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PREVENTING ADHERENCE OF CONGEALED SUBSTANCES TO METALS

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This invention is concerned with preventing congealed liquids from adhering to metals by freezing thereto and aims to provide a method of preventing such adherence and a new metal product to which ice and the like does not tend to adhere. The invention also provides improved metal articles such as refrigerator trays and other metal structures the surfaces of which are exposed to substances under such conditions that the substances tend to congeal.

The difficulties which attend the removal of ice cubes from metal trays of mechanical refrigerators are well known. It suffices to say that the heretofore customary practice of thawing the cubes sufficiently to release them from the metal surfaces of the trays chills and wets the hands and wastes ice. Prior efforts to overcome these difficulties have evolved the flexible rubber tray, which is satisfactory from the standpoint of ice removal but introduces another disadvantage, in that rubber is a poor conductor of heat so that ice forms but slowly in rubber trays. Nor is the mechanical refrigerator the only device in which ice adherence is a serious problem. The tendency for ice to form and adhere to airplane wings during inclement weather is well known. Inflatable rubber "de-icers" applied to the leading edges of airplane wings have been developed, but are not entirely satisfactory, and like the rubber refrigerator trays leave much to be desired.

As a result of my investigations I have devised a method of preventing substances from adhering to metal surfaces by freezing thereto which comprises forming the metal in a porous condition and impregnating the porous metal with a material which is substantially insoluble in and repellent of the substance. My invention also contemplates a product to which a substance does not tend to adhere by freezing thereto which comprises a finely porous metal base impregnated with a material which is substantially insoluble in and repellent of the substance.

Any metal or alloy in porous form may be employed and any method of fabrication is satisfactory so long as it ensures a pore structure which communicates with the surface of the metal object thus affording an avenue for the introduction of the impregnant into the metal object and for the exudation of the impregnant once it has been impregnated. However, I prefer to employ a porous aluminum or aluminum alloy base prepared according to the method described in the co-pending application to Claus G. Goetzel, Serial No. 148,662, filed June 17, 1937. Briefly, this method comprises compressing finely divided metal powder containing a relatively large proportion of aluminum and a relatively small proportion of a metal alloyable with aluminum into a coherent mass, and heating said mass to and maintaining it for a considerable period of time at a temperature below the melting point of aluminum but at which aluminum diffuses between the metal powder particles so that the whole becomes bonded.

Porosity of the metal base may be obtained in either of two ways, i. e., by controlling the pressure under which the powders are compacted to assure the presence of a considerable proportion of voids in the resulting coherent mass, or by including in the powder mixture subjected to compression a finely divided volatile and preferably solid substance such as camphor or other organic substance or a volatile salt, which will be expelled from the coherent mass upon heat treatment leaving the structure porous. The latter way is preferable for the manufacture of the porous metal base employed in my invention, because it assures that substantially all of the pores will be open and therefore useful for absorbing and exuding the impregnant.

The degree of porosity is not critical, although it must be substantial. Generally speaking, the greater the degree of porosity the more effective the product will be for inhibiting ice adherence. However, the structure must not be so porous that it lacks requisite mechanical strength. A porosity of 30% by volume is satisfactory for aluminum or aluminum alloys fabricated into ice trays.

The size of the pores should be small for best results. The porosity developed when aluminum powders having a particle size of minus 200 mesh are employed in the aforementioned method is satisfactory.

As indicated hereinbefore the nature of the impregnant depends upon the nature of the congealing substance. It should be insoluble in and repellent of the congealing substance. In addition the impregnant preferably should be solid at ordinary temperatures and at the temperature of congelation so as to be retained by the metal base, but fluid at more elevated temperatures so that it is easily impregnated into the base and may exude therefrom to renew the coating on the exterior surface of the base. Waxy substances such as true waxes or compositions containing waxes in substantial proportions and various synthetic resins are substances that possess these qualities (insofar as most congealing substances are concerned) and are especially suited for use in forming the composition of the invention. A

soft wax, such as paraffin or beeswax, or a hard wax, such as carnauba wax, or a wax of intermediate hardness, such as Japan wax (or tallow), may be employed, depending upon the particular properties desired of the composition. If a soft wax is employed, it is more easily worn from the surface of the porous metal product, but when worn off is more easily renewed because of the low temperatures at which it is caused to exude from the porous metal. A hard wax such as carnauba wears better on the surface of the metal, but the product must be heated to a relatively high temperature to cause it to exude from the pores of the metal and thereby renew the surface film. In addition to the pure waxes specifically mentioned above by way of example, mixtures or blends containing these and other waxes or wax-like materials, with or without various bituminous or resinous materials, may be employed.

If the composition of the invention is to be employed for refrigerator trays or other products with which articles intended for human consumption come in contact, the waxy material should be one that possesses no unpleasant odor or taste. The waxes specifically mentioned above are substantially odorless and tasteless, and other such waxes and waxy compositions are known.

In applying the wax or waxy material to the porous metal base, the product is brought in contact with a melted body of the wax. The metal product is heated at least to the temperature of the melted wax during at least a portion of the time that it is in contact therewith in order that the wax will not solidify and clog the pores of the metal, thus preventing thorough impregnation of the pores of the metal. A convenient manner in which to apply the wax is to immerse the porous metal base, heated to a temperature somewhat above the temperature of the wax, in a molten bath of the wax. The metal base is allowed to remain in the bath of molten wax for a sufficient period of time to enable the wax to impregnate the pores into which it penetrates by capillary action. Impregnation of the pores of the metal product with the wax may be facilitated if the wax is under pressure during the impregnation operation.

