

Dec. 1, 1970

SETSUO NAKAI ET AL
METHOD OF MAKING A LAMINATE, ONE LAYER
COMPRISING A REVERSIBLE SOL-GEL
 Filed Sept. 13, 1967

3,544,405

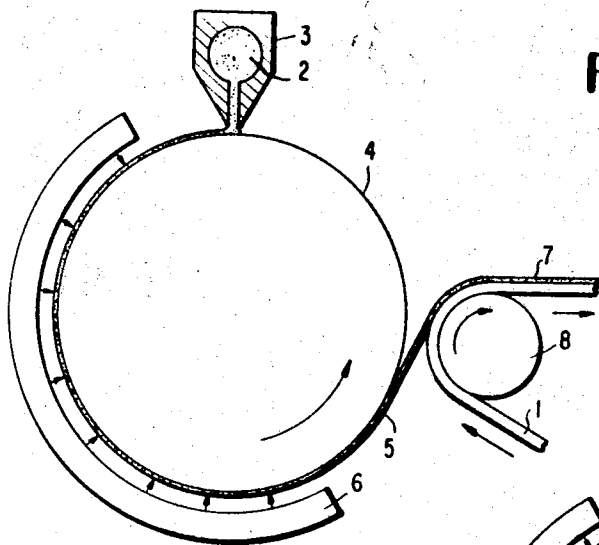


FIG. 1

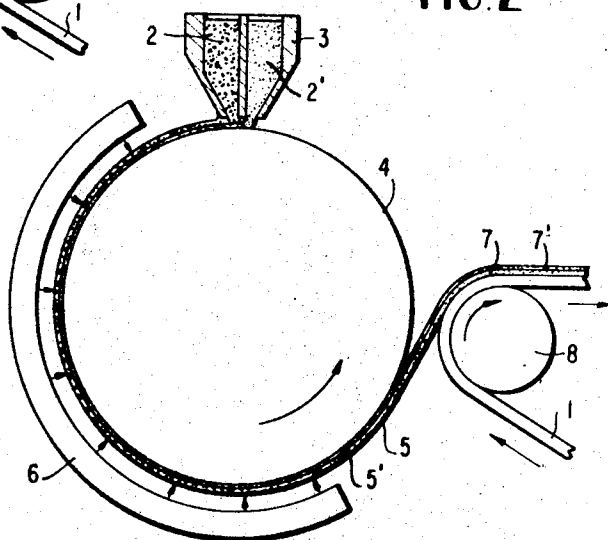


FIG. 2

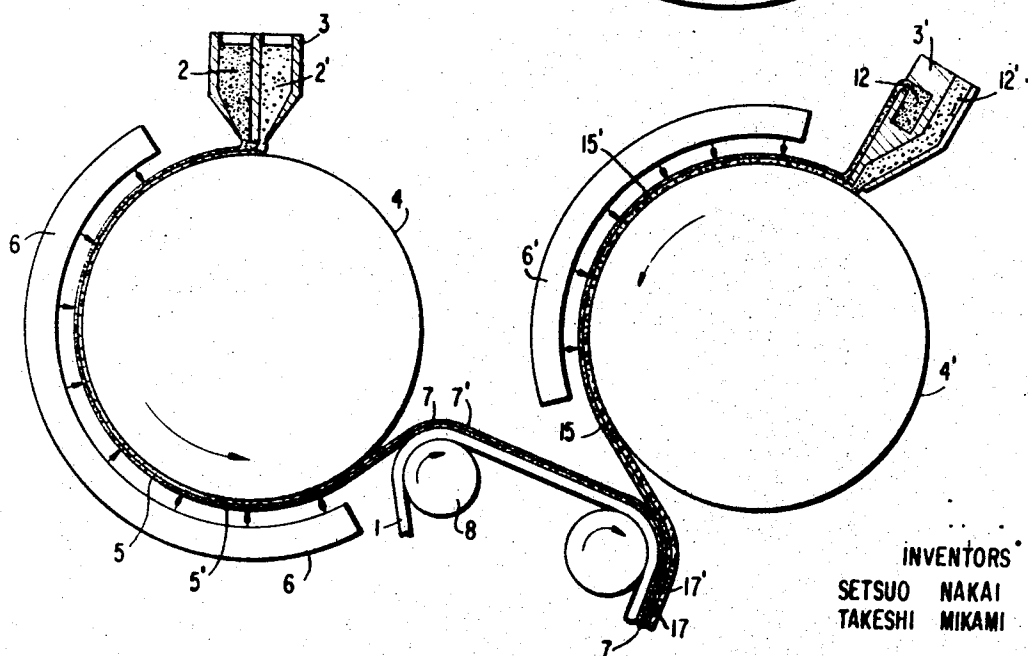


FIG. 3

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METHOD OF MAKING A LAMINATE, ONE LAYER COMPRISING A REVERSIBLE SOL-GEL

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Filed Sept. 13, 1967, Ser. No. 667,465

Claims priority, application Japan, Sept. 13, 1966,
41/60,596

Int. Cl. B32b 31/08

U.S. Cl. 156—164

3 Claims

ABSTRACT OF THE DISCLOSURE

A process for coating a reversible sol-gel coating composition on a surface of a travelling support in a thin layer by applying the coating composition to a cooling surface moving at a speed slower than that of the support, gelling the layer formed by cooling, stripping the layer from the cooling surface, and then transferring to the surface of the support while stretching.

BACKGROUND OF THE INVENTION

Field of the invention

The present invention relates to a coating process in which a sol-gel reversible coating composition containing gelatin, such as a photographic silver halide light-sensitive emulsion, is applied to a cooling surface and gelled thereon by cooling, the gelled gelatin layer is stripped from the cooling surface and is then transferred to the surface of a travelling support while stretching, whereby the gelatin layer is formed on the surface of the support.

The process of this invention is particularly suitable for preparing a photographic light-sensitive element by applying at a high speed in a single thin layer or multiple thin layers to the surface of a support, such as a film base or a baryta paper, a sol-gel reversible coating composition, such as a gelatinous liquid, e.g., a gelatinous silver halide emulsion, a backing layer coating composition, a protective layer coating composition, or an intermediate layer coating composition for a photographic light-sensitive element.

Description of the prior art

