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METHOD AND APPARATUS FOR COATING PAPER

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Fig. 1.

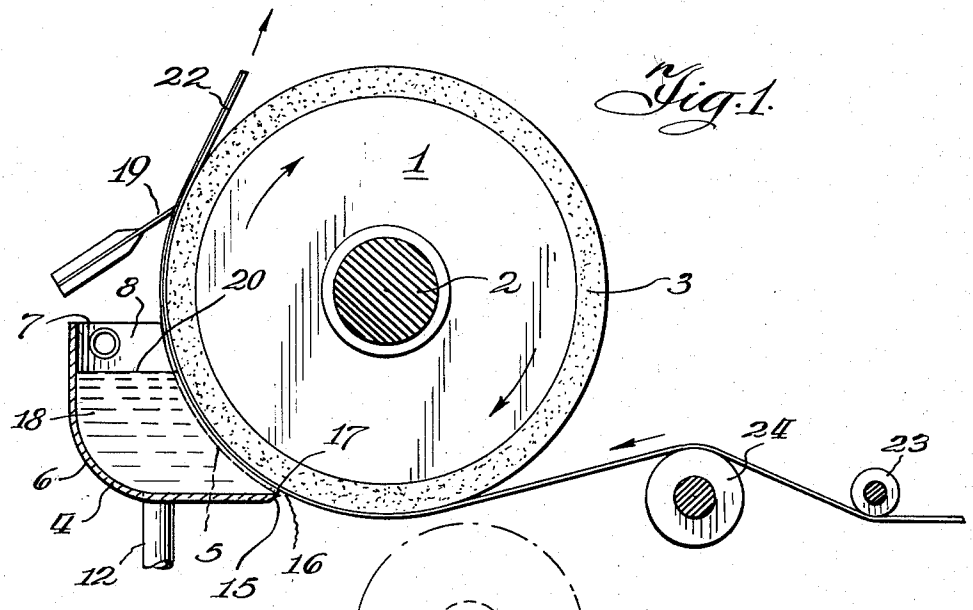

Fig. 3.

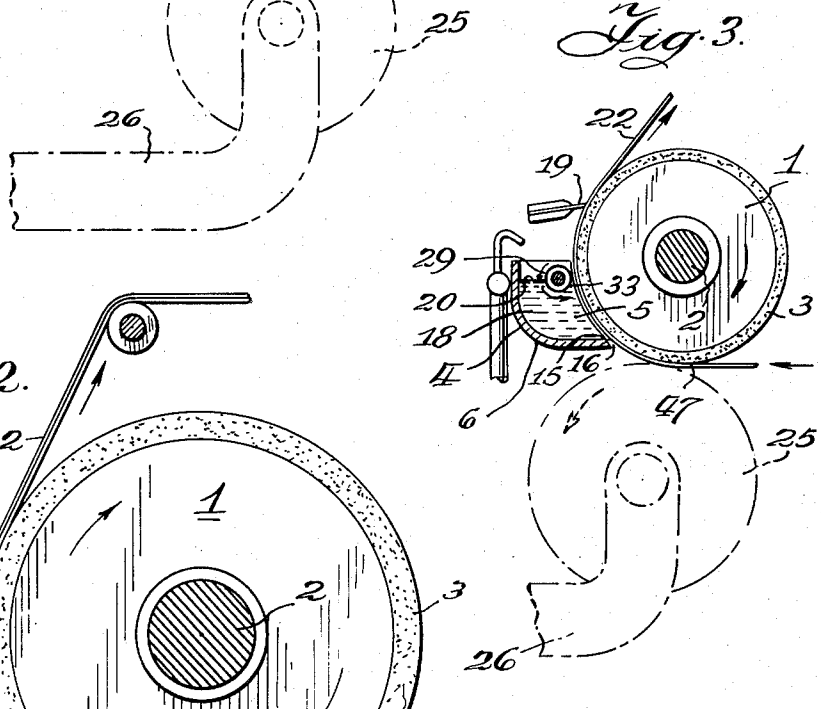

Fig. 2.

