

April 30, 1940.

E. F. IZARD

2,198,621

APPARATUS FOR FORMING FILM

Filed May 27, 1937

FIG. 1.

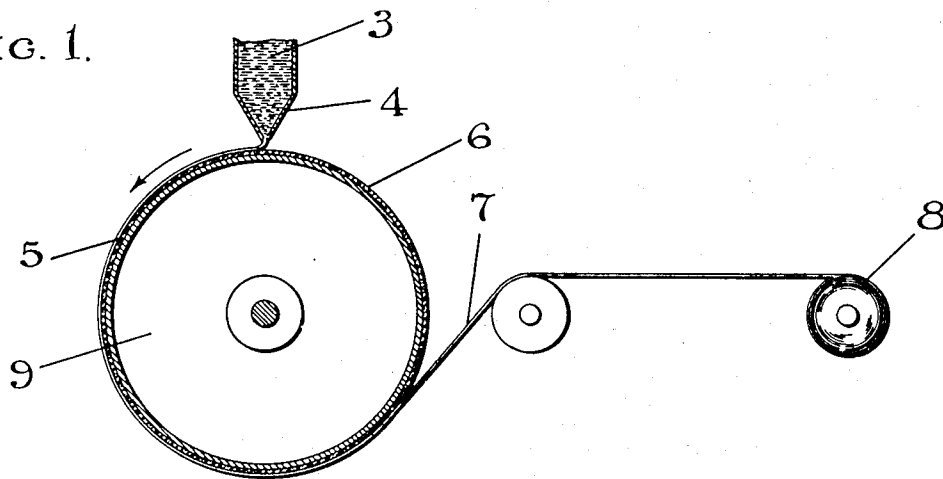
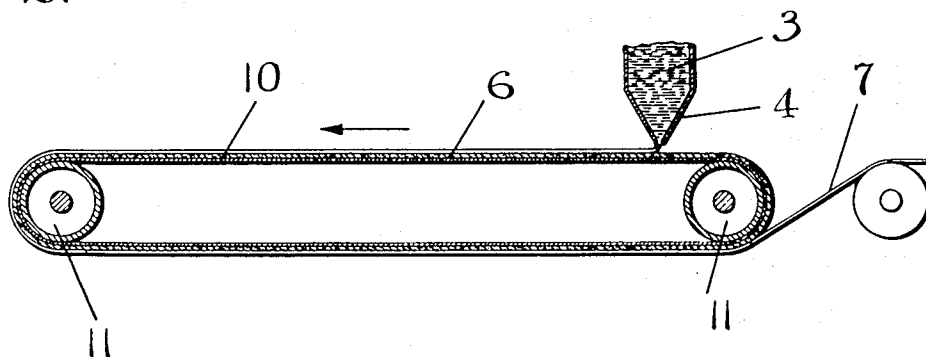


FIG. 2.



INVENTOR.
Emmette F. Izard
BY *Charles F. Daley*
ATTORNEYS.

UNITED STATES PATENT OFFICE

2,198,621

APPARATUS FOR FORMING FILM

Emmette F. Izard, Kenmore, N. Y., assignor to
E. I. du Pont de Nemours & Company, Wil-
mington, Del., a corporation of Delaware

Application May 27, 1937, Serial No. 145,115

7 Claims. (Cl. 18—15)

This invention relates to an apparatus for forming self-sustaining film. More particularly, it relates to an apparatus for casting film by the dry or evaporative method. Still more particu-

larly, it relates to an apparatus for forming a self-sustaining film in which a film-forming composition dissolved in an organic solvent is cast onto a surface, the solvent evaporated, and the film thus formed stripped from the surface.

