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PROCESS AND APPARATUS FOR APPLYING A COATING TO A MOVING WEB

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Fig. 1

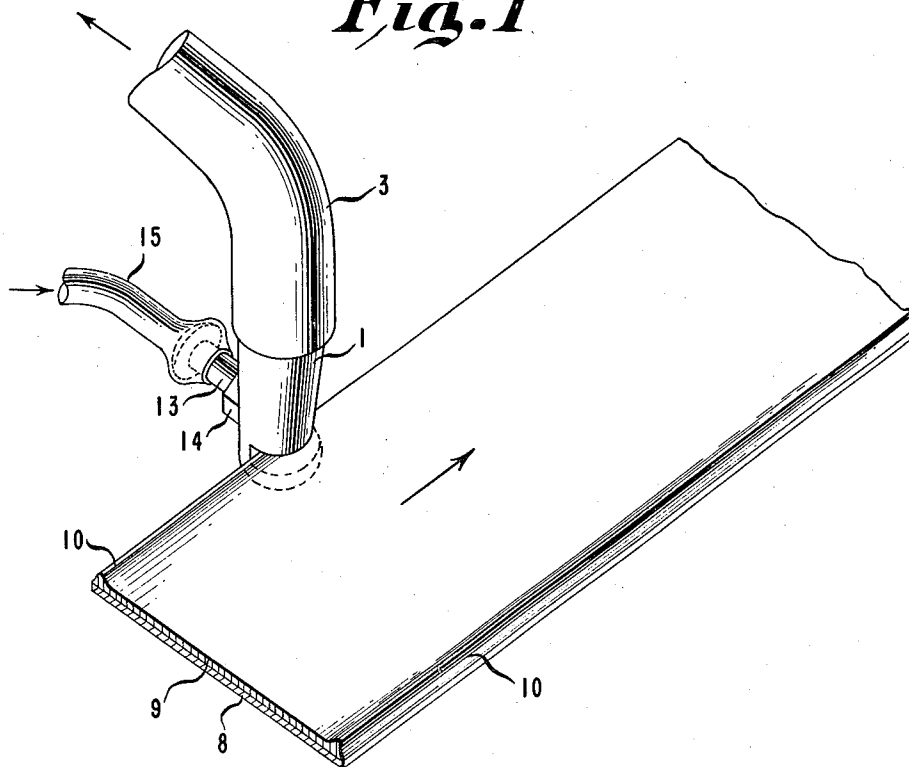
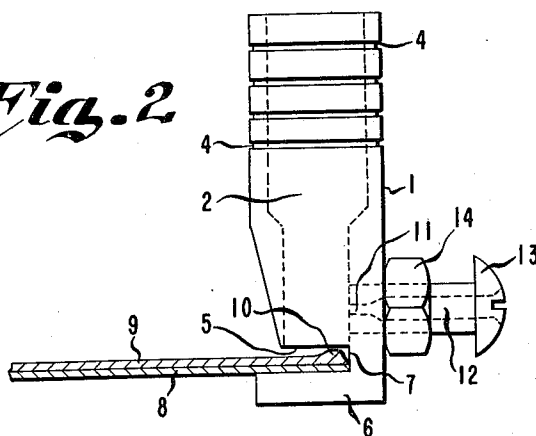


Fig. 2



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PROCESS AND APPARATUS FOR APPLYING A COATING TO A MOVING WEB

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This invention relates to web coating process and apparatus and more particularly to a method and means for continuously applying a coating of viscous photographic material of uniform thickness to a flexible support or web. Still more particularly, it relates to a process and device utilizing vacuum means for producing a coated web without objectionable edge beads caused by surface tension.

The formation of edge beads, i.e., the heavy coating of material at the lateral edges of the coated area due to surface tension, is characteristic of web coating processes. The area covered by these edge beads is generally non-uniform and must be subsequently trimmed and discarded.

In many instances, the coating material, e.g., a viscous photographic emulsion, is expensive and a costly and complex recovery system is required to salvage the coating material on the trimmed edge portions or valuable ingredients therefrom. Additionally, the edge bead portion, having greater thickness than the central portion of the web, requires a relatively longer period for drying. In continuous coating operations, this often necessitates either slowing down the operation or providing for additional drying facilities. In the coating of low viscosity materials, a portion of the excess material in the edge bead formed at the lateral edge of the coated area may tend to run off the edge of the web, fouling the coating equipment, becoming deposited on the uncoated side of the web and resulting in poor quality material.