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Fig. 4.

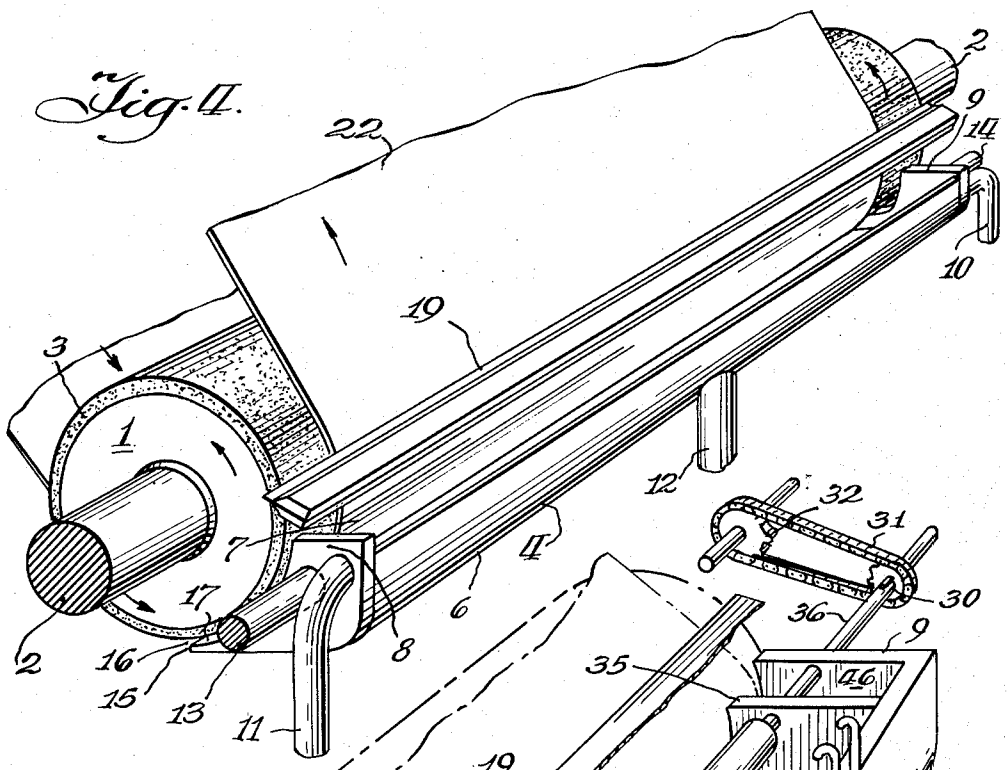

Fig. 5.

