United States Patent [19]

Damrau

[11] **3,916,077**

[45] **Oct. 28, 1975**

[54] **WEB COATING METHOD**

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[22] Filed: **Oct. 25, 1973**

[21] Appl. No.: **409,403**

Related U.S. Application Data

[62] Division of Ser. No. 220,895, Jan. 26, 1972, Pat. No. 3,799,111.

[52] **U.S. Cl.** **428/537**; 427/248; 427/345; 427/348; 427/424

[51] **Int. Cl.**[2] **B44D 1/44**; B05C 11/10; C23C 11/00; B05B 13/02

[58] **Field of Search** ..... 117/64 R, 102 R, 105.3, 117/106 R, 102 L; 118/63, 325; 427/248, 345, 348, 424; 428/537

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Primary Examiner—Michael R. Lusignan
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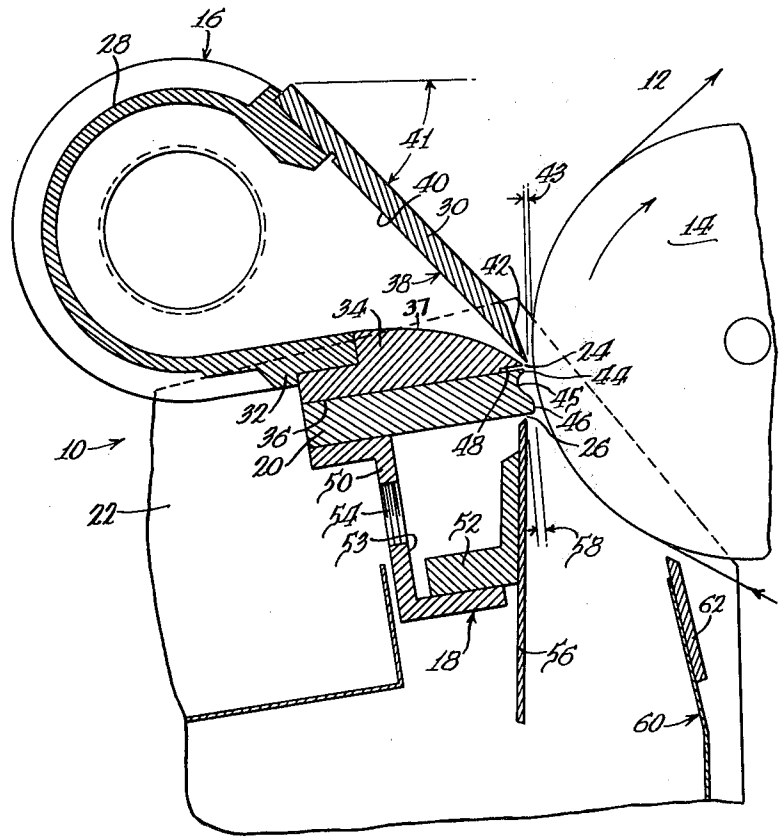
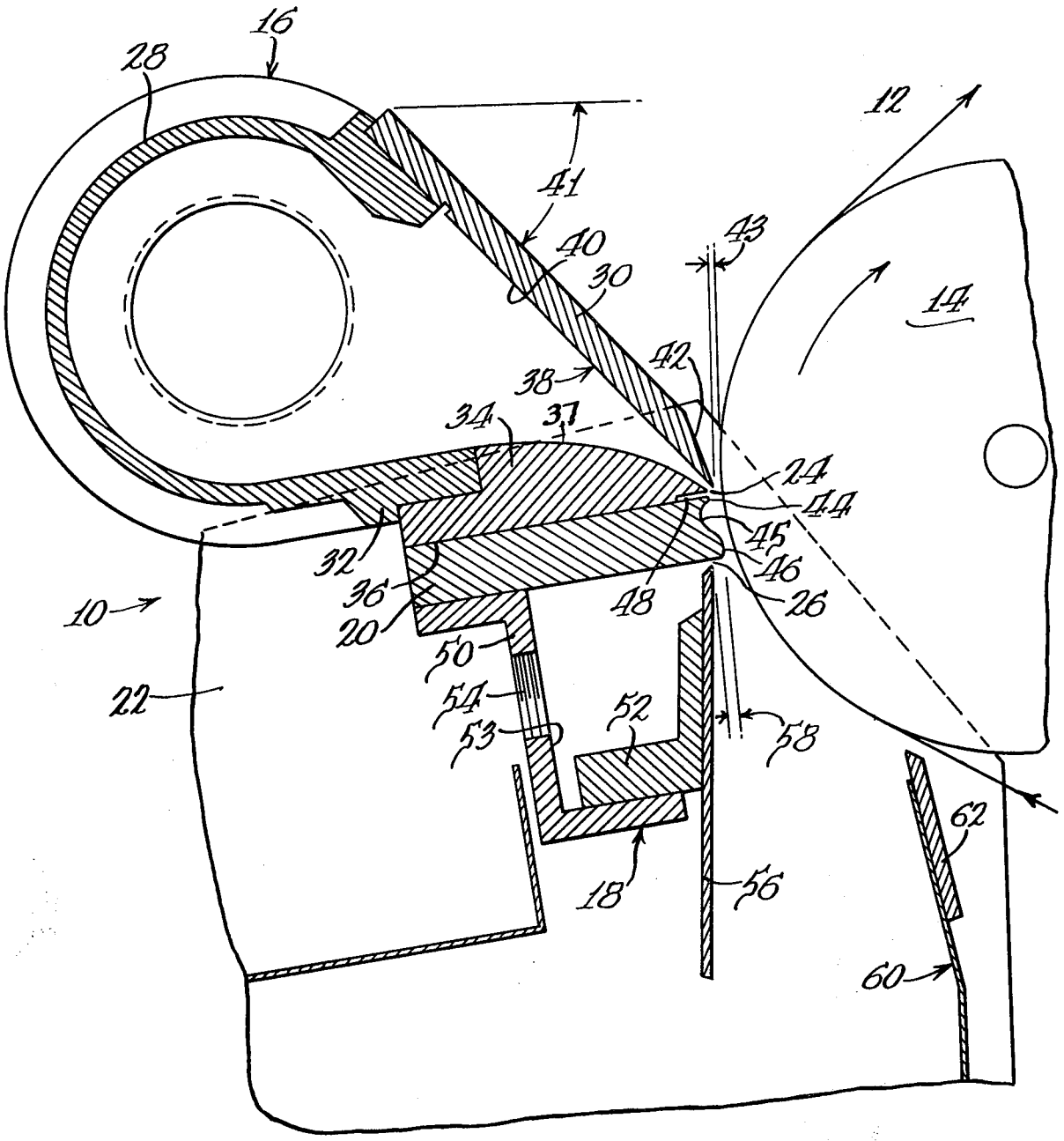
[57] **ABSTRACT**