A conventional process of coating a single thin layer or multiple thin layers on a support, such as a film or paper, comprises applying a coating composition or coating compositions to a support through a coating device such as an extrusion hopper, a slide hopper or a doctor hopper while forming a bridge of the coating composition or compositions between said support and the coating device. Another conventional process comprises applying a coating composition or coating compositions to a support by forming a bridge of the coating composition between the support and a coating roller.

When high-speed coating is practiced by such conventional processes of forming a bridge of a coating composition between a coating device or a coating roller and a support, the bridge of the coating composition becomes

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unstable and when the coating speed is further increased, the maintenance of the bridge becomes impossible and will break. Also, in order to form a thinner coating, it becomes necessary to let the coating device approach the support extremely closely. This requires dimensional precision of the support, coating device, backing roller and the like. In this case, small foreign matter, such as dust or waste threads adhered to the support also introduce serious faults to the quality of the coated materials. Further, a precise means is required for rapidly separating or returning the coating device in the case where connected portions of supports are passed through the coater.

Moreover, another process of applying multiple layers to a support, comprises applying a coating composition to the surface of the support and, after gelling the coated composition by cooling, another coating, in the sol state, is applied to the thus formed layer to form multiple layers. In another process, a coating composition is applied to a support and while the layer thus coated is in a sol state, another coating composition is applied to the layer.

However, in processes of applying a coating composition to a gelled layer of a coating composition and applying a coating composition to a layer of a coating composition in a sol state, there are restrictions in the properties of the coating compositions and coating conditions owing to the problems of wetting between the coating compositions of adjacent layers or mixing of the coating compositions.