In casting a film-forming solution, such as cellulose acetate dissolved in acetone, onto a surface, more or less difficulty is encountered in stripping the film thus formed from the surface, depending upon the particular film-forming composition and solvents being used. When the casting and stripping are carried on continuously, such a surface must be both smooth and strong, and it is therefore customarily metallic. In order to prevent imperfections in the film, these metallic surfaces have been kept highly polished. Due to the fact that the film, upon being stripped from the surface, tends to take loose particles of metal with it, the metallic casting surface must be resmoothed and/or repolished at frequent intervals, which is both tedious and expensive. Additionally, film stripped from a metallic surface tends to pick up a static electrical charge which renders it extremely difficult to be handled on high speed machinery such as wrapping machinery and, at least in the case of nitrocellulose film, increases the fire hazard. To overcome these disadvantages, it has been suggested to coat a metallic or similar casting surface with various compositions. These compositions, however, have not completely overcome these difficulties, and are all objectionable for one or more reasons, such as brittleness, lack of proper adherence to the metallic or other support, solubility in the solvent of the film-forming composition, etc.

It is therefore an object of this invention to provide an improved casting surface upon which to cast a film-forming composition.

Another object is to provide such a surface for casting film-forming compositions by the dry or evaporative method.

Another object is to provide such a casting surface which will not become noticeably brittle over a relatively long period of time.

A further object is to provide such a surface which will adhere tenaciously to a metallic or similar support.

A further object is to provide such a surface which will last a relatively long period of time without the necessity for renewal.

A still further object is to provide such a surface which will not dissolve in or be deleteriously affected by the solvent for the film-forming composition.

A still further object is to provide such a surface from which a cast film can be stripped relatively easily.

A further object is to cast film from such a surface.

Other objects will appear hereinafter.

The objects of this invention are in general accomplished by providing a casting support with a surface coating comprising a polyvinyl alcohol or water soluble derivative thereof, with or without suitable modifying agents.

In the drawing, Figure 1 illustrates a cross-sectional elevation of a casting wheel and cooperating hopper in accordance with this invention. Figure 2 is a cross-sectional elevation of a casting band or belt and cooperating hopper in accordance with this invention.

In accordance with the preferred embodiment of the invention, a film-forming composition dissolved in an organic solvent is extruded from a hopper 4 and deposited evenly upon a casting support 5 having a uniformly smooth surface coating 6 comprising a polyvinyl alcohol, or a water soluble polyvinyl alcohol derivative, such as a water soluble polyvinyl alcohol acetal. The casting support is continuously advanced in the direction indicated by the arrows, and at the same time the solvent removed from the film-forming composition by evaporation. The resulting film 7 is then stripped in a self-sustaining state from the polyvinyl alcohol surface and wound up into a roll 8. The casting support 5 can comprise a metal or other wheel 9, as in Figure 1, or it can comprise a flexible metallic or other band or belt 10, supported by rotatable rollers 11, as in Figure 2. The procedure followed in each case is substantially the same.

The polyvinyl alcohol or derivatives thereof can be deposited upon the metallic or other surface in any desired fashion. Polyvinyl alcohol is preferably dissolved in hot water and in such a concentration as to form a relatively viscous solution. This solution is then spread evenly upon the surface of the casting support, and the thickness regulated by means of a doctor knife or other suitable device. The drying of the coating thus formed may take place at ordinary temperatures or may be hastened by subjection to elevated temperatures.

It has been found that the adhesion of the polyvinyl alcohol or derivatives thereof to the

base surface or support can be greatly improved by including in the polyvinyl alcohol composition water soluble or aqueous acid soluble amino polymers. The preferred amino polymers which are contemplated are all substantially insoluble in water and in 5% aqueous ammonia, but soluble in 2% aqueous acetic acid. The amino nitrogen may be primary, secondary or tertiary or part of an open chain or of a cyclic molecular structure. Of these materials, deacetylated chitin and salts thereof, such as are described in U. S. Letters Patent to Rigby, No. 2,040,879, are especially suited. Other substances which can be used in place of deacetylated chitin are: (1) resinous polymeric amino alcohol esters of acrylic acid and of its homologues substituted in the alpha position by a hydrocarbon radical, such as beta-diethylaminoethyl alpha-methacrylate, morpholine N-ethyl alpha-methacrylate, the interpolymer of beta-dicyclohexylaminoethyl alpha-methacrylate and methyl vinyl ketone and triethanolamine monomethacrylate; (2) resinous reaction products of phenols, aldehydes, and ammonia or primary or secondary amines, and (3) amino derivatives of proteins, such as dimethylaminoethyl zein and piperidylmethyl zein. Compositions comprising polyvinyl alcohol and these amino derivatives are not claimed per se in the present application, but are described and claimed in my copending application, Serial No. 145,116, filed of even date herewith.