In a coating method, the web is conveyed and supported on a rotating roll. Liquid coating material is applied by atomizing the material with air to create a mist adjacent to and contiguous with the supported web. A thin line of pressurized air from the discharge orifice of an air knife is directed toward the web on an angle against the direction of web travel and into a confined space away from the orifice to create a turbulent zone adjacent the web. Liquid coating material is metered under pressure into the turbulent zone through a slot of a chamber. The coating on the web is leveled by the same air stream in a second zone closely adjacent the air orifice.

7 Claims, 1 Drawing Figure

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WEB COATING METHOD

CROSS REFERENCE

This is a divisional application of my copending application, Ser. No. 220,895, filed Jan. 26, 1972, now U.S. Pat. No. 3,799,111, issued Mar. 26, 1974.

BACKGROUND OF THE INVENTION

This invention relates to a method for coating webs and more particularly to a method for applying a thin coat of a coating composition to a moving flexible web composed of paper or the like.

It has been customary heretofore to utilize so-called dip or applicator roll devices with or without air or mechanical doctor blades to apply and spread a liquid composition onto one or both of the surfaces of a moving strip material or web. Coating compositions have also been applied to a moving web by pumping the composition through a slot in a hopper and onto the web surface. These methods have been satisfactory to the extent that uniform and usable coatings have been achieved at normal coat weights. At lower coat weights, such as those in the order of about 0.5 to 1 pound of solids per ream, it becomes increasingly difficult to maintain uniformity by these methods, and many proposals to apply uniform low weight coatings have been made. A particular difficulty in applying light weight coatings with blade coaters is the possibility of exposing prominent surface fibers. Attempts at applying coatings by spraying have been generally unsuccessful because of the necessity of overlapping the spray patterns, resulting in an uneven coating.

