

(19)



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Office européen des brevets



(11)

EP 0 537 086 B1

(12)

EUROPEAN PATENT SPECIFICATION

(45) Date of publication and mention
of the grant of the patent:
20.08.1997 Bulletin 1997/34

(51) Int Cl.⁶: **G03C 1/74, B05C 5/00**

(21) Application number: **92420341.7**

(22) Date of filing: **30.09.1992**

(54) Curtain coating method and apparatus

Vorhangbeschichtungsmethode und Vorrichtung

Méthode de couchage au rideau et appareil d'enduction

(84) Designated Contracting States:
BE CH DE FR GB LI NL

(30) Priority: **11.10.1991 US 775676**

(43) Date of publication of application:
14.04.1993 Bulletin 1993/15

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• **PATENT ABSTRACTS OF JAPAN vol. 13, no. 111**
(C-577)(3459) 16 March 1989 & JP-A-63 287 575
(FUJI PHOTO FILM CO LTD) 24 November 1988

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Description

FIELD OF THE INVENTION

The present invention relates to a method and apparatus for coating objects or moving supports advancing continuously through a coating station with a free falling curtain of coating liquid. More particularly, the present invention relates to a curtain coating method and apparatus for the manufacture of photographic film and paper.

BACKGROUND OF THE INVENTION

Curtain coating is a method of applying a coating liquid to an article or support. Curtain coating is characterized by the formation of a free falling curtain of coating liquid which falls from a hopper lip and, under the influence of gravity, impinges on the article moving through the curtain to form a coating. A variety of curtain coating methods and apparatus have been used in the past to coat, for example, furniture or sheets of iron. In more recent years, high-precision curtain coating methods and apparatus have been developed for use in the manufacture of multilayer photographic material, as disclosed in United States Patent Nos. 3,508,947 to Hughes and 3,632,374 to Greiller.

When preparing multilayer photographic materials by curtain coating techniques, the quality of the coating is dependent largely on the quality of the free falling curtain. The curtain must exhibit stable, laminar flow from where it is formed to the line of impingement on the moving support. Absent suitable apparatus, surface tension will cause the curtain to contract inwardly and disrupt the required laminar flow of the curtain. To prevent this, conventional curtain coating methods employ edge guides to engage the free falling curtain at its edges and prevent inward contraction due to surface tension.

Generally, the edge guides used in curtain coating methods and apparatus are stationary, solid members attached to the hopper lip to stabilize the free falling curtain as it leaves the lip. United States Patent No. 4,933,215 to Naruse et al., for example, discloses a curtain coating hopper having solid guide rods. It has been noted, however, that supporting the free falling curtain at its edges creates friction drag and instability at the curtain edges which hamper the ability to coat with a high degree of curtain stability.

Various solutions have been proffered to simultaneously increase the stability of the curtain and keep coating rates high. One solution is to deliver a low viscosity liquid (e.g., water) to the edge of the edge guide to act as a liquid bridge between the edge guide and the edge of the free falling curtain. United States Patent No. 4,479,987 to Koepke et al. discloses an apparatus for stabilizing free falling curtains which utilizes a liquid bridge between the edge guide and the edge of the free falling curtain. United States Patent No. 4,974,533 to

Ishizuka et al. discloses a coating apparatus employ jets which expel an auxiliary liquid to the edge guides and serve to prevent thinning of the curtain in the vicinity of the edge guides of the apparatus. United States Patent No. 4,830,887 to Reiter discloses a method and apparatus for coating less than the full width of support. The Reiter method and apparatus utilize edge guides, a flushing means on the edge guide, and a suction apparatus to regulate the thickness of the coating edges.

In addition to using a flushing liquid to reduce the effect of friction drag, approaches to the friction drag problem have used straight, vertically oriented, thin edge guides. See, e.g., United States Patent Nos. 3,632,374 to Greiller, 4,479,987 to Koepke et al., and 4,830,887 to Reiter. However, edge rods having substantially the same width as the curtain edge, while reducing friction drag, are not effective to avoid problems associated with another phenomenon of curtain coating, commonly known as "bendback." Bendback is characterized by a bending of the coating solution as it leaves the tip of the hopper lip. As the solution leaves the hopper lip, a moment is established about the tip of the hopper lip, and a horizontal velocity component is established which causes the solution to bend inwardly toward the body of the hopper. Bendback increases as curtain viscosity decreases or the flowrate per unit width of curtain increases. Bendback also increases as surface tension decreases.

Although bendback does not preclude the formation of uniform coating layers on the support, failure to accommodate the bendback of the coating solution (i.e., failure to allow the entire curtain width to follow its naturally inflected path) can produce a "standing wave" in the curtain. Standing waves are commonly produced, for example, when a narrow edge guide is attached to the hopper lip and guides the coating liquid down a vertical path different from its naturally inflected path. This creates a perturbation at the point of intervention. A standing wave is produced which emanates from the source of the perturbation. This standing wave can produce longitudinal streaks in the dried coating.

United States Patent No. 4,135,477 to Ridley addresses the problem of bendback. Ridley discloses a curtain coating apparatus having wide edge guiding plates extending from the hopper lip all the way to the support to be coated. The edge guiding plates are wide enough to allow the curtain edge to follow its naturally inflected path to the support. In essence, the edge plate is substantially wider than the curtain edge over its entire length. This type of edge plate, however, creates other problems.

Initially, the greater width of the edge plate relative to the curtain edge leads to a decreased velocity at the curtain edge. This decreased velocity reduces the stability of the curtain. Additionally, a wide meniscus is formed between the curtain edge and the wide edge plate. This leads to a relative thinning of the curtain adjacent to the meniscus. As a result, there is a lack of

uniform width-wise coverage to the outer edges of the curtain.

