

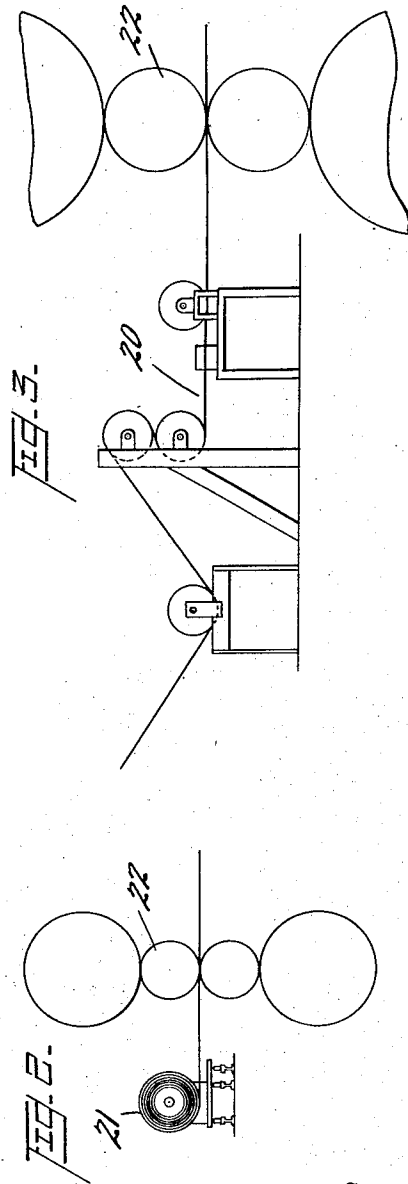
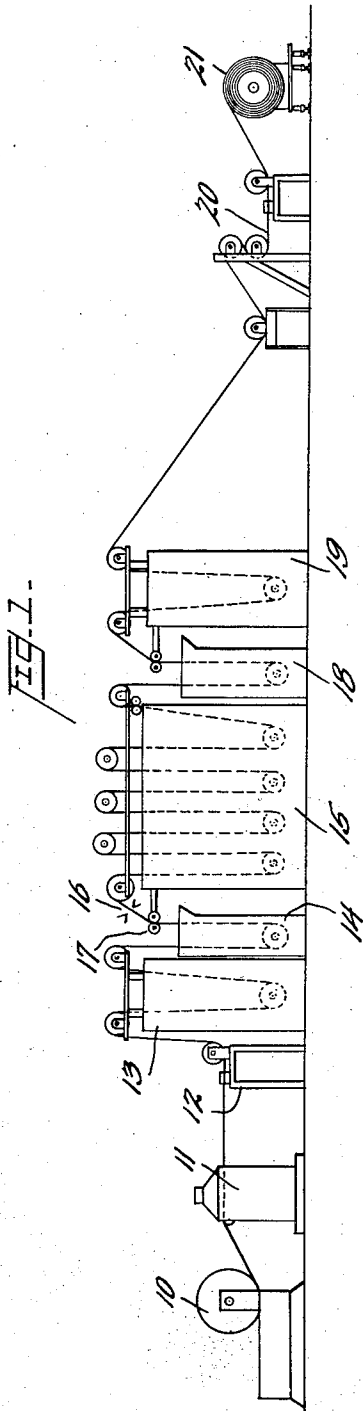
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METHOD OF MAKING TIN PLATE

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METHOD OF MAKING TIN PLATE

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This invention is an improved tin plate and method for preparing same.

One object of the invention is to provide tin plate with a tin coating having enhanced rust resistance.

Another object of the invention is to provide tin plate with a surface of increased hardness. The hardness characteristic renders the product more abrasion resistant and materially lessens the likelihood of scratching and incipient oxidation of the base.

A further object of the invention is to produce tin plate having a higher lustre and smoothness as compared with tin plate heretofore available. Since tin plate is employed frequently because it is desired to give a nice appearance to an article, the presence of a surface having an improved polish is very desirable.

