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(71) Applicant: **DOW GLOBAL TECHNOLOGIES INC.**
Midland, Michigan 48674 (US)

(72) Inventors:
- **Gueggi, Markus**
  1723 Marly (CH)
- **Urscheler, Robert**
  8810 Horgen (CH)

(74) Representative: **Raynor, John**
W.H. Beck, Greener & Co
7 Stone Buildings
Lincoln's Inn
London WC2A 3SZ (GB)

(54) Method and apparatus for curtain coating

(57) Apparatus for starting and stopping curtain coating process of a movable substrate especially for high-speed coating of a continuous paper web substrate (12) wherein a substrate (12) is moved below a movable hopper arrangement (14) providing one or more liquid coating materials in the form of a free-falling curtain (16) impinging the substrate (12) at a dynamic wetting line, and wherein a collecting pan (24) is provided. The collecting pan (24) is movable and a baffle (26) is provided to build a discharging channel for the boundary layer or film during preparation of the curtain (16)

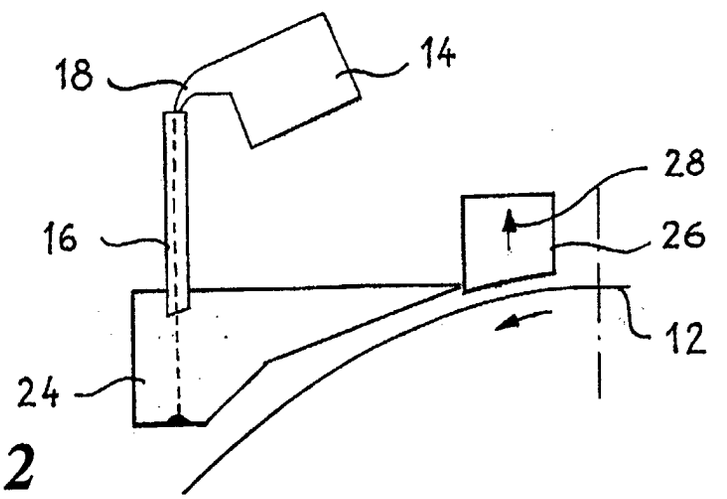

Fig.2

EP 1 319 747 A2

Description

Field of the invention

[0001] The present invention relates to a method and apparatus for curtain coating of a continuously moving substrate with one or more simultaneously applied layers of liquid coating materials, and, more particularly to a method and apparatus for starting and stopping a curtain coating process.

Background of the invention

[0002] Mainly in the field of manufacture of photographic papers or coated films, curtain coating methods and apparatus are widely known and used. Typically a continuous web or sheets are continuously moved below a coating hopper. One or more liquid compositions are provided from a hopper arrangement in the form of a liquid curtain.

[0003] For the manufacture of photographic papers, liquid compositions are used of relatively low viscosity, generally less than about 150 cP (centipoise), most in the range from about 5 to about 100 cP.

[0004] The manufacture of photographic papers is a tremendously difficult art requiring extremely accurate control. The practical use of curtain coating provides a number of difficulties coming with a need for an extremely uniform coating on the one hand and a need for coating of substrates in form of a continuous web at high speeds on the other hand.

[0005] A number of problems associated with curtain coating have been addressed in the prior art and many proposals have been made to overcome such problems.

[0006] Besides obtaining a free-falling curtain having uniform curtain characteristics over its width perpendicular to the moving direction of the substrate, one of the most often addressed problems for coating, especially at speeds higher than approximately 150 m/min, is the starting and stopping of the coating process without contaminating the substrate or coating apparatus due to spattering of the applied liquid, destroying of the substrate due to wrinkling and causing interference because of moving air during preparation of the curtain and unevenness of coating on the substrate. Moving air may also cause contamination of the substrate and the apparatus.

[0007] During the coating process air is carried along with the moving substrate to the coating point which designates the location where the coating liquid first contacts the substrate. In the curtain coating process this location has the form of a line across the substrate and is referred to as the dynamic wetting line. The area near the substrate where the air is in motion due to friction is called the boundary layer.

