Jan. 16, 1962 H. J. REINDL 3,016,719

MATERIAL FOR METAL SURFACES UPON WHICH ICE ADHERES

Filed Nov. 25, 1957

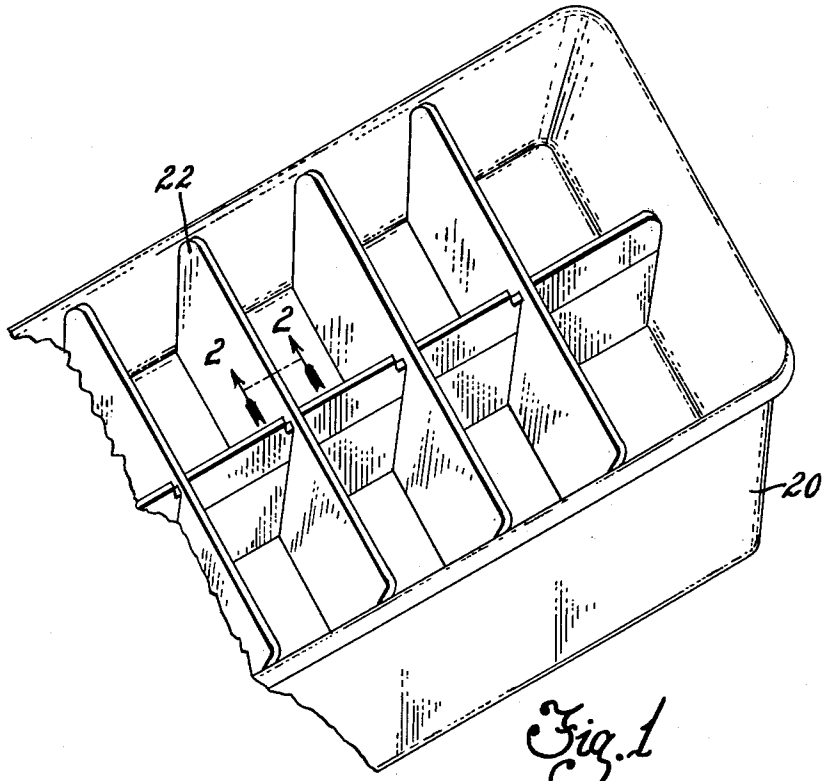


Fig. 1

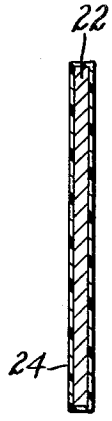


Fig. 2

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United States Patent Office 3,016,719 Patented Jan. 16, 1962

3,016,719
MATERIAL FOR METAL SURFACES UPON WHICH ICE ADHERES

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Filed Nov. 25, 1957, Ser. No. 698,411
9 Claims. (Cl. 62—357)

This invention relates to a coating composition that has water repellent properties and which is particularly adapted for use on metal surfaces or the like.

An object of the invention is to provide a water repellent coating composition which will adhere tenaciously to metal surfaces and which is not brittle but which is hard, tough and wear-resistant.

It is a further object to provide a wax-like coating for metal or the like which will adhere tenaciously to the surface thereof and which will repel water and prevent ice from adhering to the surface of the metal due to the interposed layer of coating material.

Another object of the invention is to provide a hard, transparent and substantially colorless wax-like coating for metal and metal parts which will protect the surface of the parts from water and prevent the adherence of ice thereto.

It is a further object of the invention to provide a wax-like coating material for ice trays and grids or the like which is tough and which will coextensively bond tenaciously to the surface of the ice tray and which, due to its constituency, prevents the adherence of ice to the tray over long periods of use and through many cycles of ejection of ice from the tray without wearing away and/or flaking off.

In carrying out the above objects, it is another object of the invention to provide a coating material for metal which comprises a mixture of an epoxy resin and a formaldehyde base resin together with high melting point waxes, which coating may be polymerized on the metal surface for providing a tough, wear-resisting and strongly adhering coating on the metal.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings wherein preferred embodiments of the invention are clearly shown.

In the drawings:

FIGURE 1 shows one end of an ice tray in perspective.

FIGURE 2 is an enlarged view and section taken on line 2—2 of FIGURE 1.

Mechanical ice trays of the general types shown in Patents 2,779,166, 2,714,294, 2,642,726, etc., require a surface coating treatment on the walls of the tray (including the grid) in order to reduce the adherence of the ice to the ice tray walls and thereby permit mechanical ejection thereof.

