

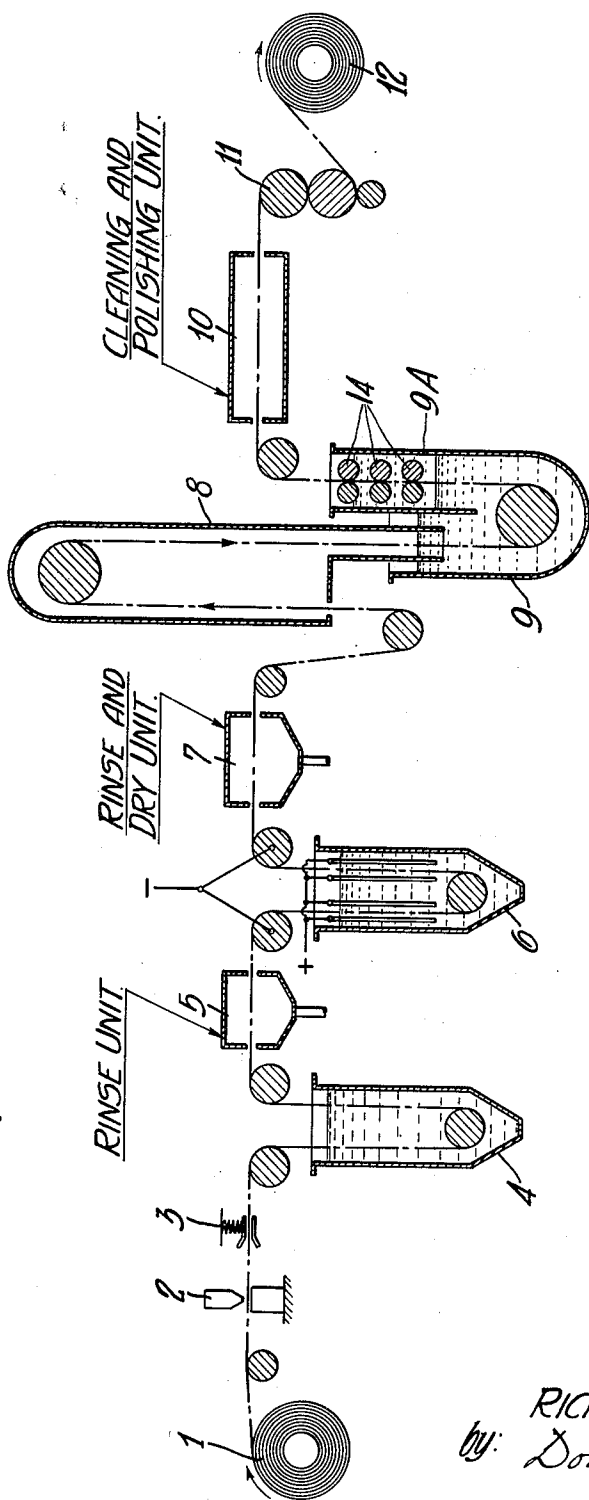
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METHOD OF LEAD COATING A FERROUS ARTICLE

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METHOD OF LEAD COATING A FERROUS ARTICLE

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This invention relates to a method of applying a coating of substantially pure lead on a ferrous metal article, and particularly to applying such a coating on low carbon sheet or strip.

It is well known that lead is resistant to the action of many corrosive media and that its corrosion resistance is greatest when the metal is substantially pure. Attempts to use the pure metal as a thin protective coating on iron and steel, however, have never been successful commercially. Lead does not alloy with iron as do tin and zinc which are commonly used as protective coating metals. Consequently, past efforts to coat iron with pure lead have failed due to (1) inadequate adherence of the coating to the base metal, and (2) incomplete coverage of the surface of the base metal.

To overcome these deficiencies it is the present practice to add to the molten lead coating bath a metal which possesses the property of alloying with iron. Tin is widely used for this purpose and the lead-tin coatings which are produced are known as terne coatings. At least 15% tin must be present to produce an adherent coating; to insure adherence 20% tin is normally used. Terne coatings are manufactured in various weights over a range of from 2 to 40 lbs. per double base box, and contain from 0.4 to 8 lbs. of tin per double base box, respectively. It is apparent, therefore, that the cost of tin represents a sizeable item in the cost of the product. Moreover, while tin is necessary for adherence of the coating, its presence in the main body of the coating detracts from the corrosion resistance and ductility of the coating. A terne coating is also duller and more granular in appearance than a coating of substantially pure lead.

I have found that an adherent, uniform outer coating of substantially pure lead can be applied to iron and steel by:

(1) Electroplating the ferrous article with a thin coating of tin, 0.2 to 0.6 lb. per double base box;

(2) Heating the tin plated article so as to melt and transform substantially all of the tin into a continuous layer of iron-tin alloy; and then

(3) Dipping the article in a molten bath of substantially pure lead.

