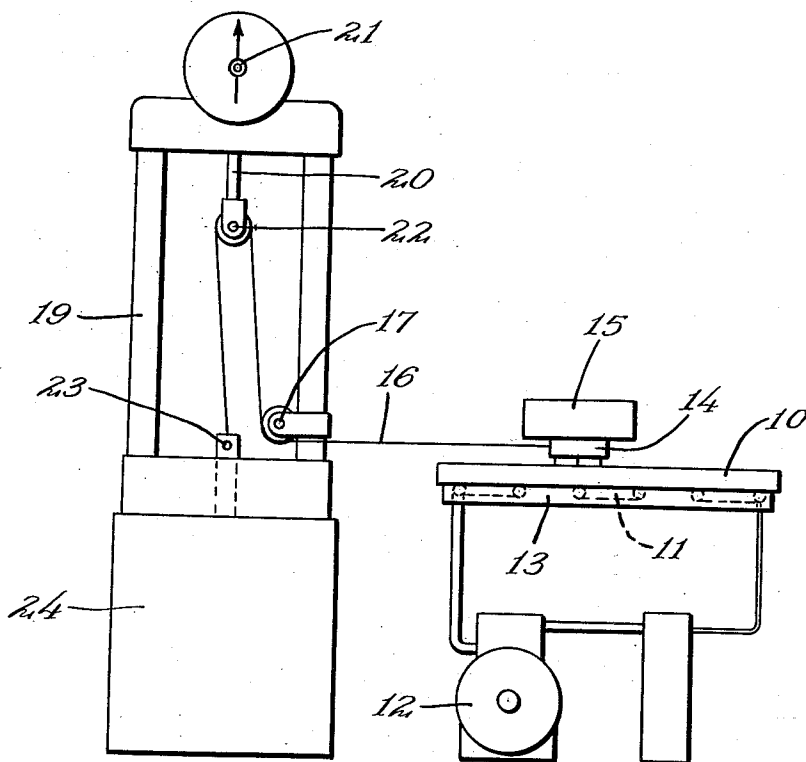


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R. H. GOMS
COATINGS FOR SIMPLIFYING FROST REMOVAL
FROM REFRIGERATED SURFACES
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INVENTOR

Richard H. Goms

BY

Robert M. Dunning

ATTORNEY

1

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COATINGS FOR SIMPLIFYING FROST REMOVAL FROM REFRIGERATED SURFACES

Richard H. Goms, St. Paul, Minn., assignor, by mesne assignments, to Whirlpool-Seeger Corporation, a corporation of Delaware

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This invention relates to an improvement in coatings for simplifying frost removal from refrigerated surfaces and deals particularly with a type of coating useful upon refrigerated porcelain, enameled surfaces, and the like, for preventing the adherence of frost thereto.

For many years, the problem of frost on refrigerated surfaces has been recognized. This problem has been intensified in view of the numerous freezers being produced for home and industrial use. Coatings have been produced which are useful in temporarily preventing the formation of frost on the surface. Other coatings have been tried which facilitate frost removal once it has been formed. While coatings of this latter type do not prevent frost formation, they help to alleviate and simplify the defrosting operation.

Since the freezer wall is necessarily maintained at a temperature slightly less than the interior air space, the partial pressure of water vapor is less at the wall surface, causing a resultant force in that direction. There are also potential forces resisting mass movement caused by friction, adherence, and penetration of the micro-porous porcelain layer. These last forces are undoubtedly most responsible for the tenacious sticking of frost and are probably the only controllable variables within practical limits.

In order to function effectively, it is desirable to produce a coating having certain definite characteristics. The coating must first be taste and odor free. Secondly, it must be non-toxic when used on refrigerators or freezers. Thirdly, it must be easy to apply on the refrigerated surface. It must have the lowest possible frost adhesive force, and should have maximum permanence. The object of the present invention lies in the production of a coating have these properties.

A feature of the present invention lies in the formation of a coating embodying a large percentage of vegetable oil. This oil is non-toxic and does not become rancid during its period of use. Tests indicate that such an oil is more effective than other oils, such as mineral oils, in minimizing adhesion of frost. Tests also show that vegetable oil compositions remain effective over a greater number of defrosts than compositions with mineral oil as a base.