These coatings have been in general use over a substantial period of time. Originally, these coatings were waxes such as paraffin coated onto the metallic surfaces of the ice tray. This interposed wax coating prevented the ice blocks or cubes from sticking to the tray. When aluminum ice trays are used, the surface of the aluminum is preferably anodized so as to improve the adherence of the wax to the tray, but even with this expedient, the wax flakes off and quickly wears away so far as its effectiveness is concerned and, after a few ejections, the ice begins to stick and, shortly, the adherence reaches a point that the tray ejecting mechanism will break before the ice is loosened.

In Patent 2,404,431, assigned to the assignee of the present invention, a water repellent coating is described which is a marked improvement over the usual wax type

coating from a standpoint of both wear and hardness. The coating material as described in the patent is a mixture of wax together with specific resins which improve the tenacity of bond as well as improving the period of effectiveness of the coating. In fact, coatings of this character have double and triple the effectiveness of the plain wax coating mentioned above.

Even with this improved coating, however, the effective life of the ice tray, so far as easy ejection of ice cubes is concerned, is limited as above noted since the coating material gradually wears off and permits the ice to bond directly to portions of the metal tray and, while the coating is a great improvement over the plain wax coatings, it still has shortcomings with respect to its life.

When the coating wears off, the ice adheres to the tray and, upon ejection, causes splintered ice and stuck cubes wherein some of the cubes will eject satisfactorily, others will stick in their entirety while still others will splinter due to portions thereof sticking while other portion thereof are free. This results in a high degree of splintered ice and necessitates manual manipulation of a number of the cubes in order to remove them from the grid. Furthermore, the condition is self-aggravating since partial adherence of the cubes tends to flake off adjacent remaining coating until no coating remains. Under these circumstances, it is necessary to replace the grid in its entirety since continued use will cause breakage of the ejecting mechanism.

The present invention is directed to a new and improved coating **24** which has, as its basis, an epoxy resin with wax wherein the coating is more adherent and considerably longer lasting than any heretofore used. The coating **24** is preferably coextensively applied to the surfaces of an ice tray **20** and the grid **22** therefor as shown in the drawings. The coating is completely transparent and clear as differentiated from all known prior art coatings which produce a yellowish tint that makes them rather unsuitable for use with color anodized ice cube trays. Furthermore, the present coating is resistant to detergents which permits washing of the trays in normal dishwashing operations without harm thereto. The problem of washing of trays has always been acute heretofore since all prior art coatings have been attacked by detergents and, after several washings, their effectiveness was markedly reduced. The present coating is capable of repeated washing in hot water and detergents without affecting its ice shedding properties.

The coating referred to is a mixture of an epoxy resin with a formaldehyde base resin together with carnauba wax and a microcrystalline hydrocarbon wax. These ingredients in the proper proportions and dissolved in a suitable solvent may be applied to the metal parts by dipping the parts therein, air drying and then baking to polymerize the resins and form a tough, adherent coating on the article being coated.

A preferred formula for the coating material is as follows:

Example I	Parts by weight
Epoxy resin	39 to 41
Melamine formaldehyde resin	9 to 11
Carnauba wax	1 to 3
Microcrystalline wax	5 to 7
Butyl acetate	200 to 220
Butyl alcohol	200 to 220
Xylol	360 to 400

The solids content of this solution is maintained at 6% to 7%. The coating is preferably formed by mixing equal quantities of butyl acetate, xylol and butyl alcohol with the epoxy resin to dissolve the resin wherein the mixture includes about 50% by weight of resin. The melamine formaldehyde component is dissolved in a mixture of

equal parts of butyl alcohol and xylol wherein the melamine formaldehyde resin component, in dissolved form, comprises about 60% by weight of the mixture.

The carnauba wax and microcrystalline wax are melted in a steam-jacketed tank maintained at 150° F. or below and the remaining xylol is added thereto. Finally, the two resins in solution, the dissolved waxes together with the remaining butyl acetate and butyl alcohol solvents are mixed together to form the coating material.

It is apparent that all of the solid ingredients may be added to all of the solvents but, in this instance, the mixing problems are accentuated whereas by dissolving the several solid ingredients separately and then mixing the solutions, the problems are greatly reduced. When all ingredients are dissolved at once, the temperature of the mixture should not exceed 150° F.