The temperature of the wax during the impregnation operation (and hence also the temperature of the porous metal product) depends upon the particular wax or waxy material employed. The temperature should be sufficient, however, to render the wax thin and fluent so that it penetrates the pores of the metal product easily and thoroughly. Temperatures may range from about 40 to 50° C. in cases where paraffin is employed to over 100° C. when using hard waxes such as carnauba.

After the porous metal has been impregnated and coated with the waxy substance, the resulting composition is ready for use. When the composition is in use, the wax should form a substantially continuous film over the surface of the metal, and when the composition is freshly prepared, the wax preferably fills the pores of the metal substantially completely to permit many renewals of the surface coating.

In fabricating the composition, it may be machined or cut, but preferably it is not subjected to any operation that will cause it to lose substantial amounts of its wax content, as might occur if the fabricating operations involved considerable heating. The porous metal product preferably is formed in its final shape before it is impregnated with the wax. Thus in the manufacture of refrigerator trays, the porous metal product may be formed into suitable trays and grids, and the resulting product may be impregnated with the waxy substance in a final operation.

Complete refrigerator trays may be made in accordance with the invention, but it is sufficient in many cases to fabricate the tray itself in the usual manner and to prepare only the grid in accordance with the invention. Usually it is the grid to which ice cubes adhere most firmly, because the grid more than the tray itself presents the surface with which water being frozen in the tray comes in contact.

Refrigerator trays made in accordance with the invention substantially overcome the difficulties heretofore experienced as a result of ice in the tray adhering to the material of the tray. Ice cubes frozen in trays according to the invention do not tend to adhere to the tray and are easily removed with the application of but little force. The waxy coating wears very well, and when it comes time to renew it, the tray is simply heated sufficiently to cause wax to exude from the pores of the metal. When a soft wax such as paraffin has been employed, the necessary heating may be accomplished by immersing the tray (or the grid alone) in hot water. If a hard wax has been used, the heating may be accomplished by introducing the tray into an oven, such as an ordinary kitchen oven, heated to an appropriate temperature to cause the wax to exude slightly from the pores of the metal. Sufficient wax ordinarily is impregnated in the pores of the metal to permit renewing of the surface coating many times.

The product of my invention presents an attractive appearance. Impregnated porous aluminum alloy sheets look like ordinary sheets of such alloys.

Although my invention has been described herein principally with reference to refrigerator trays and the formation of water ice, it is of course of much more general utility and will serve wherever the adherence of congealed substances to metal surfaces is objectionable. Congealed gelatinous substances, solidified asphalts, etc., do not become bonded to the product of my invention when waxy impregnants are employed.

I claim:

1. An article to which a liquid does not tend to adhere upon congealing in contact therewith which comprises finely-divided metal particles welded together with a considerable proportion of voids therebetween forming within the article a pore structure that communicates with the surface of the article, said pore structure being impregnated with a substance that is solid at ordinary temperatures and at the temperature of congelation but fluid at more elevated temperatures and that is substantially insoluble in and repellant of said liquid, the surface of the article having a coating of said substance, said coating being capable of repeated replenishment by exudation of the substance from the pore structure when the article is heated to a temperature above the melting point of the substance.

2. An article to which a liquid does not tend to adhere upon freezing in contact therewith which comprises finely-divided metal particles welded together with a considerable proportion of voids therebetween which form pores substantially all of which are open and communicate with the surface of the article, said pores being filled with a

substance that is solid at the temperature of congelation and at ordinary temperatures but liquid at more elevated temperatures and that is substantially insoluble in and repellant of the liquid, the surface of the article having a coating of said substance, said coating being capable of repeated replenishment by exudation of the substance from the pore structure when the article is heated to a temperature above the melting point of the substance.

3. An article to which water does not tend to adhere upon congealing in contact therewith which comprises aluminum powder particles minus 200 mesh in size bonded together by diffusion welding with a substantial proportion of voids therebetween forming within the article a pore structure that communicates with a surface of the article, said pore structure containing a waxy substance that is solid at ordinary temperatures but liquid at more elevated temperatures, said surface having a coating of the waxy substance that is capable of repeated replenishment by exudation of the waxy substance from the pore structure when the article is heated above the melting point of the waxy substance.

4. A method of making an object to which a liquid does not tend to adhere upon congealing in contact therewith which comprises compressing and heating a mixture of metal powder particles and a finely-divided volatile solid substance to form a coherent mass, the temperature of heating being above the temperature at which the substance is volatile and below the melting point of the powders, but at which metal diffuses between the metal powder particles so that they become bonded together and the volatile substance is expelled leaving within the coherent mass a substantial proportion of voids in the form of pores substantially all of which communicate with the surface of the object, impregnating said pores with a material that is solid at the temperature of congelation of the liquid but liquid at more elevated temperatures and that is substantially insoluble in and repellant of the liquid and which tends to exude partially from the pore structure while liquid, and coating the surface of the object with said material.

5. A method of preventing a liquid from adhering to the surface of an object adjacent to which it is congealed which comprises forming said object in a finely porous condition by compressing and heating a mass of metal powder particles to form a coherent mass containing a substantial proportion of voids in the form of a pore structure communicating with said surface, treating said coherent mass with an impregnant in the form of a substance that is solid at the temperature of congelation but liquid at more elevated temperatures (in which liquid condition it tends to exude from the pore structure) and which is substantially insoluble in and repellant of said liquid, so that the metal surface becomes coated with and the pore structure impregnated with the substance, repeatedly congealing batches of the liquid adjacent the coated surface of the object and separating the congealed batches therefrom, so that the coating tends to wear off the surface, and repeatedly heating the object to melt the impregnant and cause it to exude from the pores repeatedly to renew the coating on the surface.

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