A further feature of the present invention lies in the provision of a coating containing as important ingredients a water insoluble soap and a freezing point depressant. The soap acts as a wetting agent and enhances the film forming properties of the composition. The freezing point depressant causes a thin liquid film at the frost coating interface, simplifying the removal of the frost.

A further feature of the present invention lies in the provision of a coating which contains only liquids, or compositions which remain liquid during storage. As a result, no solid material can separate out from the liquid during storage or use.

These and other objects and novel features of the present invention will be more clearly and fully set forth in the following specification and claims.

2

In the drawings forming a part of the specification, the figure illustrates diagrammatically a test apparatus used in determining the relative ease of frost removal from treated surfaces.

In order to measure the degree of frost adherence on a surface a test apparatus was constructed. This apparatus is diagrammatically illustrated in the drawing. A porcelain test panel 10 was supported on the freezing plate 13 so that its angle of inclination could be varied and freezing coils 11 were placed in contact with the bottom surface thereof. A one-quarter horsepower F-12 condensing unit 12 supplied refrigeration for this assembly. With this arrangement it was possible to accumulate approximately three-eighths inch of frost in twenty-four hours. A frost scraper was produced in the nature of a three bladed sled 14 which could be placed upon the test panel 10 and held in surface contact with the panel by means of a weighted box 15. In actual practice the sled was two inches square in plan and the weighted box weighed sixteen and one-half pounds.

A flexible cable or wire 16 was connected to the sled 14 and passed over a pulley 17 on a testing machine 19. This testing machine had a vertically movable plunger 20 which actuated a scale 21 when moved downwardly. A pulley 22 was supported upon the plunger 20 and the flexible member 16 passed through the pulley 22 and was connected to a reciprocable plunger 23 which could be moved downwardly by a suitable power supply within the testing machine base 24. As the plunger 23 was drawn downwardly by the power supply a pull was exerted upon the flexible member 16 and this pull was measured by the scale 21. Due to the pulley arrangement the force exerted upon the sled was half the indicated value.

Various materials of different types were placed upon the test panel 10 and frost was then accumulated on the panel over a period of twenty-four hours. The amount of frost collected on the panel was kept constant by controlling the air humidity. Tests were then conducted to determine the relative ease or difficulty in removing the accumulated frost. Among the materials tested were petroleum type greases and oils, low vapor pressure oils, silicone oils, mixtures of solid lubricants (graphite and colloidal graphite) and liquid lubricants, certain resins, drying oils, stearic acid and some of its salts, electrofilm graphite coatings, and silicones. Also tested was a composition consisting of the following formula:

	Percent
White mineral oil	70.5
Oleic acid	9.0
Stearic acid	1.5
Slaked lime	3.0
Calcium chloride	15.0
Water	1.0

As will be more fully described later in the specification, various tests were also conducted including vegetable oils including 3% (based on weight of oil) aluminum stearate and 10% propylene glycol.

Of the composition tested, the silicones, the mineral oil composition and the vegetable oil composition proved much superior to the remaining coatings. For this reason comparative tests were mainly conducted with the mineral oil composition and the vegetable oil composition.

The co-efficient of friction for various coatings was also determined to indicate whether the co-efficient of friction of the coating is an important factor. These tests indicated that it was rather difficult to make any direct correlation between the ease of frost removal and the co-efficient of friction, although it was generally observed that a decrease in friction results in better frost removal.

3

Apparently surface frictional force is not a major factor with regard to the adherence of frost to the porcelain.

In the study of the various properties which apparently enhanced the frost adherence qualities of the various coatings it was found that three ingredients were most important. The first ingredient was an oil base and preferably a vegetable oil base because of its non-toxicity and ready availability. A second important ingredient was found to comprise a substantially water insoluble soap such as aluminum stearate. When this material was added to the oil it formed a wetting agent which enhanced the film forming characteristics of the composition. In forming a more continuous protective film, moisture vapor penetration with subsequent tenacious frost adhesion is minimized. In addition, it is possible to control the viscosity of the oil with this soap so as to obtain maximum permanence commensurate with low adhesive force. A third important ingredient was found to be a freezing point depressant. It appeared that the use of such a depressant such as propylene glycol causes the formation of a thin liquid film at the frost coating interface, thereby facilitating frost removal. This material also functioned in a manner similar to a plasticizer.