Third, the large edge plate surface area promotes the formation of deposits of coating solution on the edge plate as the free falling curtain moves back and forth horizontally as a result of pressure gradients between the front and back sides of the curtain. These deposits eventually solidify or cross-link, creating solid deposits which can themselves be perturbations that create standing waves in the curtain.

Fourth, it has been found that, in coating a continuous web, better coating results can be obtained by using an application point forward of top-dead-center on the coating roll conventionally used to transport the web underneath the coating hopper. It is not practical to use the wide edge plates of Ridley when using forward application points because the wide edge plates must be centered at top-dead-center of the roll or else the coating solution will tend to seep back between the bottom surface of the wide edge plate and the top of the support.

Fifth, in Ridley the curtain is allowed to follow its own path the entire length of the edge plate which renders it impossible to maintain a constant departure point from the edge plate. Therefore, it is not possible to practice the coating method described in United States Patent No. 4,830,887 to Reiter (coating less than the entire width of the support, referred to herein as "inboard edging") because the required suction apparatus cannot be precisely placed at the point of departure of the curtain from the edge guide.

Finally, the current edging devices utilized in the art may not be adjusted to achieve varied curtain widths. The Ridley edging device, for example, must be placed at the edges of a slide hopper at a predetermined width, and the hopper, therefore, may coat only at that width.

SUMMARY OF THE INVENTION

It has been discovered in accordance with the present invention that the maximum bendback of the curtain takes place in the initial stages of curtain free fall (i.e., immediately after the curtain leaves the hopper lip). Upon leaving the hopper lip, a moment is established about the tip of the hopper lip, and a horizontal velocity component is established which causes the solution to bend inwardly toward the body of the hopper. After this initial maximum angular displacement, gravity dominates the horizontal motion causing the curtain trajectory to approximate a straight line until it impinges on the support. The coating apparatus and method of the present invention prevent or reduce the creation of perturbations or standing waves in the curtain at the point where the curtain edge leaves the hopper lip. While providing a solution to this serious problem the invention provides rapid coating, minimal friction drag, good curtain stability, good edge uniformity, the ability to coat with forward application points, and the ability to practice the coating methods disclosed in United States Patent No.

4,830,887 to Reiter which utilize inboard edging techniques. In addition, the edging means in the apparatus of the invention can be adjusted on the hopper by repositioning the edge pad, edge wall, and edge guide to coat selected coating widths.

The coating hopper of the invention as defined in claim 1 employs an edging means comprising edge walls with flat planar surfaces which are significantly wider than the curtain edge and are located at opposite ends of the hopper lip extending downwardly and rearwardly immediately below the hopper lip. The planar surfaces of the edge walls are normal to the inclined surface of the hopper and are of a width significantly greater than the width of the edges of the free falling curtain to allow the curtain edges to assume natural paths over the edge wall surfaces.

The edge wall extends downwardly from the hopper lip only a distance sufficient to allow the curtain edges to return to a substantially straight path. Therefore, the path of the curtain edge is substantially a straight line when it leaves the edge wall. After leaving the edge wall, the curtain edges are precisely guided to the moving support by narrow edge guides that have a width comparable to the thickness of the edges of the curtain. The novel combination of a wide edge wall with a narrow edge guide solves the problem of perturbations at the junction where the curtain edges leave the edge wall and contact the edge guides.

In a preferred embodiment, the curtain coating apparatus includes hopper edge pads extending along the opposite ends of the inclined surface of the hopper down to the edge walls. The hopper edge pads serve to guide the coating liquid down the inclined surface of the hopper to the edge walls.

The method of the invention as defined in claim 6 comprises continuously flowing a coating liquid onto a downwardly inclined planar surface which terminates in a lip and thereby forming a free falling curtain of coating liquid which falls from the lip to a coating zone. A support is moved along a path through the coating zone and beneath the lip whereby the coating liquid curtain impinges laterally on the moving support. The edges of the curtain immediately below said lip are contacted with and guided by a planar surface of wide area to permit the curtain to bend back without substantial restraint. Immediately below said surface of wide area and for a major portion of the distance that the curtain falls, each edge of the curtain is contacted with and guided by a substantially straight guiding means of a width substantially less than the width of the planar surface of wide area.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of one embodiment of a slide hopper curtain coating apparatus with coating liquid and a free falling curtain according to the present invention.

FIG. 2 is a partial three-dimensional view of a film

curtain leaving a hopper lip.

FIG. 3 is a cross-sectional view of one embodiment of the edging means of the present invention showing the edge wall incorporated with the hopper edge pad as a single piece.

FIG. 4 is a cross-sectional view of an alternative embodiment of the edging means of the present invention showing the edge wall incorporated with the edge guide as a single piece.

FIG. 5 is a cross-sectional view of an alternative embodiment of the edging means of the present invention showing the hopper edge pad, edge wall, and edge guide all incorporated as a single piece and also illustrating the path of the free falling curtain over the edge wall and edge guide.