The epoxy resin is a polymer of epichlorohydrin and bisphenol A having an epoxide equivalent of 450 to 2000. The epoxy resin and the melamine formaldehyde resin, both being reactable in their mixed condition, are copolymerizable during subsequent steps and, in this connection, the melamine formaldehyde resin triggers the reaction of the epoxy resin. For this reason, only sufficient melamine formaldehyde is used to complete the reaction of the epoxy resin since any great surplus of melamine formaldehyde resin will make the coating brittle which is not usually desirable if any flexing occurs in the grids or in the tray to which the coating is subsequently applied. On the other hand, the epoxy resin, when fully polymerized, though generally hard, is, nevertheless, pliable and is not brittle which is one of the major factors contributing to the long life and rugged character of the coating.

The microcrystalline hydrocarbon wax is any of the high melting point waxes of the methane series having an empirical formula of from $C_{30}H_{62}$ and $C_{35}H_{72}$. Waxes in this range have melting points above 170° F. as differentiated from commercial grades of paraffin which has an empirical formula of $C_{24}H_{50}$ and a melting point of about 128° F. This high melting point wax is generally preferred although paraffin ($C_{24}H_{50}$) may be used in the coating and still provide considerably more effective ice shedding properties than any known prior art coating.

In general, the wax component comprising the carnauba wax and the paraffin series wax should make up between 10% and 20% by weight of the total resin ingredient. Stated differently, the wax component should be between 10% and 20% of the completed coating composition. I have found that, if the wax component is much below 10%, of the coating, it does not yield satisfactory ice shedding properties whereas, if the wax component is much above 20%, it softens the coating so that the wear characteristics thereof fall below desired figures.

In place of melamine formaldehyde resin, other formaldehyde base resins may be used, for example, urea formaldehyde, triazine formaldehyde, phenol formaldehyde, etc., wherein the formaldehyde base resins are reactable.

Also, any suitable solvents may be used providing they dissolve the solid ingredients and maintain them in solution in admixture. For this purpose, other organic solvents may be added or substituted, for example, toluol, acetone, methyl ethyl ketone, methyl isobutyl ketone, methyl isobutyl carbinol, etc.

The ratio of ingredients noted in Example I may be varied for accomplishing variable results, for example, the epoxy resin may vary from 1 to 9 times the weight of the formaldehyde base resin, with ratio of 3 to 4 parts by weight of epoxy resin to 1 part by weight of formaldehyde base resin being preferred.

Other specific examples are as follows:

Example II

	Parts by weight
Epoxy resin	10
Urea formaldehyde resin	10
Carnauba wax	1
Microcrystalline wax	1

Dissolve in suitable solvents to make up solution having solids content of from 6% to 7% by weight.

Example III

	Parts by weight
Epoxy resin	90
Phenol formaldehyde resin	10
Carnauba wax	2
Microcrystalline wax	8

Dissolve in suitable solvents to make up solution having solids content of from 6% to 7% by weight.

Example I

	Parts by weight
Epoxy resin	80
Melamine formaldehyde resin	10
Carnauba wax	4
Microcrystalline wax	6

Dissolve in suitable solvents to make up solution having solids content of from 6% to 7% by weight.

In all examples, the solids content of the solution is maintained between 6% and 7% by weight for use as a dip for ice trays. It is understood that this figure may vary widely with respect to the end use of the solution and to the method of application. For example, when the coating is to be used as a protective finish on metal surfaces, the solids content may increase considerably so long as a continuous film of the material may be applied. Also, when the application is affected by brushing or rolling, the solids content of the solution may be varied to meet the specific requirements.

When the solution, as noted in the several examples, is applied to ice trays by dipping, the anodized aluminum ice trays are dipped into the solution which is maintained at 120° F. to 130° F. and allowed to attain the temperature of the dip bath. They are then removed and allowed to drain five minutes in air at approximately 100° F. This is followed by a bake at 355°±5° F. for 15 minutes at temperature to fully polymerize the coating. The resultant coating is extremely thin, clear, has excellent adhesion, very hard and abrasion-resistant in addition to its water shedding and ice release properties.

Comparative tests of the present coating with other prior art coatings, when applied to ice trays, show that the present coating will provide satisfactory ice release through more than double the number of operations than can be obtained by using the best known prior art coating. In other words, the present coating is at least twice as effective as the previously used wax-resin coating and at least four times as effective as a plain paraffin coating according to actual test data. Furthermore, both prior art coatings mentioned are susceptible to deterioration when the trays on which they are applied are washed in household detergents while my improved coating is highly resistant to the same detergents and shows substantially no deterioration in normal washing operations in said detergents.