In order to determine the optimum amount of aluminum stearate to use, various amounts of aluminum stearate were mixed with a commercial corn oil. The following table indicates the results of these mixtures.

TABLE 1
Effect of aluminum stearate on frost adherence

Aluminum Stearate, Percent ¹	Frost Adhesive Force, lbs./in. ²
Untreated Panel.....	73.0
Corn Oil Only.....	52.0
1.....	5.0
2.....	6.4
3.....	2.5
4.....	3.8

¹ Percentage based on weight of oil.

The above table indicates that when aluminum stearate is used in an amount of substantially 3% based on the weight of the oil, the frost adhesion force was the least. The addition of 4% of heavy gel aluminum stearate produced a gel-like substance which would not pour at room temperature. It is believed that this composition has the maximum viscosity permissible for easy application by wiping on freezer walls. It was believed inadvisable to increase the percentage of aluminum stearate as a result of these tests.

With this type of thick gel aluminum stearate, percentages of from two to four percent, based on the weight of the oil, are operable. Higher percentages of lower melting point aluminum stearates may also be used, as will be later described.

In preparing the compositions the indicated amount of aluminum stearate was added to the oil at room tem-

4

perature. The stearate was then dispersed with a kitchen mixer. The mixture was heated to 300° F. with agitation and held at that temperature until all the solid stearate dissolved. The material was tested after the composition was cooled.

Using the optimum ratio of 3% aluminum stearate and corn oil as determined from the foregoing Table 1, the effects of propylene glycol on frost adherence were studied. Various percentages of propylene glycol were added to the mixture of corn oil and aluminum stearate and the frost adhesive force of each such composition was tested. The following table lists the results obtained:

TABLE 2
Effect of propylene glycol on frost adherence

Propylene Glycol, Percent	Frost Adhesive Force, lbs./in. ²
0.....	2.5
10.....	1.7
20.....	1.8
30.....	1.0
40.....	0.8
50.....	0.9

Although the frost adhesive force was found to be less for increased concentrations of propylene glycol, certain undesirable factors involving the application of coatings were observed. These observations were as follows:

(1) *Surface wettability*.—It was observed that concentrations of 20% or higher of propylene glycol did not completely wet the porcelain surface. This was evidenced by a "balling up" of the coating which left unprotected areas. It was necessary to wipe on a rather heavy coating in order to provide an unbroken film over the entire surface.

(2) *Permanence*.—The coatings containing 20% or more of glycol were practically entirely removed on the first defrosting operation. It is not believed that these films would produce an effective second frost removal.

(3) *Constituent separation*.—It was noted that glycol in concentrations of 30% or higher tended to separate out rather rapidly.

Thus it appeared that from 0 to 20% glycol was most effective and the range of from 5 to 15% propylene glycol was optimum.

In order to determine the most desirable vegetable oil for ultimate use, it was necessary to evaluate them with respect to several properties. This was accomplished by preparing frost removing compositions of oils which were initially suitable with respect to color and odor. The compositions consisted of the oil named in combination with 3% aluminum stearate and 10% propylene glycol. The results of these tests and observations are given in the following Table 3:

TABLE 3
Properties of various vegetable oil compositions

Oil Base	Initial Color	Initial Odor	Rancidity after 3 Months	Viscosity at 80° F., Centipoises	Oil Cost ¹ cents/lb.	First Frost Adhesive Force, lbs./in. ²
Corn.....	Amber.....	Slight.....	None.....	348	16	1.0
Do.....	Light Amber.....	do.....	do.....	343	13½	1.3
Cotton seed.....	Straw.....	Faint.....	do.....	388	13½	2.3
Peanut.....	Light Straw.....	do.....	do.....	443	16½-19½	0.6
Rapeseed.....	Dark Amber.....	Moderate.....	do.....	22	22	2.0
Cocoonut.....	Nearly colorless.....	Faint.....	do.....	11¼-19	6	6

¹ Prices obtained from "Chemical and Engineering News," January 21, 1952, for oils only.

In preparing the compositions the aluminum stearate was dissolved in the vegetable oil as previously described. The propylene glycol was added when the solution cooled and the mixture was thoroughly mixed with a blender of the household type having a power driven propeller driven by a shaft extending through the base of the receptacle. A contributing factor to a suitable oil selection not listed in Table 3 was the tendency of certain oils to foam during heating and mixing of the stearate. It was found that the corn and rapeseed oil tended to foam under these conditions. In addition the glycol separated out almost immediately from the rapeseed oil. It was found that the cocoanut oil solidified on cooling which probably accounted for its relatively high frost adhesion.