The use of doctor blades, scrapers, calender rolls or other devices which contact the surface of the coated material have disadvantages when used in the production of a coated web wherein the coating is a highly sensitive photographic material. Such contact devices sometimes cause surface irregularities, such as secondary edge beads, and objectionable defects on the light-sensitive photographic emulsion or other photographic layers.

Edge beads (referred to above) do not necessarily occur only at the edges of the web but may also occur at each lateral edge of any coated area, e.g., a stripe, on the web. They appear in coating by various methods, including skim coating, dip coating, nip roll coating and reverse roll coating. These edge beads are undesirable, in addition to their non-uniformity, because they result in web damage, e.g., curled and turned edges which in turn result in broken or cracked edges during subsequent wind up and handling. Furthermore, the high roll edges cause shift rolls and limit the size of rolls which can be wound up.

It is therefore an object of this invention to provide a novel process and apparatus that permits the continuous coating of a material on a web while eliminating surface tension edge bead formation during web coating. Another object is to provide such process and apparatus for continuously applying a coating of a viscous photographic material of uniform thickness to a flexible support. Still another object is to provide such process and

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apparatus which avoids physical contact of apparatus with the freshly coated layer of material. Yet another object is to provide a novel coating device that is economical to construct, not complex, requires substantially no maintenance and has no moving parts.

A specific object is to provide a process and apparatus for applying a photographic coating to a moving base without injury to the photographic properties of the material being coated. A particular object is to provide process and apparatus for providing on a moving web a coating of uniform thickness (without relatively thick edge beads) of a viscous material utilizing vacuum means. Another particular object is to provide such method and means apparatus for effecting the removal of a viscous material from the lateral edges of a coated web by vacuum while precluding the plugging and clogging of vacuum lines due to the physical and chemical characteristics of the coating material being removed. It is furthermore an object of this invention to provide novel process and apparatus which eliminates the deficiencies of the prior art. Additional objects will be apparent from the following description of the invention.

The invention is directed to the method which comprises coating a liquid material onto a moving flexible web, said coating having a central portion of substantially uniform thickness and at its lateral edges edge bead portions of thickness greater than the thickness of the central portion, and removing coated liquid material from at least one, and preferably both, lateral edge bead portions by locally applying a vacuum to the one, and preferably both, edge bead portions.

It will be understood that the process according to this invention will be carried out by continuously applying a liquid coating material in the form of a thin layer onto a moving web wherein the coated layer is characterized by having at its lateral edges comparatively thick beads due to surface tension and subsequently, while the coated material is still liquid, passing at least one, and preferably both, of the lateral edge beads through respective zones of reduced pressure whereby the edge bead is removed.

Unexpectedly advantageous results have been found to be achieved in a preferred aspect of this invention, wherein photographic coatings, particularly those of moderate viscosity, such as from about 5 to 30 centipoises, or high coating weight or both, are applied to a flexible photographic base. The effect of the vacuum or relatively reduced pressure upon viscous photographic liquid materials, especially those which have been chemically treated by methods well known in the art to set or congeal promptly upon being coated onto a web, tends to plug or clog a vacuum system used in the removal of the coating material as described above. I have found that clogging of the vacuum system in carrying out the above process can be prevented by introducing into the vacuum or low pressure zone adjacent the edge bead portion a small amount, preferably as a stream or spray being fed under pressure or drawn in by the vacuum, of a diluent for the liquid coating material. This feature contributes to the smooth continuous removal of edge bead material and enables the more rapid production of photographic elements of high uniform quality.

The process of this invention will be more clearly understood from the following description of the novel web coating apparatus according to this invention, which description will now be given with reference to the accompanying drawing, wherein:

Fig. 1 is a perspective view of one embodiment of the apparatus of this invention showing effective removal of one lateral edge bead portion of a newly coated web, with the lateral edge beads shown in exaggerated proportion for purposes of illustration; and

Fig. 2 is a side elevation of the apparatus of Fig. 1

showing its operational relationship with a coated web and showing details of one arrangement for introducing a diluent into the vacuum zone.

Referring now to the drawing, wherein the same reference numbers refer to the same part in each figure, the principal elements of the apparatus of this invention include a hollow nozzle 1 defining an interior chamber 2 leading at its upper end through connecting tube 3 to a suitable vacuum source (not shown). The connection between the nozzle and the tube may be secured by any suitable means such as coacting threads or, as illustrated, in a tight interfit aided by grooves 4 in the nozzle. The lower end of the nozzle 1 provides an opening 5 so that during operation the reduced pressure in the chamber 2 will cause suction upwards through opening 5.