BRIEF DESCRIPTION OF THE INVENTION

The coating device of the present invention comprises a low pressure liquid applicator in cooperation with a high velocity air knife, both located closely adjacent one another and directed against the web along the width thereof. The air knife orifice is directed on an angle against the direction of web travel in such a manner as to cause a thin stream of air to converge and impinge the web along a distinct zone immediately adjacent the orifice. The air is deflected and becomes divergent and increasingly turbulent toward the area of application after the first incidence of impingement and is confined adjacent the web by a spacer between the air knife and the outlet of the applicator. The liquid coating composition is introduced from a slot in the applicator toward the web and into the turbulent air from the air knife, such that the composition is at least partially atomized. A mist of coating material is thus deposited on the web, in contradistinction to direct liquid application of many prior art methods. After deposition of the coating mist, the coated web passes through the zone of convergence of the air knife whereby the wet coating on the web is leveled or skimmed.

While the method of the present invention is useful in applying a wide range of coating weights to a web, the primary advantages are two in number, namely the ability to deposit thin or light weight coatings and the ability to generate a relatively coarse or rough surface (on a fine scale) when formulations containing substantial amounts of pigment are applied. For example, the method may be employed in the application of thin coats of relatively expensive adhesives and/or film formers to a previously coated or uncoated web, thereby resulting in considerable savings of material. To this

end a conventional coater may be placed in series with the present apparatus for the purpose of applying coating of high solids content, followed by a thin finish overcoat from the presently described apparatus.

Another application may be in the manufacture of electrostatic papers where a relatively rough top coat on the sheet is desirable to give the sheet good tooth that is receptive to writing instruments.

Other advantages and objects of the present invention will become apparent from the following description of a preferred embodiment thereof, taken in connection with the appended claims and accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWING

The FIGURE illustrated in the drawing is a vertical sectional view of the novel web coating apparatus, said apparatus being shown in connection with a web support upon a roll.

DESCRIPTION OF THE PREFERRED EMBODIMENT

In the preferred embodiment, the web coating apparatus, shown generally at **10,** is supported in a position to operate in conjunction with a web **12** of paper or the like partially wrapped around and carried upon a backing roll **14.** The backing roll **14** rotates about its axis in the direction indicated by the arrow to continuously move the web **12** in the same direction past the coating apparatus and to enable application of a coating to the web in a continuous fashion. The coating device is shown in isolation with the backing roll, but it will be understood that the device may be incorporated directly in the line of a web forming machine, such as a paper machine, or may be employed in a separate coating and finishing line. Also, it will be understood that related conventional equipment, such as driers and calendering rolls, have been omitted from the present description as being unessential for a full and complete understanding of the present invention.

The coating device generally comprises an air impingement component or air knife **16** which cooperates with a liquid metering component **18** located ahead of the air impingement component in terms of direction of web travel. The components **16** and **18** are pivotally mounted as an assembly and are separated by a spacer **20.** The assembly is substantially enclosed at its sides by parallel side walls, such as **22** which also encompass the sides of the backing roll in the vicinity of application. The air outlet orifice **24** of the air knife **16** is directed inward toward the supported web and toward the outlet orifice **26** of the metering component **18,** and there is a substantially enclosed space between said orifices defined by the spacer **20,** side walls **22** and web **12,** into which air from the air knife is channeled and becomes turbulent. The turbulent air then impinges on liquid issuing from the orifice **26** of the metering component **18** and causes atomization of the coating liquid in an area adjacent the moving web ahead of said orifice. The air knife **16** also serves the second function of skimming the wet coating on the web in a vicinity immediately adjacent to its outlet orifice **24.**

The air impingement component or air knife **16** may be adjustably supported and more particularly comprises a partial cylindrical member **28** defining a plenum chamber to which is connected a source of pressurized pneumatic fluid (not shown), such as an air

pressure tank supplied by a pump. A pair of elongated converging lips **30** and **32** extend radially from the open side of the cylindrical member **28** to define the narrow outlet orifice **24** that extends across substantially the entire width of the web **12** along a zone perpindicular to the sides of said web. One of the lips **32** may include a separate and replaceable end section **34,** which may comprise a flat outer surface **36** and a convexly curved interior surface **37,** terminating in a sharp edge and partially defining the air flow characteristics from the outlet orifice **24.** The other lip **30** comprises a flat interior surface **38,** with the outer surface having a tapered portion **42** defining a sharp edge.