DETAILED DESCRIPTION OF THE INVENTION

The method and apparatus of the present invention will be described in detail with reference to a slide hopper-type curtain coater commonly used in the photographic industry. FIGS. 1 and 2 are perspective views of an embodiment of a slide hopper-type curtain coater of the present invention. FIG. 1 illustrates an embodiment of the apparatus of the present invention operating to coat a moving support with a free-falling curtain of coating liquid. FIG. 2 is a partial three-dimensional view of a film curtain leaving a hopper lip. Referring to FIG. 1, illustrated is slide hopper 1, having an inclined surface terminating in lip 7. Coating liquids are delivered laterally to slide hopper 1, ascend to exit slots 3, and are extruded as individual layers on downwardly inclined surfaces 5. Under the influence of gravity, the individual layers flow down surfaces 5, flow over one another forming a pack of liquid, discrete layers, and flow to the tip of hopper lip 7 where free falling curtain 9 is formed. Free falling curtain 9 comprises a composite of the discrete layers of coating liquid that exited from slots 3. Free falling composite curtain 9, which extends transversely or laterally across the path of moving support 11, drops over height "h" and impinges onto continuously advancing support 11 to form a composite of liquid layers on support 11. At the point where curtain 9 impinges on support 11, support 11 is preferably guided onto and around coating roll 13. The width of coating roll 13 can be narrower or wider than the width of support 11 guided around it, depending on the edging technique. Coating roll 13 is driven by a motor (not shown).

Free falling curtain 9 is laterally guided by an edging means which includes hopper edge pads 15 and 15', edge walls 17 and 17' having planar surfaces of relatively wide area, and elongated, and relatively narrow edge guides 19 and 19'. Hopper edge pads 15 and 15', edge walls 17 and 17' and edge guides 19 and 19' are vertically arranged and guide, and stabilize free the falling curtain 9 before it impinges on support 11. FIG. 2 is a partial three-dimensional view of a film curtain leaving a hopper lip and illustrates the path of free falling curtain

9 as it is formed upon leaving lip 7 and proceeds over edge wall 17 and edge guide 19.

FIG. 1 illustrates a preferred embodiment of the curtain coater of the present invention. Edge pads 15 and 15', edge walls 17 and 17', and edge guides 19 and 19' are positioned to coat less than the full width of support 11. Hopper 1 is positioned to coat onto support 11 at a point forward of top-dead-center on coating roll 13. The apparatus and method of the present invention can also be used to coat at widths as wide or wider than support 11 and at application points at or behind top-dead-center of coating roll 13.

The layers of photographic coating composition can be coated on a variety of supports. Typically, photographic supports include polymeric film, paper, metallic sheets or foil, glass, or ceramic supporting elements provided with one or more subbing layers to enhance the adhesive, antistatic, dimensional, abrasive, hardness, functional, antihalation and/or other properties of the support. The support may be coated in the form of discrete sheets, plates or, preferably, in the form of a continuous web.

The method of the present invention can be practiced with an edging means including only the wide-area edge walls 17 and 17' and elongated edge guides 19 and 19'. Preferably, however, hopper edge pads 15 and 15' extend along opposite ends of the inclined surface of hopper 1. Hopper edge pads 15 and 15' are designed to guide the layers of coating liquid down the inclined surface of hopper 1 and, therefore, extend along opposite ends of the inclined surface of hopper 1 to lip 7. Hopper edge pads 15 and 15' should be at least as high as the composite layers of coating liquid proceeding down the inclined surface of hopper 1. Preferably, the thickness of hopper edge pads 15 and 15' is comparable to the thickness of the coating liquids proceeding down the inclined surface of hopper 1.

Edge walls 17 and 17' are located at the opposite ends of lip 7, extending downwardly and rearwardly immediately below hopper edge pads 15 and 15', respectively. Edge walls 17 and 17' have flat planar surfaces parallel to the edges of free falling curtain 9. The flat planar surfaces of edge walls 17 and 17' must be of a width great enough to allow the edges of curtain 9 to follow a natural path upon leaving lip 7. By "natural path" is meant that the curtain is unrestrained in the direction of flow and can bend back along the edge wall. Thus, edge walls 17 and 17' must be of an area wide enough to permit the curtain of coating liquid to bend back without substantial restraint upon its departure from lip 7 as it forms free falling curtain 9.

The area of edge walls 17 and 17' can vary somewhat depending on the viscosity of the coating liquid, the flow rate of the coating solution, and the surface tension. For example, the angle of departure between the coating liquid and the hopper lip may be as great as 50 degrees from vertical for typical photographic materials. Therefore, edge walls 17 and 17' must extend rearward-

ly at the top of the wall far enough to accommodate an angle of departure of 50 degrees from vertical.

After the initial maximum angular displacement of curtain 9, the trajectory of curtain 9 returns to a substantially linear path. Therefore, edge walls 17 and 17' extend downwardly sufficiently to allow the trajectory of free falling curtain 9 to become a substantially linear path. For example, when the coating liquid is a photographic material, edge walls 17 and 17' should extend downwardly a length in the range of about 0.5 to about 1.0 centimeters, preferably about 0.6 cm.

Edge walls 17 and 17' can have a uniform rearward extension from top to bottom. Alternatively, edge walls 17 and 17' can have a maximum rearward extension at the top (i.e., the portion nearest hopper lip 7) and be tapered to a rearward extension comparable to the width of edge guides 19 and 19' at the junction between edge walls 17 and 17' and edge guides 19 and 19', respectively. However, the rearward extension of edge walls 17 and 17' should be sufficient to allow the curtain edges to follow their natural path from lip 7 to the point where the trajectory of curtain 9 returns to a substantially vertical linear path.

Edge guides 19 and 19' are likewise located at opposite edges of free falling curtain 9 and extend downwardly from edge walls 17 and 17', respectively, toward support 11. While edge walls 17 and 17' have a planar surface area much wider than the width of the edges of curtain 9, edge guides 19 and 19' have a relatively narrow width. Their width is substantially less than the width of the planar surface of edge walls 17 and 17'. The edge guides 19 and 19' precisely guide the free falling curtain 9 to support 11. Because of the narrowness of the edge guides, the meniscus or width of contact with each edge of the curtain is much less than the meniscus and width of contact along the relatively wide bendback areas along edge walls 17 and 17'. As a consequence, the problems encountered with wide edge guides and likewise the problems encountered in restraining bendback are effectively avoided. Edge guides 19 and 19' are preferably slotted rods as disclosed in United States Patent No. 4,830,887 to Reiter, but may be in any form sufficient to precisely guide free falling curtain 9 to support 11.