[0008] In the prior art a number of problems are described especially with respect to the starting and stopping of the coating process.

[0009] One of these problems described for instance in EP 0 344 745 B1 is solved by providing an application start plate positioned so as to prevent the curtain from reaching the web or a substrate for the thin curtain of the liquid beginning to be applied to the moving web. The application start plate is curved or bent such that it surrounds a backup roller, the lower end of the plate being pivotally coupled to a fulcrum under the nearby backup roller. When the curtain begins to be applied to the moving web the application start plate is pivoted downward about the fulcrum so that the upper end of the plate is moved away from the first position into a second position such that the curtain is allowed to reach the moving web. The apparatus also provides a slide hopper which may be moved toward the backup roller while the application start plate remains in a prescribed first position so that the curtain falls in front of the upper end of the application start plate and reaches the moving web. The application plate may be flat having an upper end extending at an oblique angle to the direction of width of the thin curtain of liquid. The oblique angle of the upper end of the plate relative to the direction of width of the curtain is 1 degree to 30 degrees, especially 2 degrees to 10 degrees. Alternatively, the application start plate is bent in an L-shape to have a curtain receiving part at the upper end of the plate, the application plate being turnable so that the upper end thereof is moved away from a first position so as to prevent the curtain from reaching the web into a second position so as to allow the curtain to reach the web. The application start plate may not only be turnable but also slidable, pivotably coupled to a fulcrum under a nearby backup roller or a curved or bent or L-shaped plate.

[0010] According to EP 0 974 403 A2 a coating method and apparatus is provided wherein before and at the start of coating an air shielding device is kept far from an impingement position where a free-falling curtain impinges onto the web. Just after starting of the coating process the air shielding device is moved close to the impingement position which prevents the air shielding device from being contaminated with splashes of coating liquids. The apparatus comprises a movement mechanism moving the coating head horizontally so as to move it to or from a backup roller. Further, a curtain deflector is arranged in a space between a coating head and the backup roller, such that during preparation of coating the coating head may be placed far from the backup roller and the curtain deflector receives coating liquid curtain free falling from the coating head to guide it into a preparation pan until the free-falling curtain stabilizes. The curtain deflector according to this document is flat and bent and the preparation pan is provided under the curtain deflector and coating head.

[0011] According to US 3,632,374 a curtain application device comprises an application starting plate which is a rectangular flat plate positioned such that the curtain is prevented from reaching the web. Firstly, the liquid flows down to the application start plate and is gathered

into a recovery vessel. The application start plate is then turned about a fulcrum so that the liquid curtain is allowed to reach the web, thus, starting the application of the liquid curtain to the web. The device provides the problem that a large space for turning or sliding the application start plate needs to be provided in the device. The large space needs to be provided so as to make it possible to move the slide hopper over the path of the moving web and to make the height of the curtain sufficient.

[0012] The problem with the devices according to the prior art is that curtain deflectors or application start plates have to be turned or slid or pivoted next to a nearby backup roller such that there is a risk of disturbing or interfering the movement of the backup roller.

[0013] Also, providing application start plates or curtain deflectors is not easy to be adapted and is costly as movement of the plate or deviator has to be ensured which could be difficult because of contamination of the moving means, especially the fulcrum. Further, the problem of splashes of coating liquids is not solved with the arrangements of the prior art as at the moment the liquid meets deviator or application start plate spattering is a usual result.

[0014] Although many approaches have been made in the prior art to overcome the drawbacks and problems coming with the use of a curtain coating process, in particular at the starting and stopping of the high speed coating process, there are still remaining drawbacks affecting the quality and cost effectiveness of curtain coating methods, in particular with respect to curtain coating of paper substrates.

Summary of the invention

[0015] It is therefore an object of the invention to provide an improved curtain coating starting and stopping method and an improved curtain coating apparatus particularly for starting and stopping high-speed coating of a paper web substrate, more particularly for high-speed coating of a continuous paper web substrate, more particularly in connection with a coating liquid having a relatively high viscosity compared to the coating liquids used for the manufacture of photographic papers, that is having a low shear viscosity of generally well above 1.5 Pa·s, which method and apparatus avoid wrinkling of the substrate and interference by air motion during start-up and shut-down of a curtain coating process.

