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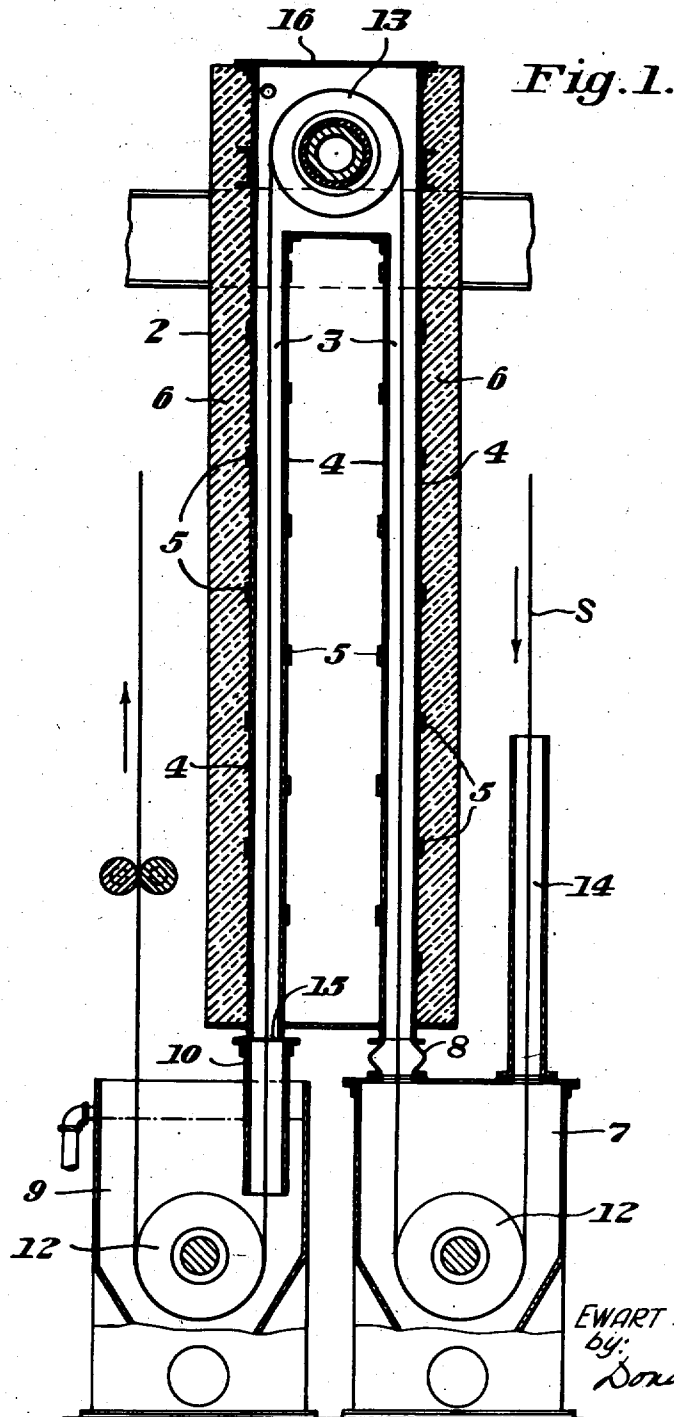
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METHOD OF TREATING ELECTROLYTIC COATINGS

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## UNITED STATES PATENT OFFICE

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## METHOD OF TREATING ELECTROLYTIC COATINGS

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6 Claims. (Cl. 204—36)

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This invention relates to coatings on ferrous metals especially to ferrous metals plated with a coating having a low melting point such as tin coatings, and particularly to an improved method of treating electrolytic tin coatings on strip steel so as to obtain a maximum surface luster and/or a bonding of the tin coating with the base metal of the strip. The present invention is a division of my copending application, Serial No. 447,966, filed June 22, 1942, which has become abandoned.

It is well known that in the hot-dipped method of coating iron or steel there is provided a bright surface finish and an alloy bond between the coating and the base metal. However, such a method of tinning ferrous metal is objectionable for the reason that the coating varies widely from one point to another upon a hot-dipped sheet. Furthermore, an excessive amount of tin is used in the hot-dipped method, thereby making this process relatively expensive.