An additional object of the invention is to produce tin plate having an increased affinity for lithograph and printing inks as well as decorative and protective lacquers and paints. Such coatings, as well known, are frequently applied to tin boxes, cans, container closures and other articles and the better and more permanent adherence of the coating to the tin plate is in marked distinction to hot-dip tin plate which because of the presence of oily residue frequently repels a coating or allows the same to be readily rubbed off.

Another object of the invention is to provide tin plate having enhanced temper and workability. That is to say, the tin plate of this invention can be fabricated, as by stamping, drawing or other metal working operations into various shapes without danger of the metal cracking or of the tin coating peeling or flaking from the metal base.

Of equal importance with the foregoing, it is an object of the invention to provide a method which is simple and economical in operation. This method embodies a combination of steps comprising (1) electrolytically coating the base metal with tin followed by (2) a skin pass treatment in the nature of a high pressure cold-rolling. Not only is an improved product obtained by this method, but the rapidity of the method and the savings in tin consumption enable a reduction in cost which may reach 50% less than with the conventional hot-dip methods.

Another object of the invention is to provide a method in which a continuous band or strip of the base metal is treated by the aforesaid method to produce a smooth continuous tin coating which completely covers the base metal, is

substantially uniform in thickness, and has increased adherence to the base metal, as evidenced by the ability of the tin plate to resist peeling and flaking when subjected to severe metal working operations.

An additional object of the invention is to provide a method wherein continuous base metal strip or sheets of increased width, as compared to sheets platable by methods heretofore available, may be tin plated with facility. I have found that base metal having a width of 30 inches or more may be readily plated by the method of the present invention. For many purposes, ability to increase the width of the tin plate affords a substantial economy, as in the manufacture of container closures and containers.

I have found that in order to obtain a coating having the required brightness and other characteristics, it is necessary to control critically the pressure or the resulting elongation or reduction of the metal in the first pass through the mill in the cold-rolling operation. In other words, I have found that successive passes will not produce the desired characteristics if a minimum elongation or reduction is not obtained in the first pass. For example, in reducing by cold-rolling, I have found that the first pass should produce an elongation of the order of at least $\frac{1}{2}$ inches for each 25 linear inches. Although I have found no objectionable maximum elongation, it is observed that very satisfactory results have been obtained when elongation varies from $\frac{1}{2}$ to $\frac{1}{4}$ inches for each 25 linear inches. Stated in terms of reduction in gauge, I find that the reduction in the first pass should be at least $\frac{3}{4}$ of one percent, which may be increased as desired. So far as the brightness of the coating is concerned, I have found no objectionable maximum reduction below which the reduction must be maintained in the first pass. However, it is desirable that the reduction not reach a point where the strip is objectionably deformed as indicated by bowing or wrinkling. Consequently, the percentage of reduction in the first pass should be maintained below that which will cause such strip deformation. Subsequent passes do not destroy the effects obtained in the appearance of the metal when the elongation or reduction in the first pass is controlled in this manner. Stated in terms of pressure, I have found that the rolls of the mill should be adjusted to apply a pressure of the order of from at least 250,000 to 500,000 lbs. Such a range of pressure has been found to produce the desired

finish and coincident reduction when rolling, for example, a strip 30 inches wide and having a gauge of approximately .011 inch. This pressure may be determined in the conventional way, by an instrument employed to register the elongation of the mill housing during the application of pressure. Such instruments are well known and are employed on substantially all types of rolling mills. The particular figures given were taken from such instrument applied to a 4-high "Mesta" tempering mill. When so controlled, the elongation and gauge reduction is of the order above recited. The metal may be fed through the mill at a rate of from 1200 to 2000 feet per minute.

It is, of course, well known that tin plate is relatively expensive because of the cost of the tin. With this invention, it has been found that smooth, nice-appearing coatings affording the desired protection of the base metal for certain uses such as for dry packages can be produced with as little as $\frac{1}{16}$ pound of tin per base box. By base box, I mean the area represented by 112 sheets of size 14 by 20 inches, i. e., substantially 33,000 square inches. Of course, coatings of increased weight may be applied with equal efficiency, and the method lends itself to regulation of the weight as desired. As is well known, by the hot-dip method, it is not ordinarily possible to reduce the weight of the coating below $1\frac{1}{3}$ pounds per base box.