Hopper edge pads 15 and 15', edge walls 17 and 17', and edge guides 19 and 19' may be made out of the same material or different materials. Preferably, the components of the edging means are constructed of easily wettable material such as polycarbonate, metals, or ground glass.

The apparatus of the present invention may be adjusted to coat multiple coating widths by adjusting edge walls 17 and 17', edge guides 19 and 19' and hopper edge pads 15 and 15' (if present), to the desired width on hopper 1.

FIGS. 3, 4, and 5 are cross-sectional views of different configurations of the edging means of the present invention implemented in the coating method and apparatus of the present invention. FIG. 3 is a cross-sectional

view of one embodiment of the edging means of the present invention showing edge wall 27 incorporated with hopper edge pad 25 as a single piece. Edge guide 29 is pivotally coupled to the bottom of edge wall 27 at pivot point 33. This configuration allows edge guide 29 to be adjusted so that it matches exactly the position of the free falling curtain of coating liquid at the impingement point of the curtain on the support.

FIG. 4 is a cross-sectional view of an alternative embodiment of the edging means of the present invention showing hopper edge pad 35 as a separate component, and edge wall 37 incorporated with edge guide 39 as a single piece. FIG. 5 is a cross-sectional view of an alternative embodiment of the edging means of the present invention showing edge pad 43, edge wall 45, and edge guide 47 all incorporated together as a single piece. FIG. 5 also illustrates the path of free falling curtain 9 over edge wall 45 and edge guide 47. The configurations of FIGS. 4 and 5 have no adverse effects on the performance of the invention and offer various equipment manufacturing or operational advantages.

The method and apparatus of the present invention may also be used in conjunction with the curtain coating method and apparatus disclosed in United States Patent No. 4,830,887 to Reiter, the disclosure of which is hereby incorporated by reference.

The following examples illustrate the advantages of the methods and apparatus of the present invention for the production of photographic material. In each example, a slide coater is provided with an edging means of the present invention as shown in FIGS. 3, 4, or 5 for a three-layer coating.

The free falling curtain height "h" was 25 cm, and the point of impingement of the curtain on the support (the "application point") was 45 degrees forward ("45 degrees") of the midpoint (top-dead-center) of the coating roll which transports the support. The coating speed was 400 cm/sec.

A three-layer photographic coating composition was used comprising an aqueous gelatin pack having a 15 centipoise viscosity bottom layer, a 50 centipoise viscosity middle layer, and a 70 centipoise viscosity top layer.

EXAMPLE 1

An edge wall with a rearward extension of 0.475 cm at its top (immediately below the edge pad) is utilized. The front surface of the edge wall is displaced 15 degrees rearwardly from vertical. The rearward extension of the edge wall is tapered down to 0.150 cm at the junction of the edge wall and the edge guide. The edge wall extended downwardly 0.635 cm from the tip of the hopper lip.

A slotted edge guide is arranged so that the coating width is less than the width of the total support. A continuous web of cellulose triacetate film with a thickness of 0.013 cm is used as the support. A water solution is

provided to the top of the slotted edge guide where the edge guide contacts the fluid curtain. A vacuum source is applied to an evacuation hole located at the end of the edge guide, to remove the flushing solution. The flow rate for the three layer composite photographic coating composition is 3 cubic cm/second/cm of coating width.

The solution thickness on the inclined surface of the hopper is calculated and the hopper edge pad height is matched to this thickness to provide an anchor point for the solutions and to prevent meniscus formation. The solutions leave the hopper lip at approximately a 30 degree angle from vertical as a result of curtain inflection. Since the edge wall is sufficiently large, the solutions do not anchor at the corners of the wall and therefore, the edges of the curtain follow the same trajectory as the center of the curtain. Neither the widthwise uniformity near the edge nor the curtain's stability is noticeably affected by the edge wall. After approximately 0.6 cm of free fall, the curtain trajectory starts to approximate a straight line at a constant angle from vertical. At this point, the curtain is transferred from the edge wall to a relatively narrow, straight edge guide, which is pivoted at the end of the edge wall, to intersect the curtain trajectory at the bottom of the edge guide. At the bottom of the edge guide, the flushing solution is evacuated from the vacuum system and the curtain detaches from the edge guide within close proximity to the support and impinges onto the support at a +45 degree application point. The bottom of the edge guides are positioned 2.0 cm behind the vertical plane of the hopper lip, to accommodate the curtain displacement from vertical caused by the curtain inflection. The wetting line is linear across the entire width of the curtain and no streaks are present in the dried coating.

EXAMPLE 2

An edge wall with a rearward extension of 0.475 cm at its top (immediately below the edge pad) is utilized. The front surface of the edge wall is displaced 25 degrees rearwardly from vertical. The rearward extension of the edge wall is tapered down to 0.150 cm at the junction of the edge wall and the edge guide. The edge wall extended downwardly 0.635 cm from the tip of the hopper lip.

A slotted edge guide with the edge wall incorporated into the top of the edge guide is arranged to produce a coating less wide than the width of the support being coated. The support is a polyethylene-coated paper web of 0.023 cm thickness. A water solution is provided to flush the surface of the edge guide in the manner disclosed in United States Patent No. 4,830,887 to Reiter at Example 2.