The alloy layer provided by the first two steps of my method serves to key the lead coating to the base metal. At least 0.2 lb. of tin per double base box, i. e. a tin coating 0.000003 inch thick, is required for good results. Heavier tin coatings can be used, however, increasing the tin above 0.6 lb./dbb. or above 0.000018 inch in thickness is

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not only wasteful but must be avoided since the alloy layer becomes excessively thick which condition tends to decrease adherence. Further, substantially complete alloying of coatings heavier than 0.6 lb./dbb. is difficult to attain within a reasonable heating time. Experience indicates that the optimum amount of tin is about 0.3 lb./dbb. or 0.000006 inch in thickness.

While the alloying is substantially complete, a small amount of free tin will always remain. This is a desirable condition, since this very thin skin of free tin will alloy with the lead adjacent it, forming a very thin and practically undetectable layer of lead-tin alloy at the interface of the iron-tin alloy layer and the outer lead coating. This aids in completing the bond between the coating and the base metal.

The product of my method, therefore, comprises a ferrous base, a thin layer of iron-tin alloy and an outer coating the main body of which is substantially pure lead.

Accordingly, an object of this invention is to provide a ferrous metal article with a tightly adhering coating of substantially pure lead.

Another object is to provide a method for applying such lead coatings to ferrous articles.

These and further objects will be made apparent in the following specification when read in conjunction with the attached drawing in which:

The single figure is a schematic arrangement of equipment for applying the new method in the continuous coating of steel strip, which equipment will not be described in detail, since the individual items of the apparatus are well known.

Referring specifically to the drawing, the equipment consists of an uncoiler 1, on which is mounted a coil of steel in strip or similar strand form S; a welder or similar joining device 2, for joining coils end to end; a tensioning device 3, for imposing sufficient drag upon the moving strips to maintain it reasonably taut during its passage through subsequent units, a cleaning vat 4; a water rinse unit 5; an electroplating unit 6; a rinsing and drying unit 7; a furnace or muffle 8; a hot-dip lead coating pot 9, which includes a chamber 9A for maintaining a layer of oil on the surface of the molten lead at the exit end of the pot; a cleaning and polishing unit 10; a drive bridge 11; and a recoiler 12. Located in the oil layer of the chamber 9A are one or more pairs of opposed rolls 14 commonly known as the coating machine. The discharge end of the furnace 8 extends below the surface of the lead in the coating pot 9 for reasons which will be made clear.

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Only those items of equipment which are necessary to illustrate the method of the present invention are shown in Figure 1 and it will be understood that common refinements in strip handling such as slack-producers, side-guides, etc. will be used in the actual operating line.

As an illustration of operations under the new method, a strip S of bright-annealed low-carbon steel is pulled from the uncoiler 1 through the various processing units shown in the drawing by the drive bridle 11. The strip is prepared for plating as it passes through the cleaning vat 4. The exact nature of the preparation depends upon the condition of the strip as it is delivered to the processing line. The surface of the strip must be freed of all grease, oxide and other foreign matter. The various means of accomplishing this are well known in the plating art. In the case of bright-annealed strip, acid pickling in 5 to 10% cold sulphuric acid solution is generally sufficient, and is the means used in the present example. The clean strip is rinsed with water in the unit 5, which rinsing can include scrubbing with rotary brushes if desired. However, such scrubbing is not usually necessary. The strip then passes into the electroplating unit 6 where it is coated with tin. Either an acid or an alkaline plating bath can be used. An acid bath is preferred since some drag in of acid from the pickling bath cannot be avoided. An example of a particularly satisfactory bath is one composed of:

Stannous sulphate, 60 grams per liter
Sulphuric acid (concentrated), 28 cubic centimeters per liter
Ortho cresol, 10 cubic centimeters per liter
Glue, 1 gram per liter
Beta naphthol, 1 gram per liter

The current density and time of plating are regulated to deposit a tin coating of approximately 0.3 lb./dbb. The plated strip is then rinsed and dried in the unit 7. Hot water sprays followed by a blast of hot air are satisfactory for this purpose. The dry strip then passes into and through the furnace 8 wherein it is subjected to sufficient heat to melt and alloy the tin coating with the steel base. One to two seconds at 600° F. is sufficient for substantially complete alloying of a tin coating of 0.3 lb./dbb. A slightly longer time is required for a heavier coating. Low temperatures can be used, but these require longer heating times. Excessive time at alloying temperature is not detrimental, but it is advantageous from a cost standpoint to effect the alloying in as short a time as possible. Temperatures above 650° F. should be avoided since the tendency for the tin coating to coalesce and produce a non-uniform alloy layer becomes pronounced at such temperatures. It also becomes more difficult to control the temperature in the lead pot 9 if the entering strip is hotter than 650° F. The strip in the furnace can be heated indirectly by gas or electric heating elements or directly by passing an electric current there-through. Heating to alloy the coating can also be accomplished by passing the plated strip through a heated oil bath or an induction coil. I prefer a furnace for economy and for other reasons which will become clear as the description proceeds. From the furnace, the heated strip passes through a molten bath of substantially pure lead maintained at 650° to 700° F. in the hot-dip coating pot 9. Since the strip is hot, very little external heat is needed to

