

UNITED STATES PATENT OFFICE

2,215,144

COATING METAL CONTAINERS

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No Drawing. Application February 9, 1938, Serial No. 189,588. In Great Britain February 18, 1937

10 Claims. (Cl. 204—1)

204-181

5 This invention relates to the coating of metal, especially metal containers more particularly intended for beverages such as beer and wine, which may be preserved by heat treatment at a relatively low temperature, and to an improved method of coating such containers.

10 It is well known that in order to prevent the development of turbidity and other defects, it is necessary to protect the beverage from direct contact with the metal surface of the container. The ordinary lacquer coatings used for food cans are unsuitable for this purpose, since an undesired flavour is imparted to the beverage. Certain waxes or mixtures of waxes with one another or with other constituents may be used, but when it is attempted to coat the metal by direct application of molten wax the results are unsatisfactory. This is principally due to the tendency of the wax to drain away from the convex portions of the metal surface, such as seams or corrugations. In order to overcome this difficulty a method is in use whereby the metal surface is first coated with a lacquer and afterwards molten wax is applied so as to cover the lacquer surface and any exposed small areas of metal.

15 According to the present invention the metal surface to be coated is brought into contact with an aqueous dispersion of the wax or like coating material and forms the anode in an electric circuit, the cathode also being in contact with the aqueous dispersion and in such a position relative to the surface to be coated that the desired coating of wax is obtained by electrode position directly upon the metal surface. The coated surface is freed from excess of the aqueous dispersion by drainage, followed if necessary by rinsing, and the moisture is removed from the deposited film. Removal of moisture may be effected by warm air, preferably at a temperature below the melting point of the wax. At this stage the deposit appears opaque and granular, and is porous. The temperature is then raised sufficiently to melt the wax, causing coalescence of the deposited particles and allowing any entrained gas to escape, whereby on cooling a smooth, impervious coating is obtained, which has the normal appearance of a wax film.

20 No intermediate coat of lacquer is necessary and stoving at high temperature is eliminated.

25 Satisfactory coatings may be obtained when the dispersion is at room temperature, but if desired, electrodeposition may be carried out at an elevated temperature, for example, above the melting point of the wax.

30 In certain cases the step of rinsing or washing

the deposit may be omitted, a dispersion being used which is of sufficiently low viscosity to leave only a small amount of dispersion clinging to the surface after draining. For example a wax containing acidic constituents, such as beeswax, or a mixture of such a wax with a neutral wax, may be dispersed in dilute aqueous ammonia. After electro-deposition, the excess of ammonia may be removed by application of heat alone. The omission of rinsing obviates risk of disintegrating the deposit. In other cases the dispersion medium may be such that washing is necessary in order to remove the excess, and in such cases it is especially desirable that the deposited wax particles should adhere well to one another and to the metal surface, in order to withstand the impact of the wash liquor. Complete coalescence of the deposited particles does not occur until the coating is melted, preferably after drying off residual moisture.

35 A further desirable feature of the dispersion is that it should possess a property known in the terminology commonly used in connection with electro-deposition processes as "throwing power." By this is meant the property whereby different areas of the electrode to be coated, in the present case the anode, receive substantially the same density of deposit even through they lie at appreciably different distances from the other electrode, in this case the cathode. A major reason for the importance of this property lies in the fact that in a fabricated container, the seams present crevices which may be relatively deep and narrow, and the electrolytic resistance which has to be overcome in treating areas of metal within the crevices may be considerably greater than that involved in treating freely exposed areas nearer to the cathode. Unless the dispersion has adequate throwing power, metal in the crevices may be imperfectly covered.

40 Where the container is of uniform cross-section, or is not narrower at the orifice than below, it is possible to employ a cathode of such contour that the distance between the cathode and the container surface is everywhere practically the same, and provided that the throwing power of the dispersion is sufficient to give satisfactory coating within crevices, a substantially uniform coating over the whole surface may be readily obtained. Certain types of containers used for beverages, however, have conical tops with narrow orifices, and in such cases it is not possible by simple means to obtain a uniform separation of the electrodes, when the container is coated after fabrication. If the throwing power of the disper-

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sion is made great enough, however, even in cans of this form a substantially uniform coating may be obtained over the whole of the interior surface.

We have found that by suitable choice of wax composition and of dispersion medium, the throwing power of the dispersion may be greatly improved, so that conical topped containers may be coated by use of a cathode in the form of a narrow rod of uniform cross-section. At the same time both the coherence of the deposit and its adhesion to the metal are considerably increased, so that it may be readily washed free of excess dispersion without disintegrating.