The total flow rate for the three layer composite coating is 5 cubic cm/second/cm of coating width. The bottom of the edge guides are positioned 3.0 cm behind the vertical plane of the hopper lip to account for the curtain displacement caused by curtain inflection.

The solution thickness on the inclined surface of the hopper is calculated and the vertical edge pad height is matched to this thickness to provide an anchor point for the solutions and to prevent meniscus formation. The solutions leave the hopper lip at approximately a 45 degree angle from vertical as a result of curtain bendback. Since the edge wall is sufficiently large, the solutions do not anchor at the corners of the wall and therefore, the edges of the curtain follow the same trajectory as the center of the curtain. Neither the widthwise uniformity near the edge nor the curtain stability is noticeably affected by the edge wall. After approximately 0.6 cm of free fall, the curtain trajectory starts to approximate a straight line at a constant angle from vertical. At this point, the curtain is transferred from the edge wall to a narrow, straight edge guide, which is pivoted at the end of the edge wall, to intersect the curtain trajectory at the bottom of the edge guide. At the bottom of the edge guide, the flushing solution is withdrawn by vacuum and the curtain detaches from the edge guide within close proximity to the support. It impinges onto the support at a +55 degree application point. The wetting line is linear across the entire width of the curtain and no streaks are present in the dried coating.

EXAMPLE 3

An edge wall with a rearward extension of 0.475 cm at its top (immediately below the edge pad) is utilized. The front surface of the edge wall is displaced zero degrees rearwardly from vertical. The rearward extension of the edge wall is tapered down to 0.150 cm at the junction of the edge wall and the edge guide. The edge wall extended downwardly 0.635 cm from the tip of the hopper lip.

A solid edge guide is arranged to produce a coating less than the width of the support being coated. A polyethylene terephthalate film web having a thickness of 0.018 cm is used as the support. A water solution is provided at the top of the edge guide and a vacuum is applied at the end of the lower edge guide to evacuate the edge guide flushing solution. The total flow rate for the three layer composite coating is 1 cubic cm/second/cm of coating width. The bottom of the edge guides are positioned directly below the hopper lip to account for the relatively small amount of bendback which occurs.

The solution thickness on the inclined surface of the hopper is calculated and the vertical edge pad height is matched to this thickness to provide an anchor point for the solutions and to prevent meniscus formation. The solutions leaves the hopper lip approximately vertically, there being no substantial bendback. Since the edge wall is sufficiently large, the solutions do not anchor at the corners of the wall and therefore, the edges of the curtain follow the same trajectory as the center of the curtain. Neither the widthwise uniformity near the edge nor the curtain stability is noticeably affected by the edge wall. At this point, the curtain is transferred from the

edge wall to a narrow, straight edge guide, which is pivots at the end of the edge wall, to intersect the curtain trajectory at the bottom of the edge guide. At the bottom of the edge guide, the flushing solution is withdrawn by vacuum system and the curtain detaches from the edge guide within close proximity to the support and impinges onto the support at a +20 degree application point. The wetting line is linear across the entire width of the curtain and no streaks are present in the dried coating.

Although the invention has been described in detail for the purpose of illustration, it is understood that such detail is for that purpose and variations can be made therein by those skilled in the art without departing from the scope of the invention which is defined by the following claims.

Claims

1. An apparatus for curtain coating a moving support (11) with one or more layers of coating liquid, comprising:
 - (a) a hopper means (1) having an inclined surface terminating in a lip (7) for forming a free falling curtain (9) of coating liquid;
 - (b) a transport means for moving the support along a path beneath said hopper means; and
 - (c) an edging means comprising
 - (1) two edge walls (17) having flat planar surfaces each being located at an opposite end of said lip and extending downwardly and rearwardly immediately below said lip, wherein said planar surfaces are normal to said inclined surface of said hopper means and are of a width substantially greater than the thickness of the edges of said free falling curtain to allow the curtain edges to assume a natural path over the edge wall surface; and
 - (2) two edge guides (19) extending downwardly from said edge walls toward said moving support, wherein said edge guides have a width substantially less than the width of the edge walls to precisely guide said free falling curtain from said edge walls to said moving support and cause said free falling curtain to impinge transversely on said moving support.
2. An apparatus according to Claim 1, wherein said edging means further comprises:
 - two hopper edge pads (15) extending along opposite ends of said inclined surface for confining the edges of said coating liquid guiding said coating liquid down said inclined surface to said lip.
3. An apparatus according to Claim 1, wherein each of said edge guides (19) are pivotally connected to one of each said edge walls (17).
4. An apparatus according to Claim 1, wherein said coating liquid is photographic material.
5. An apparatus according to Claim 4, wherein said edge wall (17) extends downwardly about 0.6 cm.
6. A method of curtain coating a support (11) with one or more layers of coating liquid, comprising the steps of:
 - (a) continuously flowing said liquid onto a downwardly inclined planar surface which terminates in a lip (7);
 - (b) moving the support along a path through a coating zone beneath said lip;
 - (c) forming a free falling curtain (9) of coating liquid which falls from said lip and extends laterally across said path and impinges on said moving support in the coating zone; and
 - (d) guiding the edges of the curtain immediately after its fall from said lip by contact with a planar surface (17) of wide area whereby said curtain is free to bend back without substantial restraint and, immediately thereafter and for the major portion of the distance that the curtain falls, guiding the edges of the curtain by contact with an elongated, substantially straight guiding means (19) of a width substantially less than the width of said planar surface of wide area, and thereby guiding said free falling curtain from said lip to said moving support and causing said free falling curtain to impinge transversely on said moving support.
7. A method according to Claim 6, wherein said edging means further comprises:
 - confining the opposite edges of said coating liquid on said inclined surface and thereby guiding said coating liquid down said inclined surface to said lip.
8. A method according to Claim 6, wherein said support (11) is a continuous web which moves beneath said hopper means (1) on a coating roll (13) and said free falling curtain (9) impinges on said moving web at an application point forward of top-dead-center of said coating roll (13).
9. A method according to Claim 6, wherein said edging means is spaced to coat less than the full width of said support.
10. A method according to Claim 6, wherein said coating liquid is a photographic material.