The amount of amino polymer included in the polyvinyl composition can be any convenient quantity, depending partially upon the compatibility of the material. In general, the quantity should be large enough so that the desired degree of adhesion to the metallic or other base is secured, so that the coating will not be loosened when a film is stripped therefrom. The polyvinyl alcohol is preferably present in an amount exceeding 50% of the total solids in the composition in order to secure the desired strength and flexibility.

There may also be added to the polyvinyl alcohol compositions certain other ingredients which, after the coating is formed, will render it possible to convert the coating to a water insoluble form. Examples of such ingredients are polybasic acids, particularly polymethacrylic acid, water soluble dimethylurea resin, and certain polyhalogenated compounds. The method comprising forming films and threads from such compositions and then converting by means of heat into water and solvent insoluble forms is not part of the present invention, but is described and claimed in U. S. Patent No. 2,169,250 (Izard).

Other modifying substances may also be added if desired to the polyvinyl alcohol compositions such as plasticizers or softeners, resins, e. g. urea-formaldehyde resins, substances to assist in the stripping of a film from the polyvinyl alcohol surface, or others. Ordinarily, however, it is not necessary to add such other modifying substances such as softeners or plasticizers since the polyvinyl alcohol is sufficiently soft and flexible as not to require their use.

Instead of polyvinyl alcohol itself there may be used water soluble polyvinyl alcohol derivatives, such as polyvinyl alcohols containing an appreciable quantity of ester groups and/or formal or other acetal type groups, as long as these derivatives do not contain sufficient ester or acetal groups to render them insoluble in hot water.

The casting support upon which the polyvinyl

alcohol surface is deposited is preferably metallic since this possesses the necessary strength and flexibility characteristics. Flexibility, for example, is particularly necessary where the support is a continuous band as in Figure 2 of the drawing. Glass and ceramic materials have also been suggested as casting supports, but these are somewhat inferior to metal in that they lack flexibility, are brittle, are susceptible to temperature changes, and are difficult to form into a properly even surface. However, glass supports such as glass plates are occasionally used in operations on a small scale where sheets are cast individually and by hand. Instead of metal or glass, the base support may be a flexible sheet material, for instance paper or a fabric such as linen, cotton, or silk. However, the use of a porous material is generally less desirable than metal or glass as a base support in that more difficulty is encountered in securing the necessary uniformly smooth surface.

The following examples are given as representative of the formation and use of the surface according to the present invention. It will of course be understood that they are not to be considered limitative.

Example I

A plate, belt, or wheel having a surface of nickel is coated evenly with a 15% aqueous solution of a polyvinyl alcohol having, in an aqueous 4% solution, a viscosity of 22 centipoises at 20° C. The coating is permitted to dry thoroughly. A solution composed of one part of nitrocellulose (12% nitrogen content) and five parts of acetone is evenly distributed upon the dried polyvinyl alcohol surface and the acetone is evaporated to yield a self-sustaining film. The self-sustaining nitrocellulose film strips readily from the polyvinyl alcohol surface, whereas a similar film, when cast on a nickel surface, can be removed only with extreme difficulty.

Example II

The same compositions and procedure are used as in Example I, except that a smooth glass plate or wheel is employed instead of a plate having a nickel surface. The resulting nitrocellulose film strips readily from the polyvinyl alcohol surface. In contrast, the same nitrocellulose film formed directly on the glass surface can be removed only by soaking in water which is obviously impractical.

Example III

A glass or nickel surface is coated with a composition comprising ten parts of polyvinyl alcohol and five parts of deacetylated chitin acetate, dissolved in 185 parts of water. When thoroughly dry, this composition has extremely good adhesion to the glass or nickel surface and can be removed only by soaking and scraping. This modified polyvinyl alcohol surface provides an excellent base on which to dry-cast acetone solutions of cellulose acetate in that the resulting cellulose acetate film can be very readily removed without disturbing the evenness of the modified polyvinyl alcohol casting surface.