In an attempt to overcome these objectionable features, it has been suggested that the coating be deposited on the ferrous metal electrolytically. Such method provides a substantially uniform tin coating on the sheet or strip, but any alloying of the tin coating with the base metal is not obtained by this method. Also, the tin-coated surface produced by the electrolytic method is usually dull and white and there is not provided a brilliant metallic finish characteristic of the hot-dipped method. Heretofore, it has been suggested to heat the tin coating so as to melt the same by means of hot oil, gas or electrical energy. Of these methods the use of hot oil has been the most satisfactory as it provides a uniform heating the strip material. The hot oil method, however, imposes a number of limitations, the first of which is, it does not permit ready control of heating and cooling to compensate for various speeds of travel of the strip material; secondly, its use entails expensive and elaborate auxiliary equipment for the removal of the oil from the surface in the preparation of the strip product; thirdly, owing to the viscosity of the oil a maximum operating speed limitation is imposed in order to keep the oil in the receptacle. The main disadvantage of the gas method is that it is difficult to obtain and maintain uniform heating conditions. Also, rapid changes of strip speed are impossible due to the heat capacity of the furnace and heaters. Also, it is difficult to obtain a uniform heating with gas.

The utilization of electrical energy as a heating medium, i. e. by utilizing the electric resistance of the strip to the passage of electric current therethrough, has numerous advantages from

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the standpoint of controlling the melting of the tin coating; however, the employment of such electrical method of heating results in a non-uniform heating across the width of the strip. This is due to the physical shape of the strip material. Non-uniform heating in turn results in a non-uniform appearance of the tin coating after quenching. I have found, however, that the limitations of the electric resistance heating method can be overcome and its advantages utilized if a substantially isothermal shield is imposed between the strip and the surrounding atmosphere, so as to prevent heat losses from the strip. If such an isothermal shield is employed and the coating on the strip simultaneously melted by the passage of electric current there-through, I have found that a uniform appearing tin-coated product having a high luster will be obtained and that the coating is mechanically bonded to the base metal.

Accordingly, it is the general object of the present invention to provide an improved method of treating electrolytically coated ferrous metals having a low melting point coating thereon by which there is provided a coated surface having a high luster which is uniform in appearance.

It is another object of the invention to provide an improved method of treating electrolytically coated strip steel having a low melting point coating thereon which is simple and inexpensive in its use and, at the same time, efficient and effective, and which can be conveniently incorporated with existing electrolytic coating equipment.

It is a more specific object of this invention to provide an improved method of treating electrolytically tin-coated strip steel wherein the strip and the coating are heated by electric current including an isothermal shield for eliminating thermal losses so that the base metal and tin coating are uniformly heated, whereby a high luster having a uniform appearance is obtained on the strip after quenching.

Various other objects and advantages of this invention will become more apparent during the course of the following specification and will be particularly pointed out in the appended claims.

In the accompanying drawings there is shown, for the purpose of illustration, an embodiment which my invention may assume in practice.

In these drawings:

Figure 1 is a vertical section through apparatus for practicing my invention; and

Figure 2 is a wiring diagram of the apparatus as shown in Figure 1.

Referring more particularly to the drawings,

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the improved apparatus for practicing the teachings of my invention comprises a vertically arranged chamber or body member 2 having a pair of spaced apart, vertically arranged, rectangular-shaped passageways 3 arranged therein so as to provide an inverted U-shaped muffle. The side walls 4 of each of the passageways 3 are formed preferably of a metal having a high thermal conductivity, low magnetic susceptibility and which is non-corrosive, such as copper or nickel. It has also been found that stainless steel is practical for such use. Along the outer sides of the side walls 4 of each of the passageways 3 there are arranged electric grid heating elements. In the present instance these grid heating elements are shown as a plurality of spaced apart heating elements 5 which are conventional space heaters. On the outer sides of the passageways 3 and the side walls 4, there is disposed preferably insulation 6 so as to limit heat losses from the space heaters 5.