Patentansprüche

1. Vorrichtung zum Vorhangbeschichten eines sich bewegenden Trägers (11) mit mindestens einer Schicht einer Beschichtungsflüssigkeit, **gekennzeichnet durch**
 - a) einen Vorratsbehälter (1) mit einer in einen Gießrand (7) mündenden geneigten Fläche zum Bilden eines frei fallenden Vorhangs (9) aus Beschichtungsflüssigkeit, 10
 - b) einem Transportmittel zum Bewegen des Trägers entlang einer Bahn unterhalb des Vorratsbehälters, und
 - c) einem Randmittel, das 15
 - 1) zwei Randwandungen (17) mit flachen, planen Flächen umfaßt, die jeweils auf gegenüberliegenden Seiten des Gießbrands angeordnet sind und sich unmittelbar unterhalb des Gießbrands nach unten und nach hinten erstrecken, wobei die Flächen senkrecht zur geneigten Fläche des Vorratsbehälters stehen und ihre Breite im wesentlichen größer ist als die Dicke der Ränder des frei fallenden Vorhangs, so daß die Ränder des Vorhangs eine natürliche Bahn über die Fläche der Randwandung bilden können, und 25
 - 2) zwei Randführungen (19) aufweist, die sich von den Randwandungen aus zum sich bewegenden Träger nach unten erstrecken und deren Breite im wesentlichen geringer ist als die Breite der Randwandungen, um den frei fallenden Vorhang von den Randwandungen genau auf den sich bewegenden Träger zu leiten und zu bewirken, daß er schräg auf den Träger auftrifft. 30
2. Vorrichtung nach Anspruch 1, dadurch gekennzeichnet, daß die Randmittel 40
 - zwei am Rand des Vorratsbehälters vorgesehene Kissen (15) aufweisen, die sich entlang einander gegenüberliegender Enden der geneigten Fläche erstrecken, um die Ränder der Beschichtungsflüssigkeit zu begrenzen und die Flüssigkeit entlang der geneigten Fläche nach unten zum Gießrand zu leiten. 45
3. Vorrichtung nach Anspruch 1, dadurch gekennzeichnet, daß jede der Randführungen (19) schwenkbar mit einer der Randwandungen (17) verbunden ist. 50
4. Vorrichtung nach Anspruch 1, dadurch gekennzeichnet, daß die Beschichtungsflüssigkeit ein fotografisches Material ist. 55
5. Vorrichtung nach Anspruch 4, dadurch gekennzeichnet, daß die Randwandung (17) sich etwa 0,6 cm nach unten erstreckt.
6. Verfahren zum Vorhangbeschichten eines Trägers (11) mit mindestens einer Schicht einer Beschichtungsflüssigkeit, **dadurch gekennzeichnet, daß**
 - a) die Flüssigkeit kontinuierlich auf die nach unten geneigte plane Fläche geleitet wird, die in einem Gießrand (7) mündet,
 - b) der Träger entlang einer Bahn durch einen Beschichtungsbereich unterhalb des Gießbrands bewegt wird,
 - c) ein frei fallender Vorhang (9) aus einer Beschichtungsflüssigkeit gebildet wird, der vom Gießrand nach unten fällt, sich seitlich über die Bahn erstreckt und auf den sich bewegenden Träger im Beschichtungsbereich auftrifft, und 10
 - d) die Ränder des Vorhangs unmittelbar nach dessen Abgleiten vom Gießrand durch Berührung mit einer planen, breiten Fläche (17) geführt werden, wodurch der Vorhang sich ohne Behinderung zurückbiegen kann, und daß die Ränder des Vorhangs unmittelbar danach entlang des Hauptabschnitts, über den der Vorhang fällt, durch Berührung mit einer langgestreckten, im wesentlichen geraden Führung (19) geführt werden, wobei die Breite der Führung im wesentlichen geringer ist als die Breite der planen, breiten Fläche, wodurch der frei fallende Vorhang vom Gießrand zu dem sich bewegenden Träger geführt wird und bewirkt wird, daß der frei fallende Vorhang quer zum Träger auftrifft. 15
7. Verfahren nach Anspruch 6, dadurch gekennzeichnet, daß die Randmittel 40
 - die einander gegenüberliegenden Ränder der Beschichtungsflüssigkeit auf der geneigten Fläche begrenzen und dadurch die Beschichtungsflüssigkeit entlang der zum Gießrand führenden geneigten Fläche nach unten leiten.
8. Verfahren nach Anspruch 6, dadurch gekennzeichnet, daß der Träger (11) in durchgehendes Band ist, das sich unterhalb des Vorratsbehälters (1) auf einer Beschichtungswalze (13) bewegt, und daß der frei fallende Vorhang (9) auf das sich bewegende Band an einem Punkt vor dem oberen Totpunkt der Beschichtungswalze (13) auftrifft. 50
9. Verfahren nach Anspruch 6, dadurch gekennzeichnet, daß die Randmittel derart angeordnet sind, daß weniger als die volle Breite des Trägers beschichtet wird. 55
10. Verfahren nach Anspruch 6, dadurch gekennzeichnet,

net, daß die Beschichtungsflüssigkeit ein fotografisches Material ist.