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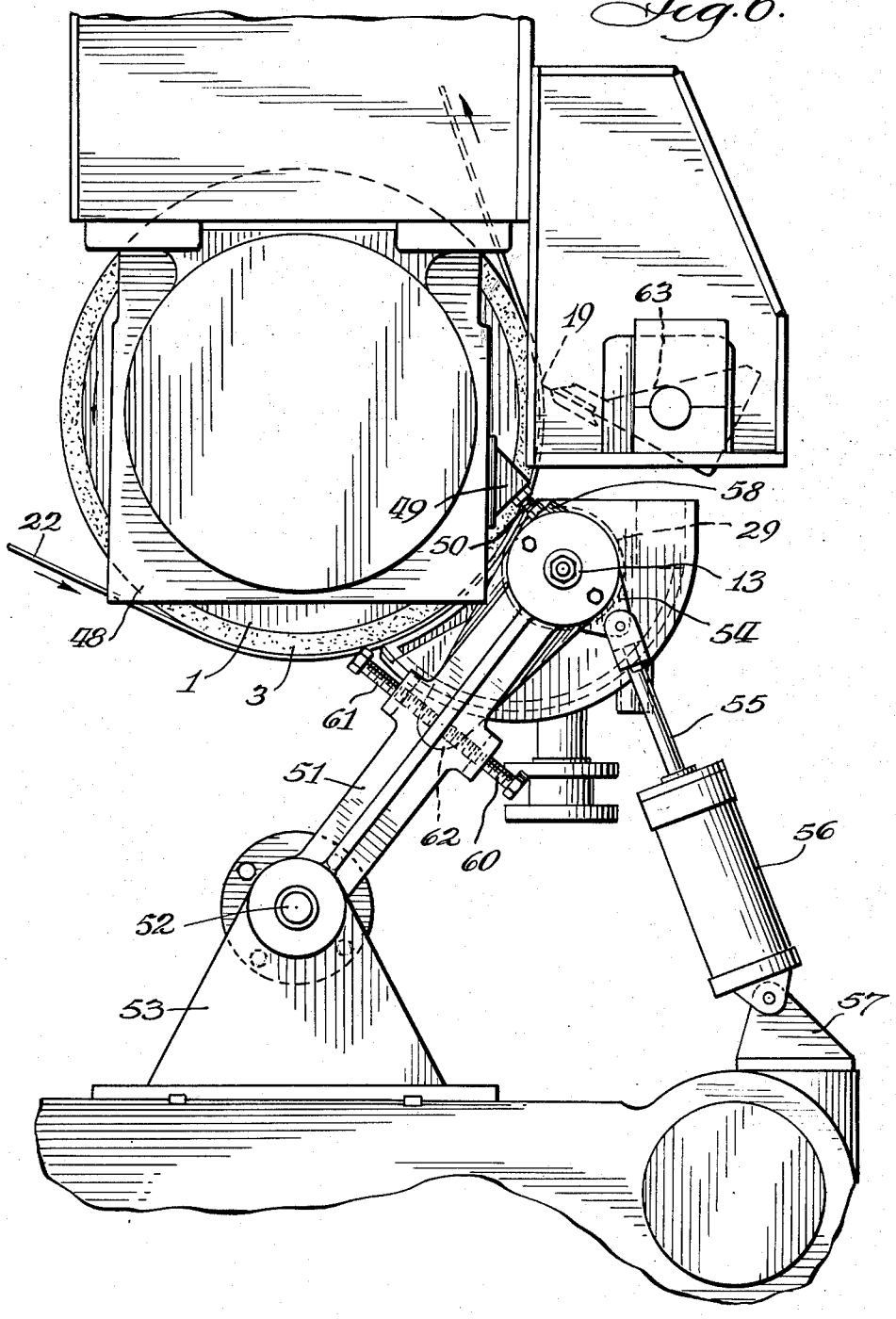
Fig. 6.



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METHOD AND APPARATUS FOR COATING PAPER

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6 Claims. (Cl. 117—102)

This invention relates to the application of coatings to traveling webs such as webs of paper; more particularly, the invention relates to apparatus and methods of coating a supported traveling web while moving the web longitudinally upwardly under tension.

It is desirable in the coating of webs of relatively low tensile strength to effect the coating application under a minimum of web tension. The present invention is based upon the finding that the draw or tension on a web may be readily minimized and controlled while yet providing dwell time between the coating application and a smoothing, blading off or troweling action; to achieve this and other advantageous results, the web to be coated is supported and passed upwardly through a pond of a coating composition and then to the smoothing device which is spaced from the pond in the direction of web travel.

For the foregoing purpose, the coating composition is suitably retained in a coating applicator trough disposed adjacent a backing roll to form with the roll an entrance gap for the web. The gap is so dimensioned that, in operation, flow of coating composition outwardly of the trough under the influence of gravity is inhibited by the web and the force of the moving web on the fluid composition at the gap.

By the arrangement thus generally described, no draw point or line of pressure contact is exerted on the web at the area of application of the coating and yet controlled dwell time between coating application and smoothing is readily attained. Other advantages also stem from the noted mode of operation; the pond is itself relatively quiet and throwing of coating is substantially eliminated even at high web speeds in on-the-machine coating operations; when a blading device is utilized as the smoothing element, for example a knife blade, it may be oscillated and may also be backed by the same roll which carries the web; delicate pressure control common to applicator pressure nips formed by cooperating rolls is eliminated; simplified web travel, machine threading and end dam construction at the coating and blading device are achieved; a relatively low installation cost is realized; and the equipment arrangement is flexible for handling various web weights which thereby contribute to more uniform quality of coatings.