At the lower end of the chamber or body member 2 and to one side thereof there is arranged a receptacle or hollow body member 7 which communicates with and is connected to the passageway 3 thereabove preferably by means of flexible sealing gasket 8. At the lower end of the body member on the opposite side thereof there is arranged a similar receptacle or hollow body member 9 in which a quenching liquid is adapted to be disposed. The receptacle 9 communicates with the passageway 3 thereabove and is connected thereto preferably by means of a vertically arranged conduit member 10 which is preferably thermally and electrically insulated from the side walls 4 at 15. The lower end of the vertically arranged member 10 is so disposed that the lower end thereof is adapted to extend down into the quenching liquid in the receptacle 9 so as to prevent air from entering the passageway 3 thereabove.

Within each of the receptacles 7 and 9 there is rotatably arranged a metallic conductor roll 12 and there are provided electric brushes which are connected preferably to the secondary of a transformer for supplying current thereto. At the upper end of the chamber body member 2 in a hollow portion thereof with which both passageways 3 communicate, there is disposed a rotatable deflector roll 13 which may be a conductor roll but which is preferably an idler roll of low heat capacity which is preferably thermally and electrically insulated from the other parts of the body member 2 in any suitable manner. The roll 13 is arranged so that the periphery thereof is in tangential alignment with each of the passageways 3. Above the roll 13 there is disposed a cover 16 for closing the top of the chamber and passageways 3.

In the wiring diagram shown in Figure 2 of the drawings, one side of the strip heaters 5 is connected to one side of a power line by means of wires 17 and the other side of the strip heaters is connected to the other side of the power line by means of the wires 18 through a conventional type standard temperature control unit 19. There is arranged preferably at the lower end of the passageway 3 at the melting zone thereon adjacent the quench tank 9, a thermocouple 20 which is connected to the temperature control 19 by means of the wires 21. It is the purpose of the thermocouple 20 in conjunction with the controller 19 to automatically control the temperature of the walls of the passageway 3 so as to maintain the temperature of the walls at a temperature

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below the melting point of tin, for a purpose hereinafter to be described.

At the sides of each of the conductor rolls 12, as shown in the wiring diagram, there are arranged electric brushes 22 which establish an electric contact between the rolls 12 and the secondary of a transformer 23. One side of the primary of the transformer 23 is connected to a suitable source of power by means of a wire 24 and the other side of the primary of the transformer is connected to the power line by means of a wire 25 in which there is arranged preferably a saturated core reactor or suitable induction regulator 26 for regulating the current passing to the transformer. The current passes from the conductor rolls 12 through the strip S which is disposed over and around the conductor rolls 12 and the insulated roll 13 at all times during the continuous passage of the strip through the apparatus, whereby heat is generated in the strip S due to the resistance of the strip to the passage of electric current therethrough.

It will be understood that the chamber body member 2 together with the receptacles 7 and 9 are arranged in the electrolytic tin coating line at any suitable point therein after the plating operation but it is positioned preferably at a point immediately after the rinsing and drying equipment.

The improved apparatus is used in the following manner for carrying out the method of the present invention. The ferrous metal or steel tin-coated strip S as it leaves the drying operation in the electrolytic tin coating line passes preferably from an overhead deflector roll (not shown) downwardly into and through a vertically arranged conduit member 14 extending upwardly from the top of the receptacle 7. It is important that the surface of the tin-coated strip be in a dry condition as it enters the receptacle 7 of the present invention. The strip then passes into the receptacle 7 and around the conductor roll 12 therein. From the receptacle 7 the strip passes into the passageway 3 thereabove over and around the deflector roll 13 in the top of the body member and down into and through the passageway 3 on the opposite side of the body member into the conduit member 10 and into the receptacle 9. The strip then passes into the quenching liquid in the receptacle 9 and around the conductor roll 12 therein and upwardly out of the receptacle to the next operation to be performed on the strip.