Revendications

1. Dispositif destiné à coucher au rideau un support en mouvement (11) à l'aide d'une ou plusieurs couches de liquide de couchage, comprenant :

(a) une trémie ou hopper (1) comportant une surface inclinée se terminant par une lèvre (7) destinée à former un rideau tombant librement (9) de liquide de couchage,
(b) un moyen de transport destiné à déplacer le support le long d'un trajet au-dessous dudit hopper, et
(c) des moyens de limitation de bords comprenant

(1) deux parois de bord (17) présentant des surfaces planes plates, chacune étant située à une extrémité opposée de ladite lèvre et s'étendant vers le bas et vers l'arrière immédiatement au-dessous de ladite lèvre, dans lesquelles lesdites surfaces planes sont normales à ladite surface inclinée dudit hopper et sont d'une largeur sensiblement supérieure à l'épaisseur des bords dudit rideau tombant librement afin de permettre aux bords du rideau de suivre un chemin naturel sur la surface des parois de bord, et

(2) deux guides de bord (19) s'étendant vers le bas à partir desdites parois de bord en direction dudit support en mouvement, dans lesquels lesdits guides de bord présentent une largeur sensiblement inférieure à la largeur des parois de bord afin de guider précisément ledit rideau tombant librement à partir desdites parois de bord jusqu'audit support en mouvement et d'amener ledit rideau tombant librement à venir heurter ledit support mobile de façon transversale.

2. Dispositif selon la revendication 1, dans lequel lesdits moyens de limitation de bords comprennent en outre :

deux patins de bord de hopper (15) s'étendant le long des extrémités opposées de ladite surface inclinée afin de confiner les bords dudit liquide de couchage et de guider ledit liquide de couchage vers le bas de ladite surface inclinée jusqu'à ladite lèvre.

3. Dispositif selon la revendication 1, dans lequel chacun desdits guides de bord (19) est relié de façon

pivotante à l'une de chacune desdites parois de bord (17).

4. Dispositif selon la revendication 1, dans lequel ledit liquide de couchage est un matériau de couchage photographique.

5. Dispositif selon la revendication 4, dans lequel ladite paroi de bord (17) se prolonge vers le bas d'environ 0,6 cm.

6. Procédé de couchage au rideau d'un support (11) à l'aide d'une ou plusieurs couches de liquide de couchage, comprenant les étapes consistant à :

(a) faire s'écouler en continu ledit liquide sur une surface plane inclinée vers le bas qui se termine par une lèvre (7),

(b) déplacer le support le long d'un trajet au travers d'une zone de couchage au-dessous de ladite lèvre,

(c) former un rideau tombant librement (9) de liquide de couchage qui tombe de ladite lèvre et s'étend latéralement en travers dudit trajet et vient heurter ledit support en mouvement dans la zone de couchage, et

(d) guider les bords du rideau immédiatement après sa chute depuis ladite lèvre par contact avec une surface plane (17) de grande étendue, grâce à quoi ledit rideau est libre de se recourber en arrière sans contrainte substantielle et, immédiatement après et pendant la majeure partie de la distance suivant laquelle le rideau tombe, guider les bords du rideau par contact avec un moyen de guidage allongé pratiquement rectiligne (19) d'une largeur sensiblement inférieure à la largeur de ladite surface plane de grande étendue, et guider ainsi ledit rideau tombant librement depuis ladite lèvre jusqu'audit support en mouvement et amener ledit rideau tombant librement à venir heurter ledit support mobile de façon transversale.

7. Procédé selon la revendication 6, dans lequel ladite étape de guidage des bords comprend en outre les étapes consistant à :

confiner les bords opposés dudit liquide de couchage sur ladite surface inclinée et guider ainsi ledit liquide de couchage vers le bas de ladite surface inclinée jusqu'à ladite lèvre.

8. Procédé selon la revendication 6, dans lequel ledit support (11) est une bande continue qui se déplace au-dessous dudit hopper (1) sur un rouleau de couchage (13), et ledit rideau tombant librement (9) vient heurter ladite bande en mouvement au niveau d'un point d'application en avant du point mort haut dudit rouleau de couchage (13).

9. Procédé selon la revendication 6, dans lequel lesdits moyens de limitation de bords sont espacés de façon à couvrir moins de la pleine largeur dudit support.

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10. Procédé selon la revendication 6, dans lequel ledit liquide de couchage est un matériau de couchage photographique.