In addition to the foregoing advantageous aspects of the invention, it is a particular object of the invention to provide a novel coating process in which the coating composition is continuously circulated to the advancing web while the quantity of coating applied is metered to the web in an amount which is in excess of that required on the finished product.

It is also an important object of this invention to provide improved apparatus for coating a traveling web, which apparatus is operable over a wide range of speeds and basis weights with a variety of coating compositions to achieve high quality coated printing papers.

These and other allied objects of the invention will be more fully understood by reference to the following detailed description and acompanying drawings wherein:

FIG. 1 is a schematic view in side elevation of one

embodiment of the apparatus of the invention with optional equipment indicated in dotted lines;

FIG. 2 illustrates a modification of the coating apparatus of FIG. 1;

FIG. 3 is a view similar to that of FIG. 2 but illustrating another and preferred embodiment of the coating apparatus;

FIG. 4 is a view in perspective of the coating apparatus of FIG. 1;

FIG. 5 is a view of a modification of the coating applicator trough; and

FIG. 6 is an end view illustrating one form of linkage mechanism suitable for the practice of the invention.

Throughout the drawings corresponding parts are designated by similar numerals where such is practicable.

Referring to the drawings and particularly initially to FIGS. 1 and 4, the numeral 1 designates a longitudinally extending backing roll which is adapted to be supported on trunnion 2 and to be driven in rotation in the direction indicated by the arrows by any suitable mechanism (not shown).

Backing roll 1 suitably has a resilient rubber covering 3 (FIG. 1) of a Pusey and Jones (⅛" ball) hardness of between about 30 to 80; the roll 1 diameter is usually about 28 inches and the speed of rotation controllably variable between about 300 to 2000 feet per minute.

A coating applicator trough 4 is disposed adjacent the backing roll 1 and has an open side 5 fronting on the backing roll. The trough 4 has: a back 6 of curvilinear configuration to facilitate coating movement within the trough and to eliminate dead spots; top 7 opens to the atmosphere and facilitates web exit from the trough; closed ends 8, 9 (FIG. 4) serve as end dams for the coating composition; a valved coating composition lower inlet 10, upper outlet 11, and bottom drain 12 are provided; fixed end shafts 13, 14 permit positioning the trough as shown in FIG. 4 by suitable mechanism (FIG. 6); and a lower forward bottom edge 15 of the trough is spaced from backing roll 1 by a gap 16.

The bottom edge 15 of the applicator trough extends (FIG. 4) generally parallel to and linearly of the roll 1 with the trough across the face of the roll. The gap 16 is sufficiently wide that a web to be coated may pass freely through the gap but the combination of web thickness and web movement is such as to inhibit coating movement outwardly of the trough in the operation of the equipment. The gap in practice suitably has a width between edge 15 and a web of about 0.05 inch which has been found appropriate for all customary mineral coatings, i.e., aqueous coatings containing pigment and adhesive. Gaps as large as 0.10 inch have been employed with the heavier basis weight webs without any outflow of coating from the trough. Commonly, the web itself will have a thickness of about 0.003 inch in publication grades of coated paper and as high as 0.010 inch for commercial grades.

The end dams 8, 9 of the trough may be integral with or simply suitably secured to the trough proper by fluid tight means. In any event, the end dams preferably have a shape conforming substantially to the curvature of the roll 1; in practice end dam plate 1" in width have been employed. The spacing 17 (FIG. 4) between the end dams and the roll surface, despite the pressure exerted by the coating composition, may be considerably greater than the gap 16—up to ¼ inch without coating leakage.

The coating composition is designated in FIG. 1 by the numeral 18 and for the purposes of coating paper

is a usual aqueous adhesive-pigment composition; exemplary of such compositions are starch-clay or casein-clay materials in which the clay serves primarily to fill the paper and provide a fine printing surface while the adhesive bonds the clay particles together and also bonds the clay to the fibers of the paper. Such compositions commonly have a solids content of between about 48 and 65% and a viscosity of between 28° Brookfield to 80° Brookfield measured as noted hereinafter in connection with a specific illustrative composition.