As the strip passes through the apparatus, as has been described, the portion thereof extending between the conductor roll 12 in the receptacle 7 up through the passageways 3 and over the deflector roll 13 and the conductor roll 12 positioned in the receptacle 9, acts as an electric resistor and is heated by the passage of electric current therethrough and between the conductor rolls 12. The conductor rolls 12 are connected to a source of power, for example the secondary of the transformer, as shown in the wiring diagram of Figure 2. It will be understood that the strip is gradually heated as it passes from the conductor roll 12 and the receptacle 7 over the roll 13 to the conductor roll 12 in the receptacle 9. It will be seen that the strip is heated from the inside rather than from the outside due to the steel base of strip itself acting as the heating element. The current supplied to the strip for heating the same is controlled so that strip and tin coating thereon will not reach a temperature at which the tin

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coating becomes molten until the strip is about to leave the passageway 3. In other words, the speed of the strip and the current supplied thereto are balanced so that the tin coating will become molten at a point immediately before the strip passes into the quenching liquid in the receptacle 9 and not before. It will be understood that inasmuch as heat losses from the strip are eliminated by the effect of the heated side walls 4 of the passageways 3, the value of the current and voltage required to maintain the above point of melting with respect to the surface of the quenching medium at any strip speed can be readily calculated and can be easily regulated.

The walls of the passageways 3 through which the strip passes are heated by means of the electric space heaters 5 arranged along the walls 4. It will be understood that the heating elements or space heaters 5 are not provided for heating the tin coating on the strip but are provided merely for the purpose of maintaining the walls 4 of the passageways 3 at a uniform temperature slightly below, i. e., approaching the melting point of the tin, namely to a temperature of about 410° F., the melting point of tin being about 450° F., so as to prevent thermal losses while the strip is being heated by the passage of electric current therethrough in a manner hereinbefore described. In other words, the walls 4 of the passageways 3 act as an isothermal shield so as to prevent loss of heat by radiation. It will be understood that the cross sectional area of passageways 3 is relatively small so as to minimize heat losses due to convection. It will be seen that by heating the walls 4 of the passageways 3 at a uniform temperature slightly higher or at least as high as the temperature of the strip radiation, losses from the strip are effectively eliminated. It has been found that by electrically heating the strip and at the same time heating the walls of an enclosed chamber to a temperature below the melting point of the tin coating there is provided a uniform heating of the strip, thereby eliminating the objectionable features obtained by merely heating the strip by electric resistance alone.

It is important that the heating elements 5 maintain the walls 4 at a temperature in the vicinity of the melting point of tin, preferably slightly below the melting point for the purpose of controlling the heating of the tin coating. In other words, the thermal capacity of the walls is such that if they are maintained too hot control of melting is lost during a change in speed of the strip. It will be understood that the maintenance of the temperature of the walls at or below the melting point of tin is particularly important if the electrolytic line is stopped for any reason. For example, if the walls 4 were maintained above the melting point of tin damage to the coating and the top deflector roll would occur during the periods when the line was stopped. Such damage would result from the heating of the strip by the walls 4. A spotty appearance would result on the strip. Also, tin would be transferred to the top roll and would result in mechanical damage to the coated strip and the roll which, of course, is objectionable. On the other hand, by heating the strip by electric resistance and merely heating the walls around the strip to a temperature sufficient to prevent heat losses from the strip as it is being heated by resistance a control of

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the tin coating thereon can be conveniently and accurately maintained if the electrolytic tin line is shut down for any reason. This is one of the most important aspects of the present invention. By heating the strip by electric resistance, it has been found that the heating of the tin coating on the strip to a molten state is stopped almost instantaneously when the current is shut off. Consequently, it will be seen that the objectionable features obtained by heating the tin coating by an exterior heating means have been entirely eliminated.

As a result of my invention, it will be seen that there is provided an improved method of heating the tin coating on strip, whereby the base metal together with the coating metal is uniformly heated. After the strip together with the tin coating thereon has been heated to such a uniform temperature and immediately quenched it has been found that there is provided a smooth and even tin-coated surface having a brilliant finish and a high luster so as to provide a tin-coated strip having an enhanced appearance and a finish far superior to those finishes obtained by heating and quenching means heretofore suggested and used.