Example IV

A glass or nickel surface is coated evenly with a 15% aqueous solution of a formaldehyde polyvinyl alcohol condensation product which is water soluble but insoluble in an organic solvent. A solution composed of one part of nitrocellulose (12% nitrogen content) to five parts of acetone

is evenly distributed from a casting hopper onto the coated and dried surface and the acetone is evaporated to yield a self-sustaining film. The self-sustaining nitrocellulose film strips quite readily from the coated surface.

The polyvinyl alcohol casting surface in accordance with the present invention can be used advantageously for casting many film-forming compositions dissolved in organic solvents, including polyvinyl alcohol acetal resins of the type disclosed in U. S. Patents Nos. 2,035,939 and 2,036,092, vinyl ester polymers, methyl methacrylate, rubber hydrochloride, chlorinated rubber, cellulose derivatives such as cellulose acetate, cellulose nitrate, and ethyl cellulose, and many others.

These polyvinyl alcohol and modified polyvinyl alcohol compositions have many advantages over others, such as gelatin, which have been used in the past as surface coatings on casting supports. As is generally known and well recognized, gelatin becomes rather brittle upon drying and when used as a casting surface must be replaced quite frequently. In contradistinction, a polyvinyl alcohol coating apparently does not become brittle upon drying, and remains substantially flexible over an extended period of time. Another outstanding advantage of the polyvinyl alcohol type of surface coating resides in the fact that film stripped from such a surface appears to pick up a static charge much less readily than similar compositions stripped from a metal surface. This is of particular advantage in casting cellulose acetate and certain other films. In addition, the polyvinyl alcohol surface coating adheres tenaciously to the casting support, is not detrimentally affected by the organic solvents employed to dissolve the film-formers, and hence offers the advantage of not separating from the casting support during the stripping of the self-sustaining film from the casting surface. To a lesser extent these advantages are also true of the casting surfaces consisting of polyvinyl alcohol acetal type derivatives soluble in water but insoluble in organic solvents. The casting surfaces of the invention do not contaminate the films with minute amounts of microscopic metallic particles as seems to be the case with metallic casting surfaces. Consequently, they are of particular advantage in casting photographic film although

they are also of advantage in casting other film, such as thin sheeting for wrapping purposes.

Any variation of or modification of the invention as it has been described above in this application, which conforms to the spirit of the invention, is intended to be included within the scope of the claims.

I claim:

1. In an apparatus for forming film from a film-forming material dissolved in an organic solvent, a casting support coated with a composition comprising a material taken from the class consisting of polyvinyl alcohol and its water-soluble derivatives which material is insoluble in the organic solvent of the film-forming material.
2. In an apparatus for forming film from a film-forming material dissolved in an organic solvent, a casting support coated with a composition comprising polyvinyl alcohol.
3. In an apparatus for forming film from a film-forming material dissolved in an organic solvent, a casting support coated with a composition comprising polyvinyl alcohol and an amino polymer.
4. In an apparatus for forming film from a film-forming material dissolved in an organic solvent, a casting support coated with a composition comprising polyvinyl alcohol and deacetylated chitin.
5. In an apparatus for forming film from a film-forming material dissolved in an organic solvent, a casting support coated with a composition comprising a material taken from the class consisting of polyvinyl alcohol and its water soluble derivatives and 0%-50% of resinous reaction products of phenols, aldehydes, and amines.
6. In an apparatus for forming film from a film-forming material dissolved in an organic solvent, a casting support coated with a composition comprising essentially polyvinyl alcohol and 0-50% of resinous polymeric amino alcohol esters of acrylic acids.
7. In an apparatus for forming film from a film-forming material dissolved in an organic solvent, a casting support coated with a composition comprising polyvinyl alcohol and 0-50% of amino polymer insoluble in water and in 5% aqueous ammonia but soluble in 2% aqueous acetic acid.

EMMETTE F. IZARD.