The lips **30** and **32** are narrowly spaced from one another at the outlet **24** and are closely spaced from the supported web **12** to cause a thin jet of air to be directed toward the web surface. In order to define optimum air flow characteristics, the distance between the lips **30** and **38** at the outlet **24** is in the order of about **20** to **30** thousandths of an inch. The angle **41** of the air knife downward from horizontal toward the web is preferably maintained from about 45° to 53°, and optimum results are achieved at about 47°. Also, the distance between the air orifice **24** and the web, indicated at **43,** is important in defining proper air flow characteristics and should be maintained between about one-eighth to one sixty-fourth inches. In this manner, the air issuing from the orifice **24** will initially be convergent and will impinge the web **12** along a sharp line to achieve a flexible skimming effect.

The external surface **36** of the lip section **34** is connected to a flat surface of the spacer **20,** which may generally comprise a rectangular bar extending across the width of the web. Preferably, the spacer **20** is adjustable relative to the air knife in a direction toward and away from the web, and the surface thereof facing the web and spaced therefrom may have a groove **45** therein. The groove **45** is preferably most sharply recessed immediately below the air outlet **24** to define an edge **44** even with the edge of the lip section **34.** The part of the groove **42** adjacent the liquid orifice **26** is more gradually curved to form a relatively thick edge **46,** which projects slightly beyond the other edge **44.**

The confined space between the groove **45** and the support web **12** forms a channel of fluid communication between the air orifice **24** and the liquid orifice **26** wherein the air stream, after its initial impingement upon the web, may become divergent or turbulent before encountering the coating liquid. In order to prevent excessive accumulation of the coating material on the lips **30** and **32** of the air knife **16,** it has been found that a thin, open end slot **48** between the lip section **38** and the spacer **20** facing the web will minimize this undesirable result. The slot **48** is preferably in the order of about from one thirty-second to one-half inches in thickness and apparently causes minor air turbulence in a vicinity immediately below the air orifice **24,** thereby minimizing spattering of liquid against the lip surfaces.

The liquid metering component **18** is connected to the side of the spacer **20** opposite to that of the air knife **16** and comprises a flanged L-shaped channel **50** secured from the spacer and carrying a corresponding reverse L-shaped blade support **52.** The channel **50** and the support **52** together define a fluid tight chamber **53** for containing a liquid coating composition, such as an aqueous mixture of a powdered mineral material and an adhesive, which may comprise, for example, clay and starch. An inlet **54** to the chamber **53** may be provided in the channel **50** through which the desired coating mixture may be delivered under pressure from a pump (not shown). A wide range of solids may be incorporated into the coating material, such as between about 5 percent (or lower) to 37 percent, and at viscosities ranging from at least 10 to 264 centipoises at 20 rpm Brookfield.

A blade **56** having a tapered end is mounted on the support **52** and extends across the width of the web **12** in a plane substantially parallel to a plane tangential to the backing roll **14.** The tapered end of the blade **56** is preferably located in a position level with or behind the edge **46** of the spacer **20** at a distance of up to about three-sixteenths of an inch, said distance being indicated at **58.** To achieve optimum results, the offset spacing indicated at **58** is preferably adjusted to about one-eighth of an inch. The blade **56** is also adjustably spaced from the spacer **20** to define the liquid orifice **26,** said orifice being separated from the web by from three-sixteenths to three-eighths of an inch.

The metering component operates by means of maintaining positive pressure upon the liquid coating mixture within the chamber whereby liquid is forced out of the orifice **26** toward the facing surface of the web **12.** In order to assure a uniform coating, the pressure within the chamber is maintained at a constant level within the range of about 0.1 to 3 pounds per square inch. The liquid coating mixture is therefore injected into the turbulent atmosphere created by the air knife **16,** which causes the coating to atomize and be deposited upon the web.