In order to provide a comparison between various vegetable oil compositions and mixtures of these compositions and also to compare them with the previously described mineral oil composition, additional tests were conducted. The tests were conducted at intervals on each treated surface to determine the average number of defrosts that could be expected from a single application of the coating. The following results were obtained:

TABLE 4
Expected "life" of various surface coatings

Oil		Aluminum Stearate		Surface Temp. prior to Application	Average Adhesive Force, ¹ lbs./in. ²				
Type	Per-cent	Type	Per-cent ²		Number of Defrosts				
					1	2	3	4	5
Patented Composition				Room	1.8	2.0	2.3	4	
Corn	100	heavy gel	3	do	1.0	0.9	1.4	3.1	4
Peanut	100	do	3	do	1.1	2.5	4		
Do	100	do	3	Chilled	0.5	1.9	3.7	4	
Peanut	90	do	3	do	4				
Cocoanut	10	do	3	do	1.1	0.9	2.1	4	
Peanut	95	do	3	do	0.8	2.1	4		
Cocoanut	5	do	3	do	3.5				
Peanut	100	thin gel	3	do	1.1	1.3	1.7	2.3	3.8
Do	100	thin gel	5	do					
Peanut	95	Non-gel	5	do					
Cocoanut	5	thin gel	4	do					
		Non-gel	4	do					

¹ Previous experience has indicated that an adhesive force greater than 4 lbs./in.² is relatively ineffective with regard to easy defrosting. Adhesive values between 3-4 lbs./in.² are marginal and indicate that another coating is required.

² Based on weight of oil.

From the foregoing tests, it was determined that in general it was advantageous to chill the porcelain surface to normal operating temperature before applying the surface coating. This will prevent the consumer from attempting to cover a large area with a small amount of material which would result in inadequate protection to moisture vapor penetration. The reason for this lies in the fact that when the coating is first applied to the cold surface the viscosity increases appreciably and a certain minimum film thickness is retained on the surface.

Table 4 further indicates that the coating having the lowest initial adhesive force does not necessarily have the longest life. There is a general correlation between the life of the coating and the adhesive force which indicates that a material with a lower viscosity has a lower initial adhesive force, but a shorter life than a higher viscosity material.

Various types of aluminum stearate were employed, the types varying mainly in melting point and viscosity of the resultant coating. The thick gel type of aluminum stearate was used effectively up to 3% concentration as there was no appreciable increase in viscosity of the coating. At 4% the oil becomes similar to a heavy gel having rubber like properties.

A thin gel type of aluminum stearate defined as di-aluminum stearate having a melting point of 135° C. was useful in concentrations up to 5% with no appreciable

increase in viscosity. Beyond 5% the oil becomes stringy and has poor cold fold proportions.

A non-gel type of aluminum stearate having a melting range of 101 to 112° C. was useful in the composition in quantities up to 15% with no appreciable increase in viscosity.

Equal parts of the thin gel di-aluminum stearate and non-gel aluminum stearate were effectively used in quantities up to ten percent based on the weight of the oil. When used in the total amount of 8% in a mixture of 95% peanut oil and 5% cocoanut oil (the percentage of aluminum stearate being based on the weight of oil), a composition is produced with a sufficiently high viscosity to prevent the propylene glycol from settling out and yet does not produce a mixture which is rubbery or stringy. Less stearate results in a low adhesive force, but poorer permanence. The viscosity is too low to prevent glycol separation in quantities much less than 3%. The addition of more than 10% stearate, and particularly the thin gel or thick gel types, causes a high initial adhesive force as well as a stringy product.

From the foregoing information it is obvious that

various types of vegetable oil compositions are effective in decreasing the adhesion of frost to a porcelain surface. A composition containing peanut and cocoanut oil is preferred to one containing corn oil for reasons of color, odor and foaming during preparation. A small amount of cocoanut oil does not change the viscosity of the oil at room temperatures, but at freezing temperatures it solidifies and builds up a certain degree of toughness to the protective coating. The vegetable oil coatings have been found preferable to a mineral oil composition, such as that previously described, not only because of its greater resistance to frost adhesion, but also due to the fact that all of the components remain in liquid form. The final composition is homogeneous and does not contain any solid material which feels gritty and which may eventually settle out from the solution. This is not true of the previously described composition which contains calcium chloride in the amount of 13%. The composition also is believed to produce better results with no danger of toxicity of any of the ingredients.