An object of this invention is to overcome such conventional difficulties and to provide an improved process of coating a thin layer or layers at high speeds.

SUMMARY OF THE INVENTION

The invention comprises applying a reversible sol-gel coating composition, such as the compositions employed in the manufacture of photographic, light-sensitive elements to a moving gelling surface on which the composition is gelled, stripping the gelled layer from the surface, stretching the layer and transferring the layer to the surface of a faster moving support, the stretching of said layer being effected by maintaining a suitable difference between the speeds at which the gelling surface and the support are moved.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention is illustrated in the accompanying drawings, in which;

FIGS. 1, 2 and 3 are somewhat schematic, cross-sectional views showing embodiments of apparatus for carrying out the process of the invention.

DETAILED DESCRIPTION OF THE INVENTION

First of all, the invention will be explained with reference to the embodiment of the invention illustrated in FIG. 1.

Numeral 1 stands for a continuously travelling support, such as a film base or a baryta paper. A coating composition 2 is applied uniformly to a cooling surface 4 of a continuously rotating drum by means of a coating device 3, such as an extrusion-type hopper.

The cooling surface 4 may be a rotary cooling drum or a rotary belt conveyer and the surface moves at a speed slower than that of the support 1.

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The coating composition applied to the cooling surface 4 is immediately cooled to form a gelled, thin layer 5. In this case, cold air (arrows) having a suitable temperature may be blown onto the surface of the layer through a cold air blowing means 6 to promote the cooling of the coating composition coated on the cooling surface 4. Then, the thus gelled thin film or layer 5 of the coating composition is stripped from the cooling surface 4 and bridged between the cooling surface 4 and a support 1 which travels at a speed higher than that of the cooling surface 4, whereby the gelled layer 5 is stretched by the difference in speed between the cooling surface 4 and the support 1 and at the same time the layer 7 which has been further thinned by stretching is closely attached to the surface of the support.

For facilitating the stripping of the gelled thin layer 5 from the cooling surface 4, it is preferable to use a stripping means, make the surface of the cooling drum smooth, and apply to the cooling surface a material which permits easy stripping of the gelled layer from the cooling surface.

Furthermore, in order to reduce the deviation in the width direction at stretching, it is preferable to make the bridge of the gelled film between the cooling surface and the support as short as possible, for example, to bring the roll 8 close to the surface 4 of the cooling drum as close as possible.

The invention may also be adapted to form two superimposed layers at the same time, as shown in FIG. 2.

Coating compositions 2 and 2' are applied simultaneously to a cooling surface 4 through a coating device 3 in a desired layer structure and are gelled by cooling. The gelled layers 5 are stripped from the cooling surface and bridged between the cooling surface 4 and a support 1, whereby the layers are stretched as the result of the difference between the speeds of the cooling surface 4 and the support 1 and at the same time multiple layers 7 having thinner thickness are formed on the support.

Moreover, the invention may also be adapted to the formation of four superimposed layers on a support as shown in FIG. 3. According to the method previously explained in regard to FIG. 2, gelled and stretched layers 7 and 7' of coating compositions 2 and 2' are formed on a support 1. In the same way, coating compositions 12 and 12' are applied to a cooling surface 4' by means of a coating device 3' and are gelled by cooling to provide gelled layers 15 and 15'. In this case, a cold air blowing means 6' may be employed to increase the cooling speed and gel the layers quickly.

The gelled thin layers 15 and 15' are stripped from the cooling surface 4' and then superimposed on the layers 7 and 7' of the coating compositions 2 and 2' formed on the support 1 while being stretched simultaneously due to the difference between the speeds of the cooling surface 4' and the support 1. In this case, by suitably selecting the kind and number of coating devices and the number of cooling devices, other layer structures than that shown in FIG. 3 can be formed.

When the gelled layer is transferred to a support after being stretched to n times the original dimensions by the process of this invention, the speed of applying the coating composition to the cooling surface may be about $1/n$ times the speed of applying the coating composition directly to the support. Also, the thickness of the layer of the coating composition formed on the cooling surface may be about n times the thickness of the layer to be directly formed on the support.

