

UNITED STATES PATENT OFFICE

2,303,035

BRIGHTENING ELECTRODEPOSITED TIN-CONTAINING COATINGS

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No Drawing. Application September 14, 1942,
Serial No. 458,320

10 Claims. (Cl. 204—36)

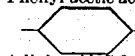
This invention relates generally to a process of brightening electrodeposited tin-containing coatings and to a brightening bath for such coatings. It is known that electrodeposited tin-containing coatings have many advantages over those produced by the hot dip process. Electrodeposited coatings may be made more uniformly than those obtained by hot dipping and with a thinner coat and freer from porosity. However, one objection to electrodeposited tin coatings is that they have a dull or matte finish which precludes their use in certain industries.

In accordance with the present invention, I have provided a process whereby the dull finish characteristic of electrodeposited tin-containing coatings can be converted efficiently and simply into a bright mirror-like finish. I have found that this may be accomplished by heating the tin coated body, for example a steel strip coated with tin, to a temperature above its fusion point in an oil bath containing sufficient uncombined organic carboxylic acid to provide the carboxyl radical (COOH) within certain proportions by weight of the oil bath. I may start with a mineral oil bath which of itself is ineffective for brightening the coating and add to this oil bath a certain proportion of one or more organic acids. I have found that if the amount of carboxyl radical is below or above a certain percentage by weight of the oil bath, it is not effective in brightening the coating. Where the amount of carboxyl group is too low, it does not brighten the coating, and where it is too high, it attacks the coating, giving etching or breaking of the crystalline film, which precludes the production of a mirror finish. I have found that a bright mirror finish may be obtained on a tin coating by heating the coating to a temperature above its fusion point in an oil bath containing preferably from 0.10-2.6% by weight of carboxyl radical, although the upper limit may be increased up to about 4% without pronounced roughening effect rendering the product unmerchantable, when the preliminary steps of plating, cleaning and pickling have been very efficiently performed. The coating is then rapidly cooled. If the coating after fusion in the oil bath is cooled slowly, it results in spangling. The preferred oil bath is one consisting principally of mineral oil but adjusted by the addition thereto of an organic acid so as to give the content of carboxyl radical above specified.

Tests have been made starting with either a Russian mineral oil or a mineral oil known as "Quaker State" lubricating oil S. A. E. 50, and

adding to these oils various amounts of organic acids. The electrodeposited tin coated bodies were immersed in the oil bath heated to a temperature of about 250° C. for various periods of time, usually about ten seconds, and were then rapidly cooled by immersing in a cooling bath of oil or water. It was found that the straight mineral oil baths without the addition of organic acid did not produce a bright finish, irrespective of how short or how long the coatings were heated. However, the addition of organic acids to produce the carboxyl content of the bath within the range referred to resulted in bright mirror finishes irrespective of the particular organic acid which was employed. It was found that twice as much capric acid as sebacic acid, figured on a molar basis, was needed to give a mirror plate. It will be noted that capric and sebacic acids are similar in structure except that the sebacic acid has two carboxyl groups, whereas capric acid has only one.

The following table illustrates the results of tests carried out by adding various amounts of different organic acids to mineral oil and testing them for their brightening effect on electrodeposited tin coatings. The oil bath was heated to 250° C. and the samples were immersed in the bath for a period of about ten seconds. After immersing, the samples were withdrawn from the oil bath and rapidly cooled. The table shows the lower and upper limits of carboxyl radical for each of the acids within which bright surfaces are produced.

Acid used (added to mineral oil)	Molecular weight	Lower limit in per cent by wt. —COOH	Upper limit in per cent by wt. —COOH
40 Palmitic acid $C_{15}H_{31}COOH$	256	0.17	1.7
Phenyl acetic acid			
45  CH_2COOH	136	0.14	1.6
Adipic acid $COOH(CH_2)_4COOH$	196	0.10	2.0
Sebacic acid $COOH(CH_2)_8COOH$	202	0.12	2.0
45 Capric acid $CH_3(CH_2)_8COOH$	172	0.15	2.6

It will be seen that bright surfaces are produced when the carboxyl radical constitutes between 0.10 and 2.6% by weight of the mineral oil bath, which may be regarded as the preferred general range, although it should be noted that the appropriate lower and upper limits vary somewhat depending on the particular constituents used. Also, as already mentioned, it is possible by the use of particular care in the pre-

liminary plating, cleaning and pickling steps, to add carboxyl radical up to about 4% by weight, before the roughening effect becomes so serious as to render the product unmerchantable. However as the upper limit is approached, the brightening effect is to some extent impaired by the increased roughness of the surface.

In carrying out the invention on a commercial scale, an organic acid or a mixture of organic acids may be added to a mineral oil until the carboxyl radical content is within the limits given above. These oil baths in use are likely to change in composition, due to oxidation, polymerization and contamination and it is necessary in order to retain the effectiveness of the bath in its brightening action to maintain the carboxyl radical content within the limits referred to. In the event that the carboxyl content falls below 0.10% by weight, the bath may be adjusted by adding a carboxylic acid to raise the carboxyl radical content. If, on the other hand, the carboxyl radical content rises above 2.6%, due to oxidation or other causes, it is preferred to lower the carboxyl content, and as above stated this becomes absolutely necessary at about 4% of carboxyl content. This may be done by adding an alkali to the bath, for example, sodium hydroxide, or by adding a further quantity of mineral oil which by dilution reduces the concentration of carboxyl radical. Instead of adding mineral oil, I might add any other oil which has a lower carboxyl content than the carboxyl content of the oil bath, in order to reduce the carboxyl content to within the limits referred to. The brightening bath of the present invention preferably consists principally of mineral oil but it may comprise certain non-drying vegetable, fish, animal oils or fats, for example, hydrogenated cottonseed oil, hydrogenated pilchard oil, palm oil, lard, menhaden oil and the like, provided that in any case the carboxyl content of the oil bath is within the range specified.