Referring again to FIG. 1 a primary leveling element in the form of a flexible knife blade **19** is positioned above the surface **20** of the coating composition and in the direction of travel of roll **1** from the trough **4** at an angle of between about 30 to 60° to a tangent to the roll at the line of blade contact. This blade is adapted for pressured engagement with a web of paper on the backing roll to remove excess coating material. This primary leveling element **19** may be in other forms; for example, a roller or an air knife. As may be most clearly seen from FIG. 4, the flexible blade **19** extends beyond the width of the backing roll **1** at each end of the roll, and is at least as long as the trough; as also may be noted from FIG. 4, the roll width is at least slightly greater than the width of the web **22** of paper to be coated.

Web **22** as indicated by the directional arrows, is passed leftwardly in FIG. 1 to the backing roll **1** over a spreader roll **23** and paper carrying roll **24** which may have a usual braking adjustment mechanism (not shown) associated with it to control web tension to the backing roll. The web passing onto the backing roll is passed upwardly through the gap **16**, the arrangement, as already noted, being such that a positive clearance exists between the edge **15** and the paper web. One surface of the web has the coating applied thereto as the web passes upwardly; blade **19** then removes coating excess which is directed laterally of the web by the blade and falls back to the coating applicator trough. Thus, no end dams at the blade are required and with a knife blade pressured to the web, the arrangement is such that the edges of the backing roll beyond the paper are wiped clean of coating fluid by the blade.

It has been found that the web **22** may readily be threaded through the coating apparatus without use of the bottom roll **25** as indicated in dotted lines in FIG. 1; however, if it is desired to employ a bottom roll, it may be mounted on a suitable pivot arm **26** and positioned as illustrated in dotted lines in FIG. 3 for threading; such roll is returned to the inactive position of FIG. 1 when the coating operation has begun, thus avoiding a positive nip at the oncoming side of the web. Roll **25** may also serve the additional function of cleaning, by wiping, the backing roll when a web is not being processed.

At higher backing roll and web speeds, and particularly in connection with coating operations carried out on the papermaking machine, the excess of coating material carried to the blade **19** may be considerable in volume. To limit the quantity of coating passing to the primary leveling element, a secondary or metering element may be disposed at about the surface **20** of the fluid coating composition. This metering element is illustrated in FIG. 2 as a blade designated at **28** and is spaced from the backing roll a convenient distance to control the volume of coating to the primary blade. Flow of the coating material occurs over the back side of blade **28** back to the coating pond, the web carrying the metered excess to the primary blade. The blade **28** may itself be supported by the trough inwardly of the trough.

A preferred metering element is illustrated in FIG. 3. As shown, the roll **29** is mounted for rotation in an angular direction which is opposite to that of the backing roll **1**. This roll **29** suitably projects into the coating composition pond **18** for a distance which is somewhat greater than ½ of its diameter. As indicated in FIG. 5, roll **29** is adapted to be driven through sprocket **30**, chain **31**, and drive sprocket **32**. Thus, roll **29** contributes to the circulation of the coating composition through the passage **33** (FIG. 3) formed with the backing roll, as indicated by the arrows. Such a roll is suitably relatively small in diameter, and has a rotational speed which is low, relative to that of the backing roll. The rotation of the roll **29** maintains its surface wetted providing for a clean, smoothing action on coating passing through the passage **33**.

Referring to the structure of FIG. 5, more particularly, the roll metering element **29** is illustrated as extending in a very close proximity with baffles **34** and **35**, and is journaled in the baffles and end plates **8**, **9**. Shaft **36** has the sprocket **30** fixedly secured thereto. The clearance between the baffles and roll extremities is maintained close to prevent coating leakage therebetween.