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maintain the operating temperature. The time of immersion is not critical as is the case in present practice wherein cold wet strip is hot terne coated. One to two seconds immersion is sufficient in the new method. Moreover, since the strip is already coated with tin, fluxing in the ordinary sense is not necessary. However, the surface of the lead must be kept free from oxide. While this can be done by maintaining on the surface of the lead a thin layer of flux or other deoxidizing blanket, I prefer to have the discharge end of the alloying furnace 8 extend just below the surface of the lead in the coating pot 9 and to maintain a deoxidizing atmosphere in the furnace 8. This arrangement not only maintains the surface of the lead adjacent the point of strip entry free of oxides, but makes maximum use of the heat applied to the strip by the furnace 8 to maintain the lead bath at the desired temperature. The strip leaves the lead pot in a substantially vertical pass through a layer of oil floating on the surface of the molten lead. Examples of suitable oils are molten paraffin or a mixture of a high flash point mineral oil and 10 to 30% palm oil. The lead-coating thickness is regulated by adjusting the pressure exerted by the rolls 14 as the strip passes therethrough. From the oil bath the strip emerges into the atmosphere where it is cooled by forced air cooling or the like. The strip is then cleaned of excess oil and polished during its passage through the unit 10 which may be a standard wet washer and branner. The finished strip is reeled on the recoiler 12 which is driven from the bridle 11 through a slip-clutch. Thus, the speed of processing can be maintained constant regardless of the build up in coil diameter on the recoiler. Electrical controls can be provided for maintaining the strip speed through the equipment constant. Continuity of processing is obtained by joining coils end to end with welder 2.

While the foregoing example deals with the continuous coating of steel in strip or similar strand form, the new method can also be applied in the coating of individual ferrous articles on a batch or continuous basis. Equipment for such applications take a variety of readily available forms.

The coatings produced by my method are brighter and smoother than terne coatings, and are more corrosion resistant. They are more ductile and therefore more easily handled in forming operations. Their appearance is equal to or better than that of terne coatings. The adherence is achieved with a minimum of tin and the tin is concentrated at the place where its presence is required.

The saving of tin increases markedly as the weight of lead coating applied is increased. In the new method, the quantity of tin used is substantially the same regardless of the weight of lead coating applied. Thus where a 40 lb./dbb. coating is required, the new method uses 0.2 or at the most 0.6 lb. of tin, whereas a terne coating of the same weight would contain 3 lbs. of tin. At present prices, this difference represents a savings of about \$5.25 per double base box of plate produced. The heavier lead coatings can be obtained by the use of two dipping pots in a manner analogous to the double dip procedure customarily used for the production of the heavier-weight ternes.

While I have shown and described one specific embodiment of my invention, it will be understood that this embodiment is merely for the pur-

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pose 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 applying an adherent coating of substantially pure lead to a ferrous metal article which consists of electroplating the article with a tin coating between 0.000003 and 0.000018 inch in thickness, heating the tin plated article to a temperature between the melting point of tin and 650° F. to substantially completely alloy said tin with the surface of said article, and then immersing the heated article in a molten bath of lead.

2. The method of applying an adherent coating of substantially pure lead to a ferrous metal article which consists of electroplating the article with a tin coating between 0.000003 and 0.000018 inch in thickness, heating the tin plated article to a temperature of 600-650° F. for one to two seconds in a substantially deoxidizing atmosphere until said tin is substantially completely alloyed with the surface of said article and while still protected by said atmosphere immersing the heated article in a molten bath of lead.

3. The method of applying an adherent coating of substantially pure lead to a ferrous metal article which consists of electroplating the article with a tin coating not less than 0.000003 inch and not more than 0.000018 inch thick, heating the tin plated article to a temperature between the

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melting point of tin and 650° F. in a substantially deoxidizing atmosphere until said tin is substantially completely alloyed with the surface of said article and while still protected by said atmosphere immersing the heated article in a molten bath of lead.

4. The method of applying an adherent coating of substantially pure lead to a low carbon elongated steel strand consisting of cleaning the strand, electroplating the cleaned strand with a tin coating not less than 0.000003 inch and not more than 0.000018 inch thick, heating the tin coating to a temperature of 600-650° F. for one to two seconds to completely alloy said tin with the surface of said strand, and then hot-dip coating the heated strand with substantially pure lead.

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