[0016] Briefly stated, these and other features, objects and advantages are obtained by providing a method and apparatus for starting and stopping the curtain coating process of a moving substrate, like a paper web, wherein a substrate is moved below a hopper arrangement providing one or more liquid coating materials in the form of a free-falling curtain impinging the substrate at a dynamic wetting line, wherein a movable collecting pan is provided as well as a movable hopper arrangement. Preferably, also a baffle means is provided to build a discharging channel for the boundary layer or film during preparation of the curtain. The method of starting the coating process comprises the steps of starting the apparatus and movement of the substrate providing an increased distance to a wiper or baffle means, preparing the curtain by pouring coating material from the hopper arrangement into a movable collecting pan, moving the hopper arrangement and curtain into a pre-coating position, preferably near the baffle means while still pouring coating material into the collecting pan, bringing the hopper arrangement and baffle means into the coating position and rapidly moving the collecting pan away from baffle means and the substrate to be coated. Preferably, the hopper arrangement is in a preparation position during the starting step of the curtain coating method. The coating process is started by retracting the collecting pan as rapidly as possible to provide an even coating thickness over the width of the substrate.

[0017] As the substrate or web begins to move, preferably with a wiper or baffle means provided spaced a distance from the surface of the moving substrate, having preferably the collecting pan positioned near the wiper or baffle means, there is no risk of wrinkling or web breaking.

[0018] It is preferred that the collecting pan builds a discharging channel for the boundary layer during curtain preparation such that there is no risk of air motion during curtain preparation. The hopper arrangement, preferably positioned in pre-coating position during starting of the apparatus, prevents contamination of the substrate and the apparatus during starting and stopping of coating process.

[0019] In a preferred embodiment of the invention the coating process can be stopped by reversing the performing order of the steps used to start the process.

[0020] Consequently, contrary to the prior art, the hopper arrangement and collecting pan are movable and there is not provided an application start plate which may cause the coating liquid to spatter leading to contamination of the apparatus and substrate. Also, when stopping the coating process, firstly the collecting pan is moved rapidly into the curtain such that the coating process stops with a definite line on the substrate. Afterwards it is preferred that firstly the hopper arrangement is moved to pour curtain into the collecting pan. Preferably after positioning the hopper arrangement the baffle, or especially wiper, means is lifted from the surface of the substrate in order to avoid wrinkling of the substrate which could lead to its scratching or breaking.

[0021] In a further preferred embodiment of the invention, means to horizontally move the hopper arrangement and collecting pan are provided as well as means to vertically move the baffle or wiper means.

Brief description of the drawings

[0022]

Figure 1 is a schematic overview showing generally a curtain coater arrangement as known from the prior art;

Figure 2 is a schematic view of an improved curtain coating apparatus according to a preferred embodiment of the invention in a first starting position;

Figure 3 is a schematic view of the curtain coating apparatus according to figure 2 in a second starting position;

Figure 4 is a schematic of the curtain coating apparatus according to figure 2 in a third starting position; and

Figure 5 is a schematic of the curtain coating apparatus according to figure 2 in a fourth starting position.

Detailed description of the invention

[0023] Figure 1 shows an apparatus for curtain coating as known from the prior art. Such conventional curtain coating apparatus has means, preferably in form of a backing roller 10 for forwarding separate sheets or continuous web 12 as a substrate to be coated. The web 12, which may comprise a paper is forwarded along the backing roller 10 through the curtain coater. A hopper arrangement 14 is located generally above the backing roller 10. Various forms of hopper arrangements 14 are known, generally providing a curtain 16 of a coating liquid free falling over a distance forwarded over a lid 18 or any other suitable means. The coating curtain 16 is moved towards the substrate 12 on the backing roller by gravity force and impinged on the substrate generally perpendicular to the moving direction of the substrate.

