July 30, 1968 R. PRZYBILLA 3,395,034

PROCESS OF APPLYING THIN COATS OF GELATIN CONTAINING SILVER HALIDE TO A FILM

Filed May 19, 1965

FIG. 1

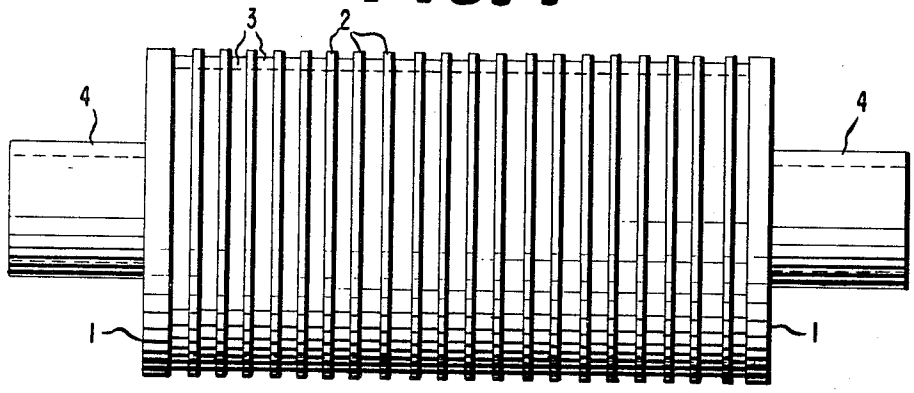


FIG. 2

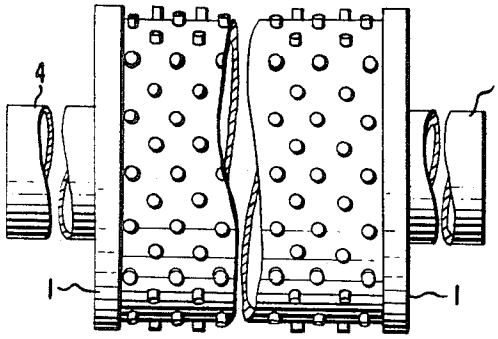


FIG. 3

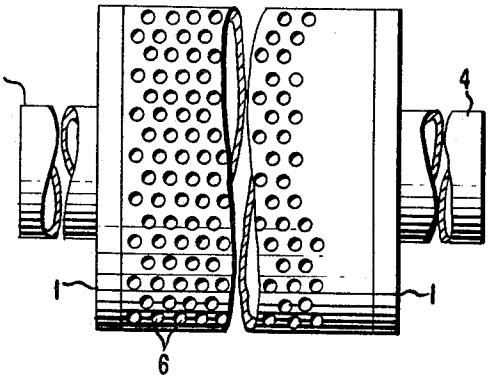
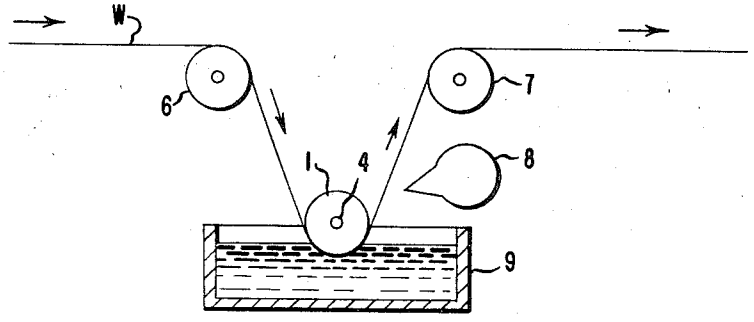


FIG. 4



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United States Patent Office 3,395,034 Patented July 30, 1968

3,395,034
PROCESS OF APPLYING THIN COATS OF GELATIN CONTAINING SILVER HALIDE TO A FILM

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Filed May 19, 1965, Ser. No. 457,121
Claims priority, application Germany, July 9, 1964, A 46,544
2 Claims. (Cl. 117—34)

This invention pertains to a process and apparatus for applying film-forming solutions and dispersions, especially photographic emulsions, to carrier webs, of any type suited to the purpose, by the so-called dip-coating or skim-coating process.

It is known in the art that application of film-forming solutions and dispersions to moving webs can be effected by processes in utmost variety. A familiar and widely used process is the so-called skim-coating process. In this process the web to be coated is passed around a roll which is so disposed in a coating pan that the web to be coated comes into contact with the coating solution and picks up or entrains a layer of the film-forming liquid. The thickness of the entrained layer then depends on the speed at which the web to be coated is conveyed past the coating pan, as well as on the viscosity and the solids content of the coating liquid; i.e., solution, emulsion or dispersion.