In the operation of the present apparatus, an excess of coating liquid is introduced through the orifice **26** and means are provided to collect and recirculate unused material back into the chamber **53.** A barrier **60** comprising a knife with a tapered edge extending closely adjacent the width of the web is spaced from and substantially parallel to the blade **56,** and is located ahead of the metering component **18** in terms of web travel. The barrier **60** is also encompassed by the side walls **22** and prevents escape of atomized coating material, part of which is deposited on the web between the blade **56** and the barrier **60.** A collecting chamber or separator pan and pump (not shown) may be located beneath the enclosed space between the blade **56** and the barrier **60,** in order to return unused coating material to the chamber **53.**

The operation of the coating apparatus and the method of the present invention will now be apparent. The coating apparatus is preferably supported in the position shown in the drawing, that is, the air knife is slanted downward about 47° from horizontal, with its orifice located below a horizontal plane passing through the axis of the backing roll **14.** It will be obvious, however, in view of the atomization concept by which the apparatus operates, that the apparatus may be located in other axial positions with respect to the backing roll **14.**

In the operation, the air knife **16** is pressurized to create a non-turbulent zone of air impingement immediately adjacent the orifice **24** thereof and substantially turbulent zone adjacent the liquid orifice **26.** Thereafter, a stream of liquid coating material is injected through the orifice **26** into the turbulent air and not directly onto the web **12.** In this manner, the liquid is ini-

tially atomized to create a turbulent and homogeneous mist contiguous with the moving web, whereby a film of substantially uniform and constant thickness is deposited on the web between the orifice **26** and the barrier **60.** The thus coated web is then immediately passed through the non-turbulent zone of the air knife **16,** which serves to level or skim the coating without scraping coating material off of prominent surface fibers in the web. The web is then dried in a conventional drier and may then be subjected to a calendering operation.

The apparatus herein described is extremely versatile in terms of adjustability and may apply coat weights ranging from 0.5 to 5 pounds per ream and at web speeds in excess of 1500 feet per minute. The coat weight may be varied by changing the pressure in the air impingement component **16** or in the liquid chamber **53,** by changing either or both of the orifice gaps **24** and **26,** by adjusting the air knife angle **41,** by increasing or decreasing the distance between the apparatus and the roll **14,** or by varying the coating solids, or by combinations of any of the above.

Another important feature of the present invention is that no parts of the coating apparatus contact the web. The coating is applied by deposition of a mist of the liquid material onto the moving web, and the coating is immediately leveled or skimmed by an air knife which is also spaced from the web. The cooperation between the air impingement component and the metering component is particularly advantageous in that the air component serves the two-fold purpose of atomizing the coating material and skimming the coated web. Also, the close proximity of the air knife to the metering device allows less time for moisture in the coating to migrate into the web and also allows for convenient recirculation of the unused coating liquid.

Other important advantages of the presently described coating device are the ability to apply coatings of low solids content and to cover prominent surface fibers in the web. Since the apparatus does not contact the web, it may be used to apply low coat weights onto a dilutant wet coated surface without unduly disrupting the previous coat, and without substantial increase in the drying load. For example, the previous coat may be applied by a conventional blade coater, to be immediately followed by a lighter coat from the apparatus of the present invention, in order to cover prominent surface fibers, or to utilize a relatively expensive but highly advantageous coating material.

Having thus described the invention, what is claimed is:

1. Method for applying liquid coating material to a moving web comprising the steps of directing a single stream of high velocity air across said web in a first distinct zone on an angle against the direction of web travel, channeling said stream of air from said first zone to a second distinct zone preceding said first zone and adjacent said web wherein said stream of air becomes substantially turbulent, depositing atomized coating material on said web in the vicinity of said second zone by injecting a stream of liquid coating material into said second zone adjacent said web, and the immediately leveling the coating on said web by said stream of air in said first zone.

2. The method of claim **1** comprising the further step of applying a first coating of liquid material to said web prior to the step of depositing atomized coating material thereon without drying the web between coats.

3. The method of claim **1** comprising the further step of drying the web after it has passed through said first zone.

4. The method of claim **2** comprising the further step of drying the web after it has passed through the first zone, and then calendering the web.

5. The product made by the process of claim **4.**

6. The product made by the process of claim **3.**

7. Method for applying liquid coating material to a moving web comprising the steps of supporting the moving web on a rotating roll, directing a single stream of air against the supported web, applying a mist of coating material across said web with said single stream of air, and then immediately skimming the coated surface of said web with said single stream of air.

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