[0024] There is also provided a curtain deflector 20 as well as a collecting pan 22. As depicted with the arrows the hopper arrangement 14 as well as the curtain deflector 20 are movable in two directions. Also the direction of movement of the substrate on the backing roller is illustrated.

[0025] When starting the apparatus, curtain 16 is poured onto the curtain deflector 20. The free-falling curtain is guided into the collecting pan which is provided under the movable curtain deflector. Before the preparation of coating the hopper arrangement is positioned far from the backing roller and the curtain deflector is moved to the space between the curtain head and the backing roller. The adaptation of moving hopper arrangement and curtain deflector is relatively difficult and there is still the risk of contamination of the substrate and the apparatus because of the coating liquid falling on the deflector spattering onto the substrate and apparatus. To overcome this problem according to the present invention such a curtain deviator is not provided anymore.

[0026] Figures 2 to 5 show steps of the method and an apparatus according to the present invention. Parts being the same or similar to those described above are depicted by the same reference numbers for the ease of understanding. The apparatus comprises the hopper arrangement 14 pouring the curtain 16 over lid 18 into a collecting pan 24. The moving substrate 12 is positioned next to the collecting pan according to figure 2. A baffle means 26 is also provided in a raised position illustrated by arrow 28. Figure 2 shows the curtain preparation step where the collecting pan is positioned next to the baffle means 26 and where the curtain 16 is poured into the deeper portion of the collecting pan.

[0027] The coating pan is formed to be adapted to the form of the substrate moving means, i. e. it is wedge-shaped having a relatively deep portion where the curtain can be poured into during the first preparation step. The other end of the collecting pan directed to the baffle means 26 is tapered in order not to intersect with the moving substrate.

[0028] In the second preparation step according to figure 3 the hopper arrangement 14 is moved horizontally towards the baffle means 26 still pouring curtain 16. The movement is illustrated by an arrow. The baffle means 26 is still in the lifted position to avoid wrinkling or scratching of the substrate. Coating liquid 30 runs over the bottom surface 32 of the collecting pan. The poured coating material is still collected in the collecting pan in its deeper portion.

[0029] In a fourth step shown in figure 4 the curtain 16 and the baffle means 26 are brought in coating position. This means that hopper arrangement 14 is further horizontally moved towards baffle means which itself is lowered in direction to the surface 34 of the substrate 12. The lowering step is marked with arrow 36. The collecting pan is positioned such that curtain 16 is still poured into the tapered portion of collecting pan. Coating liquid still runs over the bottom surface 32 of collecting pan 24 to be collected at the deeper portion of the collecting pan. The coating process is not yet started but the substrate is preferably accelerated to the optimal speed to be coated.

[0030] When the substrate reaches the optimal speed to be coated collecting pan 24 is rapidly retracted in the direction away from the substrate and baffle means, as illustrated by arrow 38. As curtain and baffle means have been brought into coating position before (figure 4) the coating process of the substrate starts directly at that moment, when the tapered end of the collecting pan is retracted from the curtain area as illustrated in figure 5.

[0031] Stopping of the coating process may be carried out similar to the starting of coating process, preferably

by reversing the above steps.

[0032] As there is not provided any deviator the process of starting the apparatus and the coating process is much easier than with an apparatus of the prior art as illustrated in figure 1. The apparatus according to the invention provides excellent operating behavior without the necessity of complicated and sophisticated deviator means and is therefore much easier to use, and not only assumed to be more reliable compared to the prior art but also much more cost effective.

[0033] Where this invention has been described in terms of a preferred embodiment, the present invention can be further modified within the spirit and the scope of this disclosure. This application is therefore intended to cover any variations, uses or adaptations of the invention using its general principles. Further, this application is intended to cover such departures from the present disclosure as come within known or customary practice or in the art to which this invention pertains and which falls within the limits of any claims directed to this invention.