In the structure of FIG. 5, the trough **38** is filled and provided with coating composition in a somewhat different manner than that indicated for FIG. 4. Supported outwardly on the trough rearwardly is a tube **39**, extending longitudinally of the trough and having a plurality of nozzles **40** opening into the trough; an inlet **41** to the tube is provided for inflow of coating composition. The trough **38** is itself provided with an outlet **42** communicating with the main body of the trough. Secondary outlets **43**, **44** are provided from the compartments **45**, **46** respectively, which compartments are formed by the baffles and end plates.

In operation, the baffles may serve as an overflow control for the coating composition from the main body of the trough **38**, the composition itself being recirculated from the compartments **45**, **46** to the tube **39** by any suitable recirculation means (not shown). Further, the compartments **45**, **46** receive a large volume of coating composition from the ends of the primary blade permitting recirculation rather than direct mixing with the coating composition in the trough.

One form of mechanism adapted to provide for trough movement is illustrated in end view in FIG. 6. Suitably similar mechanism is provided at each side of the machine. It is to be understood, however, that various mechanical arrangements may be employed, not only for trough support and movement, but for the leveling and metering elements also.

In the end view in FIG. 6 the backing roll **1** is illustrated as associated with an end mounting plate **48** which carries thereon a threaded protuberance **49** and which receives headed adjustment screw **50**. A support arm **51** is carried at one end on shaft **13** and has its other end secured to shaft **52** journaled on fixed support **53**.

Shaft **13** also has affixed thereto eccentric **54** to which is pivotally secured piston rod **55** of hydraulic cylinder **56**; hydraulic cylinder **56** is itself pivotally mounted on fixed support **57**.

Abutment **58** is arranged to engage headed adjustment screw **50** to limit trough movement. Fine adjustment is achieved by means of headed screws **60–61** engaged with arm **62** and which is itself secured to shaft **13**.

In use the trough is retracted on the support arm hydraulic cylinder arrangement for cleaning and the like; also, when threading a web or sheet, the trough is retracted to provide the lower trough edge about ½ inch from the roll to facilitate the passage of the web initially.

Referring now more specifically to the operation of the device, a paper web **22** as illustrated in FIG. 1, is fed over the spreading roll **23** and the carrying roll **24** at the start-up of an operation. It is then passed either directly to the backing roll **1**, which is rotating at web speed of about 600 feet per minute or, as already noted

in connection with FIG. 1, web **22** may be passed to nip **47** (FIG. 3) formed between the backing roll **1** and nip roll **25**. For this purpose, roll **25** is brought into light pressured engagement with backing roll **1** and then roll **25** is withdrawn when the web has been carried upwardly on the backing roll.

The trough to facilitate threading is backed off about ½ inch and then closed to the predetermined gap when the web is being carried upwardly on the backing roll.

The webs may vary in thickness, but customarily are of about 0.003 inch. The gap **16** in such instances suitably has a width of 0.05 inch. The composition to which the web is passed suitably has a solids content of 59%, and a viscosity of 69.5° Brookfield (measured at 100 r.p.m. with #6 spindle at 50° C.). The combination of paper movement through this coating composition and the web thickness effectively close the gap **16** such that no coating material flows outwardly through the gap. The composition itself in the instance under consideration was composed of about 100 parts by weight of coating clay, 16% by weight of pearl starch (enzyme converted), 1% soap, caustic to adjust pH to about 7.2, and water sufficient to make the noted solids content of 59%. The specific gravity of such a composition is approximately 1.42.

In the specific illustration under discussion, a roll-type metering element such as that illustrated in FIG. 3 may be employed with the trough level **20** well above the gap **16**.

The primary blade **19** is positioned well above the surface **20** of the composition to provide a dwell length of about 14 inches between the surface **20** and blade **19**. With the primary blade forming an angle of about 55° with the tangent to the backing roll at the point of contact of the blade, a coat weight of approximately 5 pounds per side per ream is attained with the conditions noted. The basis weight in this instance was 43 pounds on a 500 sheet ream, 25 x 38 inches.