That is, in the process of this invention, the coating speed may be $1/n$ times the speed of applying the coating composition directly to the support as in a conventional method and the coating composition may be applied to the cooling surface in such thickness as n times the thickness of the layer directly formed on the support. Therefore, as comparing the conventional case of directly applying to a support a coating composition by forming a

bridge thereof between a coating device and a support, the bridge of the coating composition becomes more stable in the case of forming the layer of a coating composition according to the process of this invention and further, the speed of the support can be increased while maintaining the bridge of coating composition stable.

Also, as mentioned above, in the process of this invention, since the coating amount is larger in an amount corresponding to the stretching percentage of the gelled layer, the space between the coating device and the material to be coated may be increased and hence troubles caused by the narrow space between them are reduced and the necessity for precision in the mechanical working of the apparatus is reduced. Moreover, in the process of this invention, since a cooling surface having no joints, such as a rotary cooling drum or an endless belt can be employed, a device for rapidly separating and returning the coating device, in the case where the joint portions of a support pass under the coating device, is unnecessary.

In the case of forming multiple layers, one after another, in accordance with this invention, a stretched gelatinous layer or layers are superimposed on a support or a gelled layer on a support and hence no problems will occur regarding wetting or mixing between adjacent layers of coating compositions as will occur in the case of applying a sol-form coating composition to a gelled layer or a layer in a sol state. Furthermore, by the process of this invention the coating composition applied to a cooling surface can be rapidly cooled to be gelled by means of the cooling drum or a combination of the cooling drum and a cold air blowing means as compared with the method of employing only a cold air blowing means.

The invention will further be explained with reference to the following examples.

EXAMPLE 1

By using the apparatus shown in FIG. 1, a backing layer coating composition for a photographic light-sensitive element was applied to a film base of triacetyl cellulose.

The coating composition for the backing layer was prepared by dissolving a dye into a 14% gelatin solution. The coating composition was first applied to the surface of a cooling drum having a diameter of one meter and rotated at a speed of 8 meters/min. After setting, the gelled layer was transferred, with stretching, to the film base travelling at a speed of 32 meters/min. After transfer the layer was dried.

A coating having a uniform thickness and having no coating unevenness was formed on the film.

EXAMPLE 2

By using the apparatus as shown in FIG. 2, a silver iodobromide emulsion (viscosity 60 cp.) and a gelatin solution for a protective layer (viscosity 35 cp.) were applied to the surface of a cooling drum having a diameter of one meter and rotated at a speed of 8 meters/min. and set by cooling. Thereafter, the layers were transferred, with stretching, to the surface of a film base travelling at a speed of 20 meters/min., and then were dried.

The coated amount when transferred to the film base was 80 ml./sq. m. of the silver iodobromide emulsion and 20 ml./sq. m. of the silver iodobromide emulsion and 20 ml./sq. m. of the gelatin solution.

After drying, good and uniform photographic emulsion layers were formed on the film base.

What we claim is:

1. A process which comprises applying a sol-gel reversible composition, to a cooling surface moving at a speed slower than that of a traveling support, gelling the composition layer thus formed by cooling, stripping the layer from the cooling surface, bridging the gelled layer between the cooling surface and the travelling support to stretch the gelled layer said stretching being caused by the difference in speed between the speed of the cooling surface and the speed of the support, and transferring the

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gelled, stripped, stretched layer onto the surface of the support.

2. The process of claim 1 wherein a plurality of layers are gelled on said cooling surface, and are sumultaneously stripped, stretched and transferred to the surface of said support.

3. The process of claim 1 wherein said composition is applied to the cooling surface of a rotating drum, is gelled on said surface, and then is stripped, stretched and transferred to the surface of travelling support, said support being moved at a higher speed than the surface of said drum to effect said stretching without breaking of said layer.

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U.S. Cl. X.R.

117—7; 156—229, 246, 249, 324, 344