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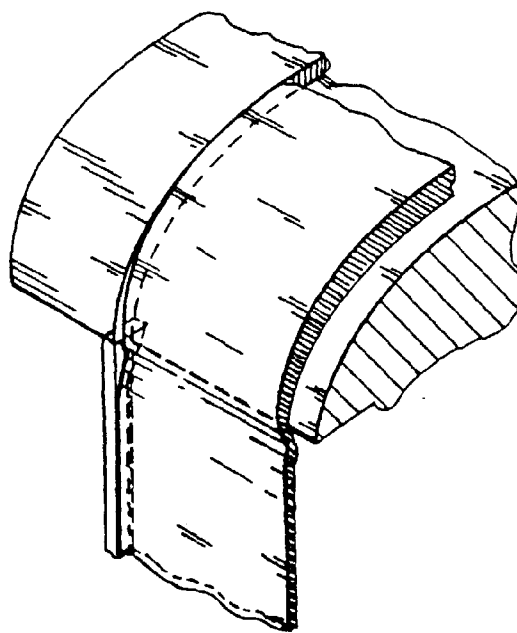
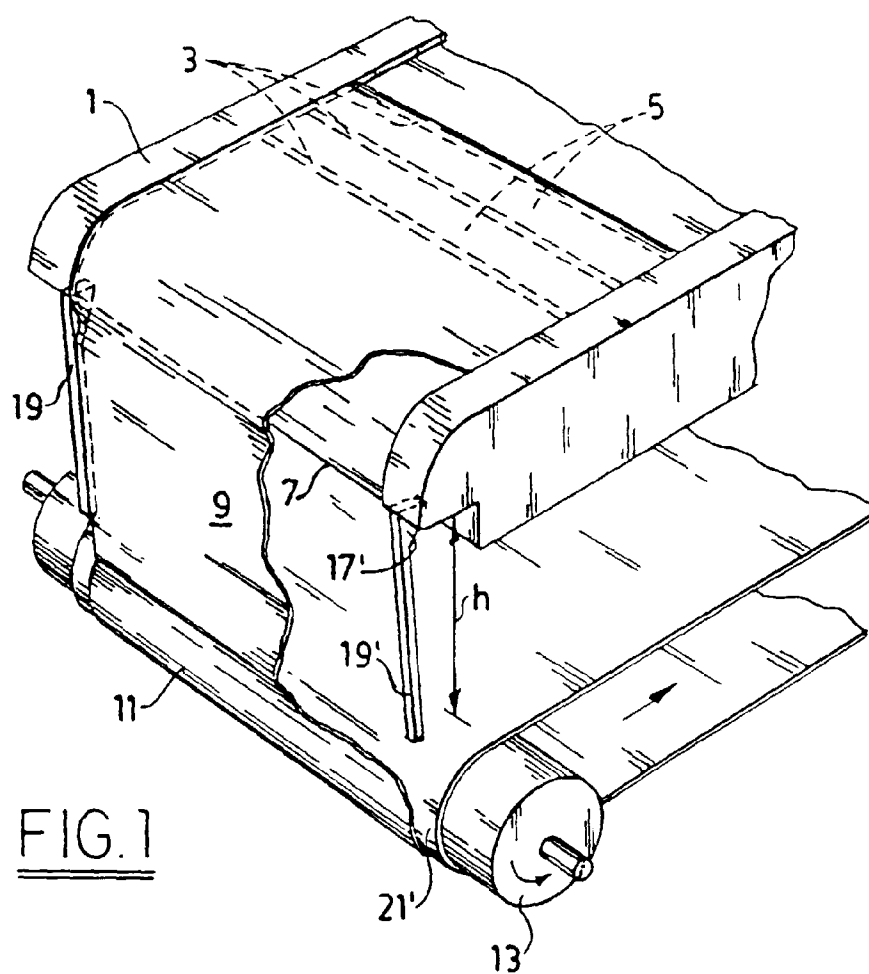


FIG. 3

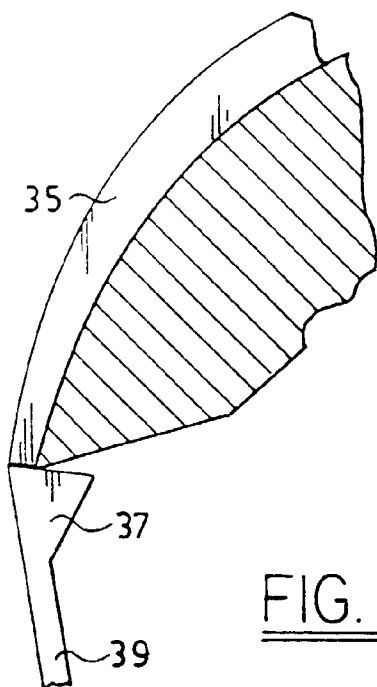
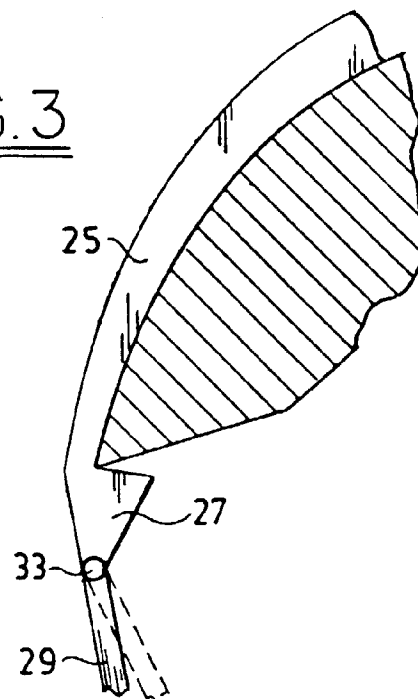


FIG. 4

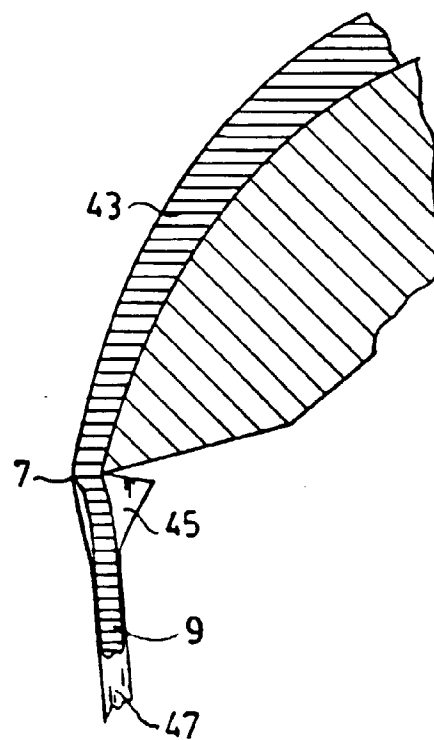


FIG. 5