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PRODUCTION OF SHEET MATERIALS

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This invention relates to the production of sheet materials and in particular sheet materials having a basis of cellulose acetate or like film-forming substance.

The principal object of the invention is to provide a simple method for the production of such sheet materials of any desired thickness, which does not involve the use of expensive plant such as the straightening and polishing presses which are necessary when the sheet materials are cut from a block of the film-forming substance.

We have found that the object referred to above can be realised by casting a solution of the film forming substance in a volatile solvent onto the surface of a flat layer of soap or a soap-like substance suitably supported, removing volatile solvent by evaporation, repeating these operations if necessary to obtain a sheet of the desired thickness, stripping the sheet from the support and removing any adhering soap or the like by means of a liquid which is a solvent for the soap but not for the film-forming substance. The sheet, even when of considerable thickness, e. g. 0.01 to 0.1 inch or even thicker, can readily be removed from the supporting layer whereas when sheets are cast directly onto the surface of glass or like hard material, difficulty is experienced in removing the sheet unless it be sufficiently flexible to be rolled back on itself. It will be appreciated therefore, that the process of the invention offers special advantages in connection with the production of sheets of low flexibility, especially sheets of thickness at least 0.01 inch.

A suitable support for the layer of soap or the like comprises a flat polished plate of glass or metal. Glass is generally to be preferred as flat, highly polished plates of glass can more easily and more cheaply be obtained than plates of metal having the desired flatness and polish. The soap may be applied to the plate in solution in a suitable solvent; e. g. alcohol, by spraying or other suitable method, e. g. brushing, and dried and polished to form a coherent layer of uniform thickness. The layer of soap may be extremely thin, e. g. considerably less than 0.001 inch in thickness. Alternatively, a thick layer or block of soap or the like may be formed by any suitable method, for instance by melting the soap and running it into a tray, e. g. of iron, which need not have a perfectly flat bottom. If necessary, to ensure the flatness of the upper surface of the block of soap or the like, the said surface may be formed by pressing on to the block of soap the flat polished surface of a block of glass, metal or other suitable former which is then with-

drawn. The sheet material may then be cast directly onto the upper surface of the block of soap.

To avoid premature stripping owing to contraction of the sheet material as the solvent evaporates, it is of advantage to provide around the surface of soap or the like a surface, e. g. of untreated glass or metal, to which the sheet material readily adheres and to cast the sheet so that it extends beyond the soap or the like and so has its edges anchored to the untreated glass or metal. With the same object in view, when a solid block of soap or the like is formed in a tray to provide the casting surface, the tray may with advantage be provided with a flat horizontal flange round its edges to form a surface flush with that of the soap for the edges of the sheet to adhere to.

It is preferable to build thick films up from several layers. This is not essential but when a thick sheet is cast in a single stage removal of the volatile solvent is a slower operation. The sheets may, before finishing and after stripping, be seasoned in a warm atmosphere to reduce still further the content of volatile solvent.

The film-forming solution from which the sheet material is cast may contain any suitable plasticiser for the film-forming substance. Among plasticisers for cellulose acetate mention may be made of triacetin, dimethyl phthalate, dimethoxy ethyl phthalate, dibutyl phthalate, diethoxy-ethyl phthalate, methyl methoxy-ethyl phthalate, ethyl ethoxy-ethyl phthalate, and diethyl and dibutyl tartrates. Plasticisers which are without substantial affinity for the cellulose acetate but which are useful with a view to increasing the fire resistance of the sheet material, e. g. tricresyl phosphate, triphenyl phosphate and trichloro-ethyl phosphate may be present in the composition, preferably in admixture with plasticisers having a high affinity for cellulose acetate, e. g. triacetin. The composition may also contain volatile solvents for cellulose acetate other than acetone, e. g. dioxane or methylene ethylene ether, high boiling solvents e. g. diacetone alcohol and ethyl lactate, and colouring agents or other effect materials.

The soap used to form the film-casting surface should be water soluble and preferably solid at temperatures such as are encountered in the film casting operation. When a block of the soap is used to provide the casting surface, a hard soap should be used, but when a thin layer of soap is used on a flat plate or glass or other suitable support, the soap may be soft. Strongly alkaline soaps should not be used in casting sheet materials of saponifiable esters such as cellulose

acetate on account of the danger of saponification. Excellent results have been obtained using sodium stearate and sodium palmitate as the soaps. Other alkali metal salts of long-chain fatty acids may be used as may the corresponding salts of nitrogenous bases, e. g. ammonia and the alkylamines. Useful examples of such soaps of nitrogenous bases are the stearate palmitate and oleate of triethanolamine. Other substances having detergent properties, in particular water soluble substances containing an aliphatic hydrophobe group of at least 12 carbon atoms, e. g. having a hydrocarbon chain of 12-18 atoms, can be used. Examples are: the sodium and potassium salts of cetyl naphthalene sulphonic acid, of sulphonated higher alcohols such as octyl, cetyl, lauryl and oleyl alcohols, of sulphonated esters of higher alcohols such as the dihexyl and dioctyl esters of succinic acid, and of sulphated higher fatty alcohols, fatty acid amides and fatty acid esters. Salts such as those specified above but containing in place of alkali metals basic nitrogenous groups such as ammonium and univalent alkylamine and alkylolamine radicles, can also be used. Use may also be made of the solid or substantially solid partial esters of ether-alcohols containing at least two hydroxy groups with soap forming acids, e. g. the mono stearates and palmitates of diethylene glycol and triethylene glycol.