In general, this new coating material is highly desirable for ice cube trays, particularly trays made from aluminum or aluminum alloys which have been anodized or color-anodized. It is completely transparent and clear and adheres tenaciously to the surface of the trays. It is understood that the wax-like coating described herein will also adhere to other metal surfacs such as brass, bronze, stainless steel, steel or iron, etc., and, in all cases, the adherence thereof will be more tenacious than that that can be expected from any of the other coatings having waxes therein. In this connection, formulas noted as Examples I, III and IV are more desirable for ice trays or the coating of other metal parts where flexing occurs while Example II is more useful as a protective coating on heavy inflexible metal parts.

While the embodiments of the present invention as herein disclosed constitute preferred forms, it is to be understood that other forms might be adopted.

What is claimed is as follows:

1. In a refrigeration system; a metal part to which ice adheres, a coating for said metal part comprising a transparent resin mixture consisting of a reacted mixture of an epoxy resin consisting of the reaction product of epichlorohydrin and bisphenol A and having an epoxide equivalent of from 450 to 2000 in quantities of from 1–9 parts by weight and a formaldehyde base resin taken from the class consisting of urea formaldehyde resin, melamine formaldehyde resin, phenol formaldehyde resin and triazine formaldehyde resin in quantities of 1 part by weight together with a wax component consisting of carnauba wax and a wax of the paraffin series wherein the waxes make up from 10% to 20% by weight of the coating composition.

2. The combination claimed in claim 1 wherein the formaldehyde base resin is melamine formaldehyde resin.

3. The combination claimed in claim 1 wherein the wax of the paraffin series is a wax empirical formula of between $C_{30}H_{62}$ and $C_{35}H_{72}$.

4. The combination claimed in claim 2 wherein the wax of the paraffin series has an empirical formula of between $C_{30}H_{62}$ and $C_{35}H_{72}$.

5. In a refrigeration system, a metal part to which ice adheres, a coating for said part comprising an epoxy resin consisting of the reaction product of epichlorohydrin and bisphenol A and having an epoxide esuivalent of from 450 to 2000 in quantities of from 39 to 41 parts by weight, melamine formaldehyde resin in quantities of from 9 to 11 parts by weight, carnauba wax in quantities of from 1 to 3 parts by weight, microcrystalline wax having an empirical formula of between $C_{30}H_{62}$ and $C_{35}H_{72}$ 5 to 7 parts by weight, said coating composition being adapted to be polymerized after application to a surface.

6. A freezing device, comprising in combination; a container member for holding a liquid to be frozen and a partitioning member for dividing the frozen contents thereof into blocks, at least one of said members having a minutely porous surface thereon, said pores being so minute as to be invisible to the eyes, said porous surface being impregnated with and coated over with a transparent water repellent coating composition which is hard and wear resistant, said composition consisting of an epoxy resin consisting of the reaction product of epichlorohydrin and bisphenol A and having an epoxide equivalent

of from 450 to 2000, a formaldehyde base resin taken from the class consisting of urea formaldehyde resin, melamine formaldehyde resin, phenol formaldehyde resin and triazine formaldehyde resin, together with a wax component consisting of a mixture of carnauba wax and a wax of the paraffin series wherein the waxes make up between 10% and 20% by weight of the coating composition.

7. An ice tray, comprising in combination; an aluminum container, an aluminum grid member adapted to fit within the container member and divide the container member into partitions in which water may be frozen, at least one of said members having an anodized surface for producing a micro-porous condition thereon, said surface being impregnated and coated with a long wearing, chip-resistant material consisting in its reacted state of a copolymer of an epoxy resin consisting of the reaction product of epichlorohydrin and bisphenol A and having an epoxide equivalent of from 450 to 2000 and a formaldehyde base resin taken from the class consisting of urea formaldehyde resin, melamine formaldehyde resin, phenol formaldehyde resin and triazine formaldehyde resin together with a mixture of waxes including carnauba wax and paraffin wax wherein the total wax component does not exceed 20%.

8. The ice tray as claimed in claim 6 wherein the formaldehyde base resin is a melamine formaldehyde base resin.

9. The ice tray as claimed in claim 8 wherein the ratio of epoxy resin to melamine formaldehyde resin is between 3 to 1 and 4 to 1.

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