the pass line of said rolls being angularly disposed to said path so that the rolls urge the trailing edge of the sheet against the vibrating means to rapidly vibrate the trailing edge portion of the sheet in the liquid layer and remove the excess molten coating metal.

9. In apparatus for coating a metal sheet with a layer of protective metal, the combination comprising, means for moving the sheet through the bath of molten metal and then upwardly through the layer of liquid along a predetermined path, and sheet vibrating means arranged on opposite sides of and spaced from said path below the top of the liquid-confining walls and the surface of the liquid layer, said vibrating means being arranged to rapidly vibrate the trailing edge portion of the sheet in the layer of liquid through an intervening layer of liquid and remove excess molten coating metal without touching the sheet.

10. In apparatus for coating a metal sheet with

a layer of protective metal, the combination comprising, means for moving the sheet through the bath of molten metal and then upwardly through the layer of liquid along a predetermined path, a member adjacent but spaced from said path extending transversely of the path of the sheet and below the top of the liquid-confining walls and the upper surface of the layer of liquid, means for rapidly vibrating the member, and means positioned adjacent the top for urging the trailing edge of the sheet against the member to vibrate the trailing edge in the layer of liquid and remove excess molten metal.

11. In apparatus for coating a metal sheet with a layer of protective metal, the combination comprising, means for moving the sheet through the bath of molten metal and then upwardly through the layer of liquid along a predetermined path, a member adjacent but spaced from said path extending transversely of the path of the sheet and below the top of the liquid-confining walls and the upper surface of the layer of liquid, vibratory means for vibrating the member, and magnetic means positioned adjacent the path for urging the trailing edge of the sheet against the vibratory means upon energization to rapidly vibrate the trailing edge portion of the sheet in the layer of liquid and remove excess molten coating metal.

12. In apparatus for coating a metal sheet with a layer of protective metal, the combination comprising, means for moving the sheet through the bath of molten metal and then upwardly through the layer of liquid along a predetermined path, a member adjacent but spaced from said path extending transversely of the path of the sheet and below the top of the liquid-confining walls and the upper surface of the layer of liquid, means for vibrating the member, and a pair of rolls disposed above the tank means in position to receive the upwardly moving sheet, said rolls being rotatable about parallel axes and the pass line of said rolls being angularly disposed to said path so that the rolls urge the trailing edge of the sheet against the vibrating means to rapidly vibrate the trailing edge portion of the sheet in the liquid layer and remove the excess molten coating metal.

13. In apparatus for coating a ferrous metal sheet with a layer of tin, the combination comprising, tank means including relatively lower tin pot means arranged to confine a bath of molten tin and relatively higher grease pot means arranged to confine a layer of palm oil on top of the bath of molten tin, means for moving the sheet through the bath of molten tin and then upwardly through the layer of palm oil along a predetermined path, said sheet moving means including power-actuated rolls positioned inside of the grease pot means below the surface of the palm oil, roll means spaced above the tank means in position to receive the upwardly moving sheet and support the sheet with its trailing edge portion free of the power-actuated rolls, a member adjacent but spaced from said path extending transversely of the path of the sheet and below the top of the grease pot means and the upper surface of the layer of palm oil, means for vibrating said member, and magnetic means positioned adjacent the path for urging the trailing edge of the coated sheet against the member upon energization to rapidly vibrate the trailing edge portion of the sheet in the layer of palm oil and remove excess molten tin.

14. In apparatus for coating a ferrous metal

9

sheet with a layer of tin, the combination comprising, tank means including relatively lower tin pot means arranged to confine a bath of molten tin and relatively higher grease pot means arranged to confine a layer of palm oil on top of the bath of molten tin, means for moving the sheet through the bath of molten tin and then upwardly through the layer of palm oil along a predetermined path, said sheet moving means including power-actuated rolls positioned inside of the grease pot means below the surface of the palm oil, a member adjacent but spaced from said path extending transversely of the path of the sheet and below the top of the grease pot means and the upper surface of the layer of palm oil, means for vibrating the member, and a pair of rolls disposed above the tank means in position to receive the upwardly moving sheet, said rolls being rotatable about parallel axes and the pass line of said rolls being angularly disposed to said path such that the rolls urge the trailing edge of the sheet against the vibrating member to rapidly vibrate the trailing edge portion of the sheet in the layer of palm oil and remove the excess molten tin.

15. In apparatus for coating a ferrous metal sheet with a layer of tin, the combination comprising, tank means including relatively lower tin pot means arranged to confine a bath of molten tin and relatively higher grease pot means ar-

10

ranged to confine a layer of palm oil on top of the bath of molten tin, means for moving the sheet through the bath of molten tin and then upwardly through the layer of palm oil along a predetermined path, said sheet moving means including power-actuated rolls positioned inside of the grease pot means below the surface of the palm oil, roll means spaced above the tank means in position to receive the upwardly moving sheet and support the sheet with its trailing edge portion free of the power-actuated rolls, and sheet vibrating means arranged on opposite sides of and spaced from said path below the top of the grease pot and below the surface of the layer of palm oil, said vibrating means being arranged to rapidly vibrate the trailing edge portion of the sheet in the layer of palm oil through an intervening layer of palm oil and remove excess molten tin without touching the sheet.

References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
811,854	Lee	Feb. 6, 1906
854,006	Steele	May 21, 1907
2,026,598	Taylor	Jan. 7, 1936
2,080,494	Martindell	May 18, 1937
2,326,372	Lignian	Aug. 10, 1943