The following examples illustrate the invention:

Example 1

A glass plate having a flat, highly polished surface is coated on this surface with a 50% solution (by weight) of triethanolamine oleate in ethanol. By drying off the solvent and polishing, a very thin coating of the oleate on the glass is obtained. A margin of uncoated glass is left round the coating and the edges of the plate are provided with detachable metal sides.

The coated glass plate is supported with its coated surface horizontal and a layer of dope consisting of a 20-30% solution of cellulose acetate in acetone, the solution containing 20-30% on the weight of the cellulose acetate of dimethyl phthalate, is flowed onto the glass plate so as to cover and extend slightly beyond the coating of triethanolamine oleate. The layer of dope is about 0.03-0.05 inch thick, according to the concentration, before drying.

The coating is dried in a warm atmosphere until the bulk of the solvent is lost. A second layer is cast on the first and the process repeated until a sheet of 20-30 layers has been built up. The edges of this sheet adherent to the uncoated glass are then freed after detaching the metal sides, and the sheet can then easily be stripped.

Example 2

Molten "glycol stearate" (the mono stearate of diethylene glycol) is poured into a metal tray having detachable sides. Each side has a lower vertical portion, an intermediate outwardly extending horizontal portion, and an upper vertical portion. Sufficient molten glycol stearate is poured into the tray to form when cold a block, the upper surface of which is flush with the horizontal portions of the sides.

A sheet is built up on the block of glycol stearate by the method described in Example 1, the area of the sheet being bounded by the upper vertical portions of the sides so that the edges of the sheet are anchored to the horizontal portions of the sides.

The sheet is stripped from the block by removal of the side pieces. The sheet is then trimmed by cutting off the marginal portions adherent to the side pieces.

Any soap or the like adhering to the sheet after stripping can be removed by washing with an aqueous liquid. Where, owing to the solvent content of the sheet and the nature of the film-forming substance, there is danger of delustring if the sheet be washed with pure water this danger may be avoided by washing with aqueous solutions of the soap or the like, if necessary in progressively decreasing concentrations, and finally with water.

Instead of cellulose acetate other organic film-forming substances which can be dissolved in suitable volatile liquids can be employed e. g. cellulose propionate, cellulose butyrate cellulose acetate-propionate, cellulose acetate-butyrate cellulose acetate-nitrate, ethyl cellulose, benzyl cellulose, ethyl cellulose acetate and other esters, including mixed esters, ethers and ester-ethers of cellulose. The film-forming substance need not be a cellulose derivative. It may, for example, be a polymerised unsaturated substance such as polyvinyl alcohol, polyvinyl acetate, polyvinyl chloride, polyvinyl chloracetate, a co-polymer of two or more of such unsaturated substances, a polymerised unsaturated compound derived from acrylic acid, e. g. polymethyl methacrylate, a polymerised unsaturated hydrocarbon, e. g. a polystyrene synthetic resin or any other organic film forming substance from which films, foils or the like can be made by the evaporative method. The invention is of particular importance in the production of transparent sheet materials.

The invention has been described with particular reference to the production of relatively thick sheet materials by a casting operation. The invention, however, includes quite generally the formation of sheet materials of any thickness on a surface of soap or the like by an evaporative method. Thus instead of being poured onto the soap layer the film-forming composition may be applied by brushing or spraying. The soap layer may be supported on a metal plate or on an endless band such as is used in the continuous production of films or foils so facilitating removal of the product from the band.

Having described our invention, what we desire to secure by Letters Patent is:

1. Process for the production of sheet materials which comprises forming a sheet by the evaporative method from a solution of an organic derivative of cellulose in a volatile organic liquid, on a surface of a water soluble substance comprising a partial ester of a soap forming acid and an ether-alcohol containing at least two hydroxy groups, and stripping said sheet from said surface.

2. Process for the production of sheet materials which comprises forming a sheet by the evaporative method from a solution of an organic derivative of cellulose in a volatile organic liquid, on a surface of diethylene glycol mono-stearate, and stripping said sheet from said surface.

3. Process for the production of sheet materials which comprises forming a sheet by the evaporative method from a solution of an organic derivative of cellulose in a volatile organic liquid, on a surface of glass coated with a thin layer of a water soluble substance comprising a partial ester of a soap forming acid and an ether-alcohol con-

taining at least two hydroxy groups, and stripping said sheet from said surface.

4. Process for the production of sheet materials which comprises forming a sheet by the evaporative method from a solution of an organic derivative of cellulose in a volatile organic liquid, on a surface of glass coated with a thin layer of diethylene glycol monostearate, and stripping said sheet from said surface.

5. Process for the production of sheet materials which comprises forming a sheet by the evaporative method from a solution of cellulose acetate in a volatile organic liquid, on a surface of glass coated with a thin layer of a water soluble sub-

stance comprising a partial ester of a soap forming acid and an ether-alcohol containing at least two hydroxy groups, and stripping said sheet from said surface.

6. Process for the production of sheet materials which comprises forming a sheet by the evaporative method from a solution of cellulose acetate in a volatile organic liquid, on a surface of glass coated with a thin layer of diethylene glycol monostearate, and stripping said sheet from said surface.

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