In the illustrated embodiment, there is affixed to the nozzle 1 at its lower end an L-shaped web supporting member 6, which together with the nozzle defines a slot 7 or passage for the moving coated web. The latter comprises a flexible support or web 8 on which is adhered a thin layer of coating material 9. As shown in exaggerated scale, the layer of coating material has assumed at each lateral edge of the coated area a beaded edge portion 10 of greater thickness than the remaining central portion of the layer of material 9. It is this edge bead that is objectionable for reasons stated above and that must be removed uniformly without injuring the remaining coated layer in any way, especially the sensitometric properties of photographic emulsions, and without clogging the removal means so that the operation can continue without interruption.

To assure freedom from such clogging, there is provided means for introducing adjacent the nozzle opening 5 a supply of diluent, a material in which the coating material is miscible or dispersible. In the illustrated embodiment, this introducing means is an injection orifice 11 leading from the hollow interior chamber 12 of screw 13. The screw is threadably engaged in a hold in the side of the nozzle and secured by means of nut 14. At the outer end of the screw, i.e., at its end opposite orifice 11, hollow interior chamber 12 is connected with a source (not shown) of diluent. The diluent enters chamber 12 through connecting hose 15 or other suitable means interfitting with screw 13.

If desired, friction reducing devices, such as spring loaded ball bearings, may be inserted adjacent slot 7 in web supporting member 6 and at the edge of slot 7 at the point where the edge of the web may contact the web supporting member 6.

In operation, the flexible support 8, having the layer of material 9 freshly coated thereon and therefore still fluid, is moved, as by suitable web handling equipment (not shown), past nozzle 1 in the relative positions shown in Figs. 1 and 2. Vacuum applied through chamber 2 in nozzle 1 effects the removal of part or all of the coating material 9 at the lateral edge of the coated area.

It will be apparent that the amount of vacuum to be applied will vary depending on the amount of material to be removed, the rate at which the material is being removed, and the viscosity, temperature, concentration, etc., of the coating material. It has also been found that the amount of coating material removed will be dependent upon the distance of the nozzle opening from the web. The smaller the distance, and consequently the greater the effect of the vacuum, the greater the amount of the material removed. It has been found that an applied vacuum of from 20 to 40 inches of water is sufficient to remove coating materials having viscosities within the range from 3 to 30 centipoises. The particular amount of vacuum to be used for any given operating conditions can be readily selected by persons in the art, depending on the effect desired, in accordance with the above teachings.

It will be appreciated that the applied vacuum can effect the removal of only the protruding elevated por-

tion of the bead to reduce the bead to a thickness approximately equal to the thickness of the central portion of the coated layer, or the vacuum may effect the removal of more or all of the coating material in the bead at the edge of the web. It has furthermore been found that by positioning the nozzle at an acute angle to the edge of the web, it is possible to taper the edge of the coated layer, i.e., to remove substantially all of the coating material at the lateral edge of the web while leaving a progressively increasing amount of material up to the amount of the desired coating material thickness toward the central portion of the web. Nozzle angles, measured from the plane of the moving web, have been found to be particularly advantageous in the range from 60° to 90°.

The amount of vacuum used is limited only by the requirement of preventing interference with the forward movement of the web. The degree of vacuum should be sufficiently low that the web itself is not pulled into contact with the nozzle, so that there will be no scratching or abrading of the surface of the coated layer.

The process and apparatus of this invention have been found effective in the removal of coating materials of viscosity of 3 to 500 centipoises. Amounts of vacuum which are suitable according to this invention range from 10 to 200 inches of water (applied vacuum) and preferably from 20 to 40 inches of water.

The solvent injection device should have an aperture or orifice 11 small enough to produce a jet of the diluent at the base or lower portion of the nozzle. The jet of diluent becomes atomized and mixes with the removed coating material. A suitable adjusting metering device to control the size of the jet can be used such as a thumb screw or similar device positioned near the chamber 12 or along the diluent delivery line. One or more jets can be used, although a single jet is satisfactory for most operations.