For a flawless coating it is known to be very important that in every case the layer thickness should remain uniform throughout the length and width of the web and not fluctuate or vary in thickness. Even the smallest variations in layer thickness of a single coating of an aqueous gelatin silver halide emulsion, for example, lead to serious defects which, after processing the material, are manifested in the form of deviations in darkening, known in the literature of the art as "haze." For example, when a photographic material in which variations in thickness occurred during coating is exposed and developed, deviations in density are distinctly apparent, and are more conspicuous the oftener variations occur between thicker and thinner spots or areas.

These irregularities have been found to have been caused in part by the fact that the coating roll, which in fact is usually at a lower temperature than that of the coating liquid, exerts a cooling effect through the web, e.g., film base on the interface of the coating liquid. Since the thickness of the film base always varies somewhat, the cooling effect will also undergo local variations. For this reason, viscosity variations occur in the coating solution or dispersion, leading to uneven application thereof. Prior efforts have been made to prevent the undesirable heat transfer between the coating roll and the coating liquid by heating the coating roll to the temperature of the latter. But this heating of the roll entails a substantial additional expense, and also embodies several new sources of trouble.

Now it has been found in accordance with this invention that the above-mentioned difficulties can be overcome and excellent results can be obtained if the skim-coating process is carried out in such a manner that during the application of the film-forming solution, emulsion or dispersion, and, if desired, also during transport of the coated web through the setting and drying zone of the coating apparatus, there is provided at least in part a gaseous layer of low thermal conductivity, preferably an air layer, between the coating roll and the web and between the coated web and guide or rolls. This gaseous insulating layer, at least to a large extent, prevents heat transfer, and the deleterious effect already mentioned, between the coating roll and the coating liquid. By this

means the process of this invention permits application of the film-forming coating liquid in a way that is characterized by improved uniformity of the coated layer throughout the length and width of the web.

In particular, by the process of this invention, aqueous dispersions of photosensitive silver halides in a natural or synthetic water-permeable organic colloid can be applied to moving webs of film or paper to produce colloid-silver halide layers of enhanced uniformity.

The process of the invention is equally applicable, however, to coating webs with other film-forming solutions used in making photographic films and papers, e.g., layers which are not photosensitive, such as protective coatings, adhesive layers, filter layers and antihalation layers.

If application by dipping is combined in a manner shown in the art with air jet or air-knife doctoring devices, it is possible by this process to apply coating liquids, i.e., solutions, dispersions or emulsions, even with high solids content, in thin layers and with improved uniform surface characteristics.

The coating apparatus of this invention that is useful for carrying out the process has

(1) A coating pan, and

(2) A coating roll for transporting a web into surface contact with a film-forming liquid in the pan; said coating roll being characterized by having a plurality of uniformly spaced surface areas of small magnitude and uniformly depressed areas of small magnitude adjacent the surface areas, whereby upon rotation of the roll, a cushion layer of gas, e.g., air, is provided between the surface of the roll and the web as the web contacts the liquid coating solution.

Thus, the coating roll can advantageously be made so that its surface is suitably shaped to provide alternate surface areas and depressed areas of small magnitude. In a particularly preferred embodiment, the surface of the web may have essentially parallel ribs and grooves, the ribs being from about 0.05 mm. to about 0.5 mm. in width and the parallel grooves being from about 1 mm. to about 8 mm. in width. Usually the depressions will have a depth equal to the average width between the projections. The width of the groove can vary in accordance with the nature of the particular web to be coated. For the stiffer webs, the grooves can be wider. The web should not dip into the grooves and, in general the grooves should not exceed about 8 mm. in width.

Instead of grooves, the surface of the coating roller may be reticulated having a mesh pattern or have knobs or similar raised portions surrounded by depressed portions.

Again, in carrying out the process according to this invention, those rolls are suitable in which the jacket of the coating roller has orifices uniformly distributed over the surface through which air can flow, so that an insulating air cushion is formed between the roll and the web to be coated. In this case, air can be supplied through a duct in a roll trunnion into the hollow roll and thence through the spaced orifices.

The desired insulating effect of the rolls made in accordance with this invention can be still further improved if rolls are employed which are made entirely, or only the jacket is made, of an organic plastic material of low thermal conductivity, for example, polyvinyl chloride, polymethyl methacrylate, polyethylene or polytetrafluorethylene, or are coated with such a plastic material. The invention will be further illustrated by reference to the accompanying drawings which form part of this application.