For the attainment of these results, the dispersion medium contains a soluble salt of alkaline reaction, having an anion such that on addition of acid to the salt an insoluble oxide or hydroxide would be formed, or a mixture of such salts may be present. As examples of suitable compounds, sodium aluminate or sodium silicate, or mixtures of sodium aluminate and sodium silicate, may be used. Furthermore, conditions are so adjusted that passage of an electrical current produces simultaneously, at the anode, deposition of wax particles and of insoluble oxide or hydroxide.

In making such a dispersion, the composition of the wax and its concentration in the dispersion are so chosen in relation to the concentration of compounds having the above characteristics, that precipitation of insoluble oxide by acidic constituents of the wax is avoided, while the dispersion is stabilized. Alternatively, within certain limits the concentration of wax and the nature and concentration of the compound or compounds contained in the dispersion medium may be adapted to the composition of the wax. For example, in certain experiments a dispersion containing 10 per cent. of beeswax in a solution of sodium silicate, having a sodium oxide to silica ratio of 1:3.8 and a total solids content of 1 per cent. was found to be stable, but the same concentration of wax in a 1 per cent. solution of sodium aluminate produced coagulation. A stable dispersion in a 1 per cent. solution of sodium aluminate was obtained when the beeswax concentration was reduced to 5 per cent. of the total weight of dispersion. It was further found that, keeping the ratio of beeswax to aluminate constant, the concentration of wax in this dispersion could be increased by addition to the wax phase of a neutral wax such as paraffin or ceresin.

We have found that the throwing power of the dispersion is dependent on the current density at which electrodeposition is carried out. The throwing power is related to the degree of constancy of the current during deposition, under otherwise identical electrical conditions.

If the deposit on a certain area of the container surface near to the cathode adds appreciably to the electrical resistance over that area, the current will fall and simultaneously a greater proportion of the current will flow to areas more remote from the cathode. Our experiments have shown that in many cases the current remains substantially constant when the current density is relatively low and the deposit then shows marked non-uniformity if the interelectrode distance varies, but that on increasing the current density a progressively more pronounced drop in current occurs during deposition, and the coating becomes substantially uniform.

Furthermore, the rate of decrease in the cur-

rent depends on the relation between the resistance due to the deposit and the total resistance of the electrical circuit. If the initial resistance (including that of the electrolyte) is low, the resistance of the deposit will be the predominating factor and the current will diminish relatively quickly. We have found that it is an advantage to arrange conditions so that the current density is high at first, but that a rapid fall in current occurs as the wax film builds up. In this way, an initially rapid deposition may be obtained with good distribution, while the subsequent decline in current offsets the tendency of simultaneous gas evolution at the anode to disrupt the deposit. With a container of uniform cross-section the distance between the electrodes can be made small, so that the initial electrolytic resistance is low, and a current variation of this kind may be obtained automatically. When the container has a constricted orifice which makes necessary the use of a cathode of small diameter, the electrolytic resistance is greater and it is then desirable to augment the automatic decline in current by progressively introducing additional resistance into the external circuit during deposition.

We have found that in general a dispersion of a wax in sodium aluminate solution yields under given electrical conditions a considerably thinner deposit than does an otherwise similar dispersion of the same wax in sodium silicate (of ratio $\text{Na}_2\text{O}:\text{SiO}_2=1:3.8$) of the same concentration, but that the throwing power is greater in the former case and the deposit shows less tendency to entrain gas and thereby produce pinholes. Stable dispersions may be made in mixtures of sodium aluminate and sodium silicate, and it has been found that as the proportion of silicate increases, the weight of the deposit for given electrical conditions also increases, and there is a transition in the character of the deposit. We have found that, if the proportion of silicate is not increased too far, deposits may be obtained from dispersions in the mixture which are superior to those from dispersions in either component alone. Thus the coating is heavier than when aluminate alone is used, while it is more uniform and free from defects than when silicate alone is used.

Further, our experiments have shown that improved results are obtained when the dispersions are so formulated that the decrease in alkalinity required to produce instability is small. For example, the ratio of the acidic constituents of the wax to the amount of aluminate may be made as high as is compatible with absence of thickening or coagulation in the dispersion. In another example, sodium silicates of high $\text{Na}_2\text{O}:\text{SiO}_2$ ratio are less effective than silicates of lower ratio.

The results of our experiments may be explained by the supposition that deposited oxide or hydroxide serves to bind the deposited wax globules, so that the coherence and adhesion of the coating are increased, but our invention is not dependent on the correctness or otherwise of any such explanation.

As examples of suitable dispersions and conditions the following may be quoted, but the invention is not to be regarded as limited to these particular examples, which are typical only. In these examples the sodium silicate used had a ratio of $\text{Na}_2\text{O}:\text{SiO}_2=1:3.8$. The current densities refer to the anode.