The particular diluent used will depend on the coating material being applied, and should be one in which part or all of the coating material is partially or completely soluble at the operating conditions of temperature and pressure. The preferred diluent, particularly for water-soluble coating materials and coating materials in an aqueous medium, is water. Organic solvents are satisfactory, when necessary.

The above described apparatus can be suitably positioned adjacent the lateral edge of the traveling web by means of brackets or other suitable supporting members, as will be understood by persons in the art. In a preferred embodiment of the apparatus according to this invention, it has been found highly desirable to use a flexible resilient material for the tube 3 and the connecting hose 15. The flexibility of these members permits the nozzle to urge itself against the side of the web at slot 7, and therefore to be automatically self adjusting with respect to minor lateral movements of the web.

A conventional vacuum source can be used such as a blower, vacuum pump, or a water or steam aspirator. The vacuum can be applied through a collecting reservoir for the coating material, from which the collected coating material can be recycled to the coating station or can be fed to a system for salvaging expensive components.

If desired, the efficiency of this system can be improved by introducing with the diluent an anti-foaming agent to prevent foaming within the nozzle or exit lines. Similarly, an anti-foaming agent, such as octyl alcohol, can be used in the collecting reservoir to prevent foaming at that location.

The invention will be further explained but is not intended to be limited by the following examples:

Example I

A gelatino silver iodobromide light sensitive photographic emulsion having a viscosity of 5 centipoises at

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a temperature of 84° F. and a solids content of 8% by weight is dip coated onto one surface of a gelatin-sized 100 gram weight photographic paper web. Promptly after coating, the web is passed through apparatus according to this invention as shown and described in the attached drawing. The nozzle opening 5 is circular and 1/4 inch in diameter. The clearance between the nozzle opening 5 and the bottom of the web is 3/32 inch. A vacuum of 24 inches of water is applied to the chamber 2. Water at a temperature of 130° F. is fed under a pressure of 0.5 p.s.i. to the diluent injection orifice 11 where it enters the nozzle through a circular aperture 0.040 inch in diameter. The web coating is subsequently dried, and it is observed that a strip 3/16 inch wide along the vacuum treated edge of the web is essentially free from emulsion. There is no surface tension bead at the side which has been vacuum treated. A surface tension bead of about 1/4 to 5/16 inch measured from the lateral edge of the paper base is observed at the opposite lateral edge of the web. Testing of the photographic sensitometric properties of the photographic paper product shows a high uniform quality, low fog level, absence of surface abrasions, and no injury to the light-sensitive emulsion.

Example II

A gelatin photographic antihalation coating composition having a viscosity of 14 centipoises at a temperature of 86° F. and a solids content of about 10% by weight is skim coated onto the surface of a gelatin subbed polyester film base of the type described in Alles and Saner U.S. 2,627,088. A vacuum nozzle is used at one lateral edge of the web as in Example I. A vacuum of 30 inches of water is applied to chamber 2 and diluent is injected into the nozzle as in Example I. The web coating is subsequently dried, and it is observed that a strip 3/16 inch wide along the edge of the web at which the nozzle is positioned is essentially free from coating composition. There is no surface tension edge bead at the side which has been vacuum treated. A surface tension bead of about 1/4 inch measured from the lateral edge of the film base is observed at the opposite lateral edge of the web. Examination of the coated product shows a high uniform quality and no injury to the surface of the coated layer.

Example III

Example II is repeated except that the gelatin antihalation layer is coated onto a 117 gram weight transparentized paper web previously coated with a gelatin sublayer. The results obtained are similar to those of that example.

Example IV

Example I is repeated except that the light-sensitive photographic emulsion has a viscosity of 9 centipoises at a temperature of 88° F. and a solids content of about 15.5% by weight. The results are similar to those obtained in that example.

The specific embodiment of this invention illustrated in the drawing is of course capable of modification without departing from the scope of the present invention. Thus, the vacuum nozzle need not be circular but can be square, rectangular, triangular or wedge shaped. Similarly, the opening in the injection orifice need not be round. Although a circular opening is preferred, an elliptical or rectangular slot can of course be used. Part or all of the equipment can be suitably heated, if desired.

In positioning the nozzle along the lateral edge of the web, it may be desirable or necessary to include means additional or supplementary to the resilient tubing for holding the nozzle against the web. To mention one possible alternative, a spring loaded supporting arm positioned to urge the nozzle into contact with the lateral edge of the web can be used. Alternatively, the

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nozzle can be stationary and the web guided by any suitable means to maintain alignment with the nozzle.