In the drawings:

FIG. 1 is an elevation of a suitable coating roll having parallel grooves and ribs;

FIG. 2 is an elevation of a suitable coating roll having knobs;

FIG. 3 is an elevation with structure in dotted outline of a coating roll having spaced orifices through which jets of air can be passed; and

FIG. 4 is a side elevation of the coating apparatus showing the web, pan, coating roll and associated elements.

Referring to the drawings, and more particularly to FIG. 1, coating roll **1** has spaced ribs **2**, grooves **3** and trunnions **4** which are to be journalled in suitable bearing blocks (not shown).

In FIG. 2, the web-supporting surface of the roll has a plurality of uniformly spaced cylindrical knobs **5**.

In FIG. 3, the jacket of the coating roll has a plurality of uniformly spaced orifices **6** which communicate with the hollow central part of the roll. If desired, orifices can be provided in the grooves or spaces of the rolls shown in FIGS. 1 and 2.

In FIG. 4, at least one of guide rollers **6** and **7** may be provided with surfaces like the coating rollers of FIGS. 1–3. In this figure an air knife **8** is provided adjacent the coating pan **9**. It can be connected through any suitable pipe to a source of compressed air. The web W passes around guide roller **6** then down under coating roll **1** where it contacts with the coating liquid in the coating pan, then past the air knife where a jet of air further smooths the coating. The coated web then passes around guide roller **7** and thence to a drying chamber, wind-up device or to a further web treating zone or apparatus.

Suitable air knives are disclosed in U.S. Patents 1,590,417, 1,980,923, 2,139,628, 2,252,345 and 2,423,768.

The coating roll may vary considerably in length and diameter and the width depends upon the width of the web to be coated. Usually the roll will be of small diameter from about 5 cm. to 15 cm.

When the coating roll is heated prior to coating, the roll acquires approximately the temperature of the hot air current, since it is not cooled by the wet film.

The apparatus of this invention is useful in coating dispersions of magnetic particles in colloid binding agents, in coating diazo and bichromated colloid dispersions, in coating baryta layers on paper webs during the manufacture of photographic papers, and for coating other film-forming liquids. Suitable film supports include cellulose esters, e.g., cellulose triacetate, cellulose acetate/butyrate; superpolymers, e.g., polyvinyl chloride (co) vinyl acetate; polyvinyl acetals, e.g., formals, acetals; polystyrene; polyamides, e.g., polyhexamethylene adipamide, and polyesters e.g., polyethylene terephthalate, polyethylene terephthalate/isophthalate; esters formed by condensing terephthalic acid and dimethyl terephthalate with propylene glycol, diethylene glycol, tetramethylene glycol or cyclohexane - 1,4 - dimethanol (hexahydro-p-xylene alcohol). The vinylidene chloride copolymer-coated oriented polyester films of Alles U.S. 2,779,684 can be coated in accordance with this invention.

The invention is not limited to the coating of gelatin-silver halide emulsions. It can be applied in coating other simple and mixed aqueous silver halide emulsions. The emulsions can contain binding agents other than gelatin or mixtures of gelatin and such binding agents. Suitable binding agents include polyvinyl alcohol and acetals thereof, polyvinyl pyrrolidone, polyvinyl lactams, cellulose esters, dextrin and dextran, the latter two, as well as polyvinyl pyrrolidone and polyvinyl lactams being mixed with gelatin.

The use of the guiding rolls with a small area of contact with the web and the provision of an insulating cushion of air has the advantage that it keeps a gelatin layer from melting. It often happens that emulsions melt in the first few meters after startup of coating with conventional smooth coating rolls, so that the material in that section of the web becomes unfit for use. Melting of the emulsion can be prevented by using as guide or conveyor rolls those made according to this invention which, by reason of their special surface construction prevent any substantial heat transfer from roll to emulsion. It has been demonstrated that melting of the emulsion is reliably prevented when rolls of the specified kind are employed.

The process and apparatus of this invention have the important advantage that they permit improved operation of the coating process and provide coated webs with layers of uniform thickness.

I claim:

1. A process for applying a thin coating of an aqueous gelatin-containing silver halide emulsion to the surface of an organic polymer film support characterized in that during the applying of the aqueous emulsion there is provided a roll having a plurality of uniformly spaced orifices communicating with a hollow interior through which a gas is forced outwardly to form an insulating gaseous layer of low thermal conductivity adjacent the back surface of the film support to prevent heat transfer between the roll surface and the coating.

2. A process according to claim **1** wherein the surface of the roll is made of organic plastic material of low thermal conductivity and the gas is air.

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