Claims

1. Apparatus for starting and stopping curtain coating process of a movable substrate especially for high-speed coating of a continuous paper web substrate (12) wherein a substrate (12) is moved below a movable hopper arrangement (14) providing one or more liquid coating materials in the form of a free-falling curtain (16) impinging the substrate (12) at a dynamic wetting line, and wherein a collecting pan (24) is provided **characterised in that** the collecting pan (24) is movable and that a baffle means (26) is provided to build a discharging channel for the boundary layer or film during preparation of the curtain (16).

2. A method for starting and stopping curtain coating process particularly for high-speed coating of a continuous paper web substrate (12) comprises the steps for starting the apparatus and movement of the substrate preparing the curtain by pouring coating material from the hopper arrangement (14) into a collecting pan (24) **characterised in** moving the collecting pan (24) and the hopper arrangement (14) and curtain into a pre-coating position during starting the coating process, providing a movable wiper or a baffle means (26), moving the hopper arrangement (14) and the collecting pan (24) near the baffle means (26) in pouring coating material into the collecting pan (24), bringing the hopper arrangement (14) and baffle means (26) in the coating position and rapidly moving collecting pan (24) away from the baffle means (26) and the substrate to be coated.

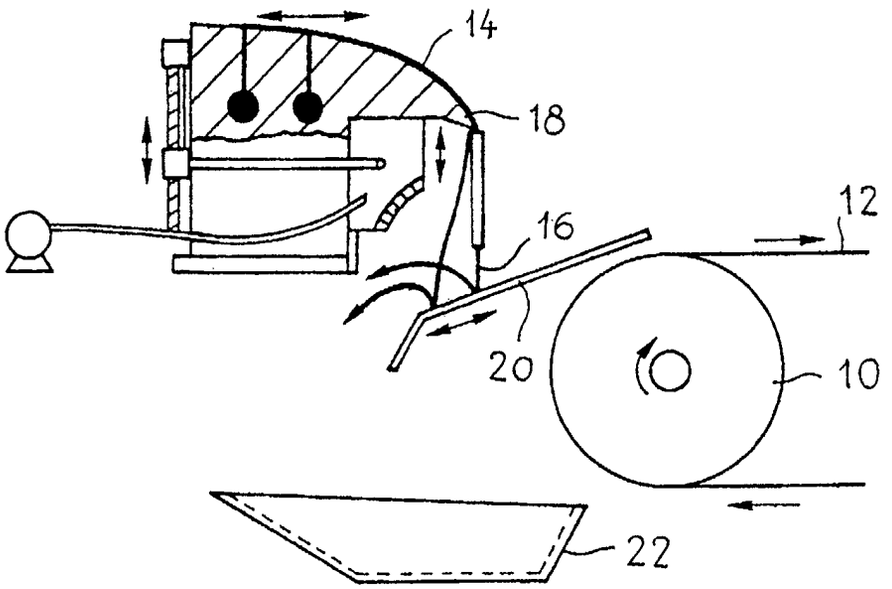

Fig.1

(PRIOR ART)