As a preferred example the following composition is suggested:

	Percent
Peanut oil	79.17
Cocoanut oil	4.17
Witco 16 aluminum stearate	3.33
Witco non-gel aluminum stearate	3.33
Propylene glycol	10.00

This composition is believed to be representative of generally effective vegetable oil coatings. It has been found to have the following general characteristics:

(1) Taste and odor free.

The material passes the conventional unsalted butter taste and odor test. In addition it successfully passes a rancidity test performed by placing open test tubes containing the composition in an oven maintained at 150° F.

(2) It is non-toxic.

The constituents do not have any toxicant properties as determined from the literature.

(3) Ability to wipe on easily even on a cold surface. The quantity of coconut oil employed is not sufficient to increase the viscosity sufficiently to create difficulty of application.

(4) Low frost adhesive force.

As determined from actual tests the adhesive force holding the frost to the test panel is extremely low.

(5) Maximum permanence.

The number of effective defrost cycles are available as determined by test and the film is not completely removed after at least five defrosts.

The foregoing description is specific to aluminum stearate as this material is non-toxic and produces effective results. Other non-toxic metallic stearates such as magnesium stearate, and calcium stearate may also be employed. The description also has been specific to use on porcelain surfaces as it is for this purpose that the composition is particularly designed for use. Effective results have been obtained on other metallic and enameled surfaces.

In accordance with the patent statutes, the principles of composition and use of my coatings for simplifying frost removal from metal surfaces have been described, and while I have endeavored to set forth the best embodiment thereof, I desire to have it understood that obvious changes may be made within the scope of the following claims without departing from the spirit of the invention.

I claim:

1. A composition for reducing the adhesion of frost on refrigerated surfaces comprising a vegetable oil containing two to four percent of thick-gel aluminum stearate and five to fifteen percent propylene glycol.

2. A composition for reducing the adhesion of frost on refrigerated surfaces comprising a vegetable oil containing two to ten percent of aluminum stearate and five to fifteen percent propylene glycol.

3. A composition for reducing the adhesion of frost on refrigerated surfaces comprising a corn oil containing two to ten percent nontoxic substantially water insoluble metallic stearate selected from the group consisting of aluminum, magnesium and calcium stearates and five to fifteen percent propylene glycol.

4. A composition for reducing the adhesion of frost on refrigerated surfaces comprising a peanut oil containing two to ten percent nontoxic substantially water insoluble metallic stearate selected from the group consisting of aluminum, magnesium and calcium stearates and five to fifteen percent propylene glycol.

5. A composition for reducing the adhesion of frost on refrigerated surfaces comprising a coconut oil mixed with a second vegetable oil containing two to ten percent nontoxic substantially water insoluble metallic stearate selected from the group consisting of aluminum, magnesium and calcium stearates and five to fifteen percent propylene glycol.

6. A composition for reducing the adhesion of frost on refrigerated surfaces comprising a mixture of coconut oil and peanut oil containing two to ten percent nontoxic substantially water insoluble metallic stearate selected from the group consisting of aluminum, magnesium and calcium stearates and five to fifteen percent propylene glycol.

7. A composition for reducing the adhesion of frost on refrigerated surfaces comprising a mixture of peanut oil with a minor amount of coconut oil, containing two to ten percent nontoxic substantially water insoluble metallic stearate selected from the group consisting of aluminum, magnesium and calcium stearates and five to fifteen percent propylene glycol.

8. A composition for reducing the adhesion of frost on refrigerated surfaces comprising a mixture of substantially ninety-five percent peanut oil and five percent coconut oil containing substantially eight percent aluminum stearate based on the weight of the oil and ten percent propylene glycol.

9. A composition for reducing the adhesion of frost on refrigerated surfaces comprising a vegetable oil containing two to ten percent of a water insoluble soap selected from the class consisting of the stearates of aluminum, magnesium, and calcium, and containing from five to fifteen percent propylene glycol.

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