I may employ a flash coat of nickel, copper, cobalt, tungsten, iron or other metal as an undercoat for the electrodeposited tin coating and then treat the coated body in the manner described.

Although it is preferred to add carboxylic acid to a mineral oil bath and then heat the tin coated body in the adjusted bath, good results have been obtained by putting a film of predetermined thickness of a carboxylic acid on the electrodeposited tin coating by wiping it with a cloth moistened with a carboxylic acid or by a dipping operation and then heating the coated body with the acid film on it in a hot oil bath of plain mineral oil. If the film of acid on the coating is too thick, etching of the coating occurs. It is intended in the claims where reference is made to heating the coating in an oil bath containing a certain amount of carboxyl radical to cover not only the process wherein the carboxyl radical is added directly to the oil bath but also the case where the carboxyl radical is supplied in a film on the article and the article then heated to a temperature above the fusion point of the coating.

This application is a continuation in part of my prior application Serial Number 280,102, filed June 30, 1939. Reference is also made to my application Serial Number 134,798, filed August 3, 1937, and to my application Serial Number 51,800, filed November 27, 1935.

In my application, Serial No. 149,885, filed June 23, 1937, a method is described in which a steel strip is given a flash coating of tin, the coated

strip is then heated in a non-oxidizing gaseous atmosphere, in order to form a tin-iron alloy at the surface of the strip, a second tin-containing coating is then deposited on the first coating and the coated body is immersed in a heated oil bath for a time sufficient to fuse the second coating. The heated oil bath has a sufficiently high acid number to produce a bright finish on the coated strip.

The invention is not limited to the particular carboxylic acids which have been referred to nor to the preferred embodiments or proportions but may be otherwise embodied or practiced within the scope of the following claims.

I claim:

1. The process of brightening electrodeposited tin-containing coatings, which comprises heating the coating to a temperature above its fusion point in an oil bath containing sufficient uncombined organic carboxylic acid to provide 0.10-2.6% of the carboxyl radical by weight of the bath, and rapidly cooling the coating.

2. The process of brightening electrodeposited tin-containing coatings, which comprises heating the coating to a temperature above its fusion point in a mineral oil bath containing sufficient uncombined organic carboxylic acid to provide 0.10-2.6% of the carboxyl radical by weight of the bath, and rapidly cooling the coating.

3. In the process of coating a metal body wherein a tin-containing dull finish coating is electrodeposited on the body and the body is heated in a brightening bath of oil containing sufficient uncombined organic carboxylic acid initially to provide 0.1 to 2.6% by weight of the carboxyl radical, but which after a period of use becomes ineffective in brightening the coating due to changes in acidity of the bath, the step which comprises adjusting and maintaining the acidity of the bath at said carboxyl radical content of 0.10-2.6% by weight.

4. The process of coating a metal body, which comprises electrodepositing a tin-containing coating on the body, heating the coated body to a temperature above the fusion point of the coating in a brightening bath of oil containing uncombined organic carboxylic acid, and regulating and maintaining the carboxyl radical content of the bath at 0.10-2.6% by weight in maintaining the efficiency thereof to produce a bright finish on the coating, and rapidly cooling the coating.

5. A bath for brightening electrodeposited tin-containing coatings, said bath consisting principally of mineral oil but containing sufficient uncombined organic carboxylic acid to provide 0.10-2.6% by weight of the carboxyl radical.

6. A process for brightening electrodeposited, tin-containing coatings, which comprises fusing the coating in a hot oleaginous bath containing sufficient uncombined organic carboxylic acid to brighten said coating and such as to provide upwards of about 0.1% of the carboxyl radical by weight of the bath, but in amount insufficient to cause substantial etching of said coating and insufficient to preclude the production of a mirror finish and thereafter solidifying the coating by rapid cooling.

7. A process for producing bright, tin-containing coatings on a higher melting base metal, which comprises: electrodepositing the coating material on the base metal, heating the coating to a temperature above its fusion point in a hot oleaginous bath containing sufficient uncombined organic carboxylic acid to provide about 0.1 to

2.6% of the carboxyl radical by weight of the bath, and thereafter solidifying the coating by rapid cooling.

8. A process for producing bright, tin-containing coatings on a higher melting base metal, which comprises: electrodepositing the coating material on the base metal, heating the coating to a temperature above its fusion point in a hot bath of palm oil containing sufficient uncombined organic carboxylic acid to provide about 0.1 to 2.6% of the carboxyl radical by weight of the bath, and thereafter solidifying the coating by rapid cooling.

9. A process for producing bright, tin-containing coatings on a higher melting base metal, which comprises: electrodepositing the coating material on the base metal, heating the coating

to a temperature above its fusion point in a hot bath of palm oil containing sufficient uncombined organic carboxylic acid to provide about 0.1 to 4.0% of the carboxyl radical by weight of the bath, and thereafter solidifying the coating by rapid cooling.

10. A process for producing bright, tin-containing coatings on a higher melting base metal, which comprises: electrodepositing the coating material on the base metal, heating the coating to a temperature above its fusion point while surrounded by hot oleaginous liquid containing sufficient uncombined organic carboxylic acid to provide about 0.1 to 4.0% of the carboxyl radical by weight of the liquid, and thereafter solidifying the coating by rapid cooling.

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