Coating composition is fed to the trough as the web moves upwardly on the backing roll; at substantially the same time, the primary leveling element is lowered into contact with the web. Excessive contact of the blade and web in the absence of coating composition should be avoided as the leveling element, particularly when in the form of a knife blade, tends to wear.

The web **22** in its passage through the apparatus handles well, due in large measure to the fact that the coating applicator device introduces only one draw point, thus permitting advantageous tension control in the passage of the web.

In the usual practice of the invention, the speed of the backing roll may be varied from between about 300 to 2000 feet per minute; the dwell between the pond and blade **19** is customarily between about 14 and 17 inches. The coat weight per side per ream, while dependent in large measure upon the web speed, may readily be controlled between about 3 and 8 pounds per side; increasing web speed usually increases coat weight. In general, it should be noted that it is preferable to maintain the pond well filled to achieve high coat weights. For example, it has been found that if the pond is permitted to drop in depth, the coat weight also tends to decrease with all other factors remaining constant. Increasing the dwell time has little effect on coat weight, but is advantageous in the control of the blading operation. The pond runs exceptionally quiet, there being substantially no throw from the pond or web itself. The procedure, however, contributes to considerable movement of coating within the pond itself, thus providing optimum circulation of the composition.

The coated web upon leaving the primary leveling element passes to the usual driers of the paper machine or coating apparatus; customarily, the second side of the web is then coated in a similar manner for the production of fine quality printing papers.

The coating applicator trough may have associated with it customary mechanical linkages and power devices for effecting trough movement to various positions relative to the roll; also, the trough may itself support the metering element from within the trough.

Coating operation with the apparatus and method described is facilitated by the single draw point in knife blade operations; such operations are preferred as the quality of paper is superior. The excess coating in such operation is acted upon by gravity, thus assisting maintaining the primary leveling or blading element free of an excessive quantity of coating. Further, the apparatus and method simplify the handling of the coating since end dams are not required at the blade.

It will be understood that this invention is susceptible to modification in order to adapt to different usages and conditions and, accordingly, it is desired to comprehend such modifications within the invention as may fall within the scope of the appended claims.

What is claimed is:

1. Apparatus for coating a traveling web of paper or the like comprising a resiliently covered backing roll mounted for rotation, a coating applicator trough having an open side fronting on said backing roll and being wholly spaced from said backing roll, said trough having a lower forward edge extending generally parallel with the longitudinal axis of the backing roll and forming a web entrance gap to said trough, said trough having a web exit side above said web entrance gap, and a flexible doctor blade also extending longitudinally of the backing roll in contact with the backing roll and spaced from the upper web exit side of the trough well above the said exit side for doctoring coating material on a web passing around said roll.

2. Apparatus for coating a traveling web of paper or the like comprising a resiliently covered backing roll mounted for rotation, a coating applicator trough having an open side fronting on said backing roll, said trough having a lower forward edge spaced from said backing roll extending longitudinally with the backing roll and forming therewith a web entrance gap to said trough, said trough having a web exit side above said web entrance gap, doctor means spaced from the upper and web exit side of said applicator trough well above the trough in the travel of said web for doctoring coating material on a web passing around said roll, and coating composition metering means disposed adjacent the web exit side of said trough for limiting the quantity of coating composition material passed to said doctor means from said trough, said coating composition metering means being spaced from said backing roll to define a passage for a traveling web and coating material thereon.

3. Apparatus as claimed in claim 2 and in which the said coating composition metering means is a flexible blade spaced from the backing roll.

4. Apparatus as claimed in claim 2 and in which the said coating composition metering means is a roller of materially smaller diameter than the backing roll, said roller projecting inwardly and outwardly of said trough and wholly spaced from said backing roll.

5. A method of coating a web of paper or the like which comprises the steps of supporting a said web on a resiliently covered rotating backing roll, passing said web on said backing roll upwardly through a narrow constricted gap which forms a boundary of a pond of aqueous mineral coating composition and whereby said composition is inhibited from flowing through said constricted gap, and upon removal of said web from said pond and while said web is supported on said backing roll doctoring off excess coating composition from said web by a blade in pressure engagement with the backing roll and spaced