While I have shown and described one specific embodiment of my invention, it will be understood that this embodiment is merely for the purpose of illustration and description and that various other forms may be devised within the scope of my invention as defined in the appended claims.

I claim:

1. The method of treating steel strip having a coating of tin electrodeposited thereon in which the strip while in motion as a strand is heated to the melting point of the coating by passing a controlled electric current therethrough, characterized by passing said strip during said heating by said current through a shield of a heat conducting material around said strip, imparting heat to the outer surfaces of said shield, controlling the amount of heat imparted to said shield independently of said controlled electric current through said strip to maintain said shield at a temperature approaching but below the melting point of tin whereby a uniform melting of the tin coating across the width of the strip is achieved and control of said melting remains in the aforementioned controlled current, and quenching the strip immediately after the tin coating becomes molten.

2. The method of treating steel strip having a coating of tin electrodeposited thereon in which the strip while in motion as a strand is heated to the melting point of the coating by passing a controlled electric current therethrough, characterized by passing said strip during said heating by said current through a shield of a heat conducting material around said strip, and imparting heat to the outer surfaces of said shield at a rate which will maintain the shield at a temperature sufficient to prevent heat transfer from the strip to the shield but below that which would cause the shield to impart heat to the strip whereby non-uniform heat loss from the strip is prevented and a uniform melting of the tin coating across the width of the strip is achieved, and quenching the strip immediately after the tin coating becomes molten.

3. The method of treating steel strip having a coating of tin electrodeposited thereon in which the strip while in motion as a strand is heated

to the melting point of the coating by passing a controlled electric current therethrough, characterized by passing said strip during said heating by said current through a metallic shield around said strip, imparting heat to the outer surfaces of said shield at a rate which will maintain the shield at a temperature approaching but below the melting point of tin whereby non-uniform heat loss from the strip is prevented and a uniform melting of the tin coating across the width of the strip is achieved, and quenching the strip immediately after the coating becomes molten.

4. The method of treating steel strip having a coating of tin electrodeposited thereon in which the strip while in motion as a strand is heated to the melting point of the coating by passing a controlled electric current therethrough, characterized by passing said strip, during said heating by said passage of said current therethrough, through a metallic shield around said strip, imparting heat to the outer surfaces of said shield at a rate which will maintain the shield at a temperature of about 410° F., and controlling the rate of heating of the shield independently of the control of said electric current passed through the strip to prevent the shield from exceeding said temperature whereby a uniform melting of the tin coating across the width of the strip is achieved but the control of said melting remains in the aforementioned controlled current, and quenching the strip immediately after the coating becomes molten.

5. The method of treating steel strip having a coating of tin electrodeposited thereon in which the strip is heated to the melting point of tin by the passage of an electric current therethrough while the strip is in motion as a strand, said electric current being regulated in accordance with speed of travel of the strip, characterized by passing said strip during said heating through a metallic shield around said strip, imparting heat to the outer surfaces of said shield at a rate which will maintain the shield at a temperature of about 410° F. and controlling the rate of heating of the shield independently of the speed of travel of said strip to prevent the shield from exceeding said temperature whereby a uniform melting

of the tin coating across the width of the strip is achieved but the control of said melting remains in the aforementioned controlled current, and quenching the strip immediately after the coating becomes molten.

6. The method of treating steel strip having a coating of tin electrodeposited thereon in which the strip is heated to the melting point of tin by the passage of an electric current therethrough while the strip is in motion as a strand, said electric current being regulated in accordance with speed of travel of the strip, characterized by passing said strip during said heating through a metallic shield around said strip, imparting heat to the outer surfaces of said shield, controlling the amount of heat imparted to said shield independently of the speed of travel of said strip to maintain said shield at a temperature approaching but below the melting point of tin whereby a uniform melting of the tin coating across the width of the strip is achieved but control of said melting remains in the aforementioned regulation of current through the strip in accordance with the speed of travel of the strip, and quenching the strip immediately after the coating becomes molten.

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