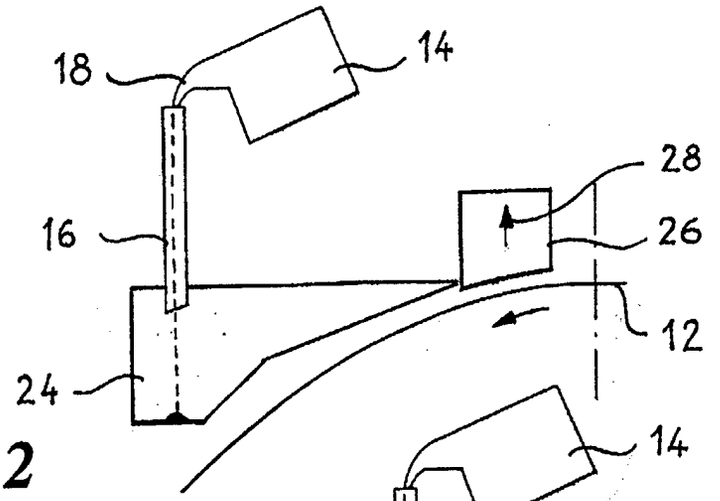

Fig.2

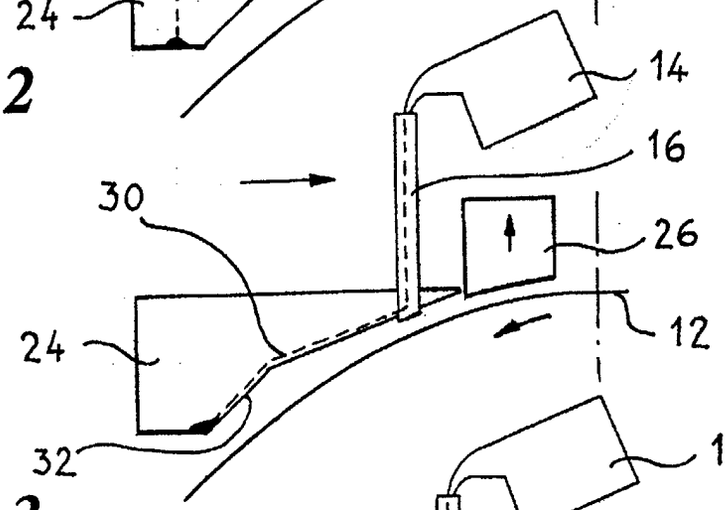

Fig.3

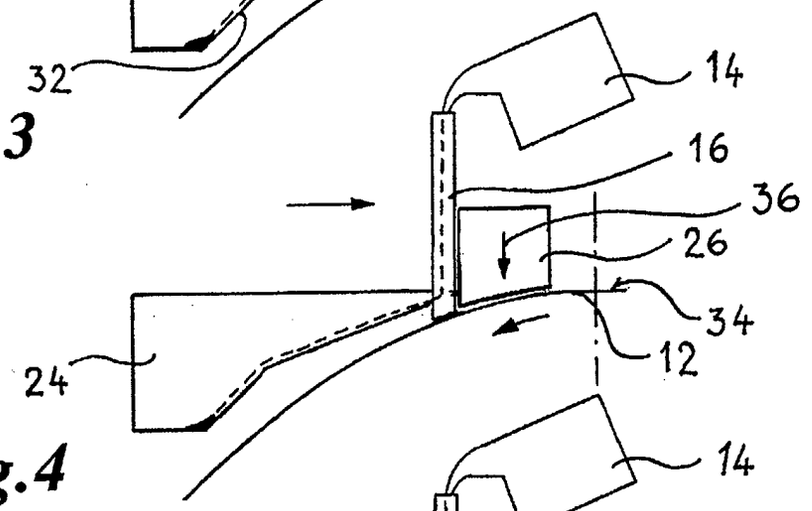

Fig.4

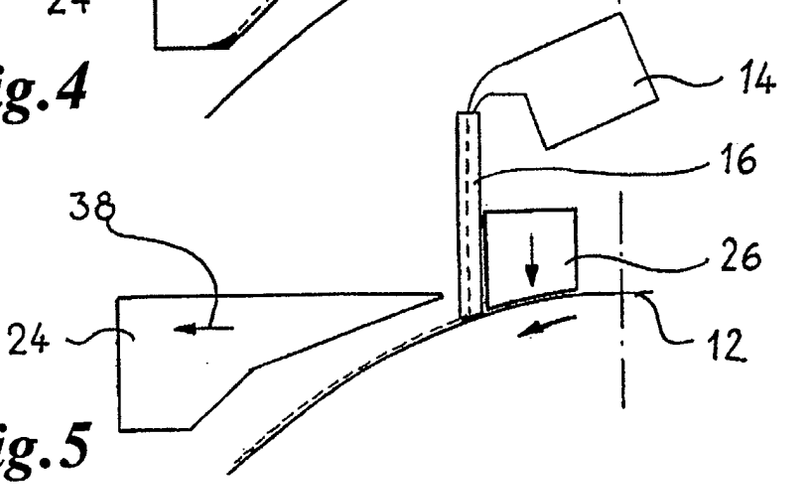

Fig.5