Economy in manufacture is important since tin plate is employed universally and particularly in the manufacture of numerous articles which must be sold at a very modest price.

For a more complete understanding of the invention reference is had to the accompanying drawing wherein

Figure 1 is a diagrammatic illustration of the electro-coating operation;

Figure 2 is a diagrammatic illustration of the cold-rolling step; and

Figure 3 is a diagrammatic view showing the manner in which the electro-coated band is continued to the cold-rolling instrumentality.

In practicing the invention, the customary steel or black iron of appropriate gauge is utilized. The metal is usually annealed and is supplied in continuous strips in the form of rolls by the steel mill.

A roll of steel strip, indicated at 10 in Figure 1, is mounted upon a conventional uncoiler for feeding the strip continuously to the electrolytic coating apparatus. The numeral 11 indicates an apparatus for welding ends of the strips together and the numeral 12 indicates a table having a holding clamp to maintain one end of the strip during the welding operation. The numeral 13 indicates the acid pickling tank which generally contains hydrofluoric or other suitable acid while the numeral 14 indicates a cold water rinsing tank. The strip 10 just prior to entering the electrolytic bath 15 is heated by means of steam jets 16 to a temperature of about 160° F. The wiping rolls 17 are of the character to permit a film of water to remain on the strip substantially until it enters the bath, whereby the strip is protected against the effects of oxidation by the air and is introduced to the bath at a temperature to promote optimum coating and without substantially reducing the temperature of the bath. As will be understood, the heating means employed, namely, steam application is of a character which will not dry the surface of the strip; there is sufficient condensation of the steam to maintain

the desired protective moist film. The strip is fed through the bath at varying speeds which may be as high as 500 feet a minute or greater. It will be noted that in the bath the strip is coated while traveling in vertically disposed position. The chemical reagents employed are preferably sodium stannate 5.4 ounces to 13 ounces; sodium acetate 2 ounces to 5 ounces; and caustic soda 1 ounce to 3 ounces, per gallon of water. In some cases, sodium cyanide is included in the bath in an amount to insure that the electrodes corrode uniformly, for example, about 1 ounce to 6 ounces, per gallon of water.

The current density is maintained between 10 and 75 amperes per square foot of cathode (strip) and the temperature of the bath is generally substantially between 158° to 200° F. As will be understood, the weight of the coating may be controlled by varying the time to which the strip is subjected to the bath as by regulating the speed of travel of the strip or by varying the amperage or by doing both.

From the bath, the coated strip is led through a cold water rinsing tank 18 and then through a hot water rinsing tank 19 whereupon it travels through a tensioning mechanism 20 and is wound into coils 21. The coated metal is dull and soft and will have a thickness or weight of tin coat controlled in accordance with the use to be made of the tin plate.

The coils of coated metal are each transferred to a suitable uncoiler for continuously feeding the strip to the cold-rolling instrumentality which is in the form of a usual 4-high mill as shown at 22 in Figure 2. In this mill, the coated sheet is given a skin pass treatment by means of a high pressure cold-rolling to impart the properties of rust resistance, smoothness, hardness, temper and workability, and high lustre in a manner appreciably better than present available tin plate now possesses. The apparatus disclosed has the rolls rotating at uniform speed.

I have discovered that cold-rolling of tin coated metal, and particularly metal which has been electrolytically coated with tin, very substantially contributes to producing the aforesaid improved properties of the tin plate. That is to say, as above explained, I have found that in order to obtain a coating having the required brightness and other improved characteristics, it is necessary to control critically (1) the pressure or (2) the resulting elongation or (3) the reduction of the metal in the first pass through the mill in the cold-rolling operation. It will be observed that the skin pass treatment is decidedly rapid, and since the metal is fed as a continuous strip and only a single skin pass treatment is required a substantial economy is effected in addition to producing an improved product.