Example 1

	White beeswax.....	220 grms.
	1% sodium silicate.....	2 litres
	Initial current density.....	30-40 amps./sq. ft.
5	Final current density.....	about 4 amps./sq. ft.
	Time of treatment.....	6 secs.

Example 2

	White beeswax.....	47 grms.
10	Paraffin wax.....	453 grms.
	0.375% sodium aluminate.....	2 litres
	Initial current density.....	25-30 amps./sq. ft.
	Final current density.....	about 3 amps./sq. ft.
15	Time of treatment.....	6 secs.

Example 3

	White beeswax.....	47 grms.
	Ceresin.....	453 grms.
	Sodium aluminate.....	5.65 grms.
20	Sodium silicate 9.35 grms. (calculated as solid)	
	Water.....	2 litres
	Initial current density.....	30-50 amps./sq. ft.
	Final current density.....	about 8 amps./sq. ft.
25	Time of treatment.....	6 secs.

The coating material may contain substances such as resins, bitumens, pitches, plasticizers or solvents to improve the adhesion between individual particles in the deposited film and between the film and the can. Similarly the dispersion medium may contain additional materials intended particularly for controlling the stability of the dispersion, for example, emulsifying agents.

The invention may be applied to completed containers or to portions thereof as a step in manufacture. For example, the bodies and ends may be coated separately before being seamed, or when partially seamed together.

We declare that what we claim is:

1. A process of coating the interior of metal containers, which comprises making the container the anode in an alkaline electrolytic bath containing a foodstuff-permissible salt of alkaline reaction having an anion such that addition of acid would produce an insoluble oxide or hydroxide said salt being present in an amount to give the dispersion sufficient throwing power to deposit the wax substantially uniformly on the container wall, and waxy material in dispersion and passing an electric current therethrough to deposit waxy material directly on the metal.

2. A process of coating the interior of metal containers, which comprises making the container the anode in an alkaline electrolytic bath containing a mixture of foodstuff-permissible salts of alkaline reaction having anions such that addition of acid would produce insoluble oxides or hydroxides said salts being present in an amount to give the dispersion sufficient throwing power to deposit the wax substantially uniformly on the container wall, and waxy material in dispersion and passing an electric current therethrough to deposit waxy material directly on the metal.

3. A process of coating the interior of metal containers, which comprises making the container the anode in an alkaline electrolytic bath containing sodium aluminate and waxy material in dispersion the aluminate being present

in an amount to give the dispersion sufficient throwing power to deposit the wax substantially uniformly on the container wall and passing an electric current therethrough to deposit waxy material directly on the metal.

4. A process of coating the interior of metal containers, which comprises making the container the anode in an alkaline electrolytic bath containing sodium silicate and waxy material in dispersion the silicate being present in an amount to give the dispersion sufficient throwing power to deposit the wax substantially uniformly on the container wall and passing an electric current therethrough to deposit waxy material directly on the metal.

5. A process of coating the interior of metal containers, which comprises making the container the anode in an alkaline electrolytic bath containing a mixture of sodium aluminate and sodium silicate, and waxy material in dispersion the aluminate and silicate being present in an amount to give the dispersion sufficient throwing power to deposit the wax substantially uniformly on the container wall, and passing an electric current therethrough to deposit waxy material directly on the metal.

6. A process as in claim 1 in which the waxy material is deposited from a dispersion at a temperature above the melting point of the wax.

7. A process of coating a metal object which comprises making the said object the anode in an alkaline electrolytic bath containing waxy material in dispersion, said waxy material having acidic constituents said dispersion containing an alkaline salt selected from the group consisting of sodium aluminate and sodium silicate in an amount to give the dispersion sufficient throwing power to deposit the wax substantially uniformly on the container wall, and passing an electric current therethrough to deposit waxy material directly on the metal.

8. A process of coating a metal object which comprises making the said object the anode in an alkaline electrolytic bath containing a dispersion of a waxy material and a foodstuff-permissible salt of alkaline reaction having an anion such that addition of acid will produce an insoluble oxide or hydroxide the salt being present in an amount to give the dispersion sufficient throwing power to deposit the wax substantially uniformly on the container wall, the waxy material containing an amount of acidic wax below that which gives an unstable dispersion in the presence of said salt of alkaline reaction, and an amount of neutral wax to increase the wax phase of the dispersion, and passing an electric current therethrough to deposit waxy material and insoluble oxide or hydroxide directly on the anode.

9. A process as set forth in claim 1 in which the deposited coating is heated to cause coalescence of said coating to a smooth impervious wax deposit.

10. A process as set forth in claim 1 in which the initial anodic current density is of the order of 25 to 50 amperes per square foot, followed by a subsequent anodic current density of the order of 3 to 8 amperes per square foot.

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