The nozzle and injection device can be made from any formable material which retains its shape at the operating temperatures, for example, plastic, wood or metal. The nozzle must be capable of withstanding, on its L-shaped web supporting member 6, the abrasive action of the web material passing through the slot 7. In a preferred embodiment, the apparatus was constructed of polytetrafluoroethylene resin. It is of course necessary to select materials that will not deteriorate upon contact with the coating materials or diluent. The tubing, connecting hose, or pipes when used for a rigid installation, can be made of metal, plastic, e.g., polystyrene, Lucite, polyethylene, polytetrafluoroethylene resin, nylon, tygon, rubber, etc., or other suitable material.

The invention is useful in the coating of aqueous silver halide dispersions in the various types of natural and synthetic water-permeable colloids useful as binding agents for the silver halide grains, including gelatin, albumin, agar-agar, water-permeable polyamides, polyvinyl alcohol, partially hydrolyzed polyvinyl esters, hydrophilic polyvinyl acetals including those containing color-former nuclei, and other types of solutions particularly viscous aqueous solutions containing colloids. It is particularly useful in the coating of gelatino silver halide photographic emulsions.

The flexible support or web utilizable in this invention can be paper, metal, cloth, or a polymeric film which can be comprised of such well known film-forming materials as cellulose derivatives, e.g., cellulose nitrate, cellulose triacetate, cellulose propionate, cellulose acetate butyrate; polyvinyl chloride, polyvinyl chloride/acetate; polyvinyl acetals, e.g., from formaldehyde and acetaldehyde; super polyesters from dicarboxylic acids and dihydric alcohols, e.g., oriented sheets of polyethylene terephthalates having melting points above 200° C. The latter is the preferred support material because of its strength, stability and other desirable physical properties.

An advantage of the invention resides in the reduction in waste of coating materials, and the elimination of costly reclamation procedures. Another advantage is that by removing the surface tension bead the coated web can be dried more uniformly at lower temperatures and at greater speeds. A further advantage is that complex adjustments of apparatus and process conditions are not required during operation. A still further advantage is that the apparatus is inexpensive, simple to construct and operate, and does not require the use of special materials or expensive machining operations. Yet another advantage lies in improved quality and a greater yield of product by reducing edge curl, cracks, kinks and sticking at the edge of the wound up rolls. A particularly important advantage is that an increased amount of footage of coated film can be stored on each roll of film without increasing the diameter of the roll. An additional advantage is that the apparatus is easy to clean and maintain and is self-aligning during operation. A particular advantage of removing the surface tension edge bead and retaining the coating to the edge of the supporting web is the elimination of selvage thereby producing salable product to the edges. Other advantages will be apparent from the above description of the invention.

The invention claimed is:

1. The process of coating photographic material onto a flexible support comprising applying to said support a thin layer of a viscous aqueous solution containing a water-permeable colloid, applying a vacuum of from 10 to 200 inches of water locally in a zone at each lateral edge of said layer, said vacuum being directed at an angle from 60° to 90° from the plane of the sup-

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port, simultaneously with the application of vacuum introducing a jet of water into each said zone adjacent each said lateral edge, and subsequently drying said coated layer.

2. The process as set forth in claim 1 wherein said thin layer is a viscous aqueous dispersion of light-sensitive silver halides in a water-permeable colloid.

3. The process as set forth in claim 1 wherein an anti-foaming agent is introduced with said water.

4. The process as set forth in claim 1 wherein said vacuum is of from 20 to 40 inches of water.

5. Processing apparatus for a moving web having a fresh coating comprising a vacuum nozzle having a chamber within, means for connecting said nozzle with a source of vacuum, an opening in said nozzle, means for introducing into said chamber adjacent said opening a diluent for said coating, and means for guiding said nozzle against a lateral edge of said moving web with said opening positioned over said lateral edge.

6. Processing apparatus for a moving web having a newly applied surface layer of coating material com-

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prising a vacuum nozzle having a chamber within, an opening in said nozzle, and means for guiding said nozzle against a lateral edge of said moving web with said opening over said lateral edge.

7. A device for assisting in the application to a photographic base by skim coating, dip coating, and the like, of a layer of uniform thickness of a photographic composition, comprising means for applying a vacuum at a particular locale, means for guiding through said locale a lateral edge of said film base having thereon a coating of said photographic composition, and an injection orifice adjacent said locale for introducing a diluent for said composition.

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