In certain cases, one or more additional skin pass treatments may be resorted to, but this has not been found necessary in actual operation, a single pass through the machine being sufficient.

The skin-pass treatment is particularly efficient when combined with the electro-deposition step, but also markedly improves tin plate prepared by immersion or by the conventional hot-dip method of coating.

Tin plate prepared in accordance with the aforesaid method, i. e., electrolytically coated and then cold-rolled shows a rust resistance substantially higher than tin plate of the same weight produced by the conventional hot-dip method. Similarly, tin plate produced by the

conventional hot-dip method and then cold-rolled in accordance with the method herein described shows a rust resistance which is materially enhanced as compared to the rust resistance of the hot-dip method product of the same weight which has not been cold-rolled.

Moreover, the improved polish or high lustre of the tin plate is appreciable and very materially enhances the appearance of the product.

Since the principal purpose of coating steel with tin is to (1) protect the metal; and (2) beautify the same, it will be understood that both of these characteristics are substantially improved by the present invention.

By way of example, a continuous strip of steel having a thickness of substantially .011" which is customarily used for making "crown" tin plate is provided in accordance with this invention with a tin coating having a weight of approximately one half to three quarters of a pound per base box. The ingredients employed per gallon of water are sodium stannate—8 ounces; sodium acetate—3 ounces; caustic soda 1.6 ounces. Sodium cyanide was included in the bath in an amount to assure that the electrodes corrode uniformly, for example, 3 ounces per gallon of water. The current density was maintained at 16 amperes per square foot of cathode (strip) and the bath temperature was of the order of 175° F. The metal was introduced to the bath at a temperature of about 125 to 160° F.

The coated metal as produced was formed into a roll 21. The rolls of the mill 22 through which the strip is now continuously fed are adjusted to exert a pressure of the order of 500,000 lbs. and at the bight of the rolls the pressure exerted per linear inch transversely of the strip upon the coated metal is about 17,000 lbs. The speed of travel of the strip is 1200 feet per minute. In this manner, the critical conditions of cold-rolling under high pressures are observed in that for any 25 linear inches the metal is elongated by the operation about $\frac{3}{32}$ inches and reduced in thickness about 1% in a single pass through the mill. In this manner, there is produced a strip having a uniform coating which completely covers the metal base. Of particular importance, the coating is smooth and continuous and has a high lustre. Continuity of the tin coat denotes

the measure of rust resistance and in the present case rust resistance is substantially higher than with a comparable weight of hot-dip tin plate. The product is difficult to scratch indicating a desirable hardness and is readily worked without cracking and without peeling or flaking of the tin coat. Likewise, the product permanently retains decorative and protective coatings much better than conventional tin plate. From the foregoing, it will be appreciated that the combination of electrolytic coating and high pressure cold-rolling produces a very satisfactory product and affords a rapid and economical method.

In some cases, instead of collecting the coated plate in a roll 21, the strip may be continued so as to be passed directly to the cold-rolling mill 22 as shown in Figure 3.

In connection with the electro-plating operation, it is sometimes desirable to give the band a cold-rolling treatment before it enters the bath, i. e., before the acid pickling, in order to properly temper the strip.

The invention may be applied in connection with any suitable gauge of base metal and any appropriate weight of tin coating and while the metal is preferably fed as a continuous strip, the product may be formed in sheets of any desired length.

I claim:

1. The method of making tin plate which comprises electrolytically coating tin on iron strip and cold rolling the coated metal with rolls rotating at uniform speed and under a pressure of from 250,000 pounds to 500,000 pounds to elongate the metal at least $\frac{3}{32}$ inch for any linear 25 inches in a single pass through the rolling instrumentality and to impart a smooth, lustrous surface to the electroplated strip.

2. The method according to claim 1 wherein the coated metal is traveled between the rolls at a speed of substantially 1,200 to 2,000 feet per minute.

3. The method according to claim 1 which comprises exerting a roll pressure of 500,000 pounds and a pressure at the bight of the rolls of about 17,000 pounds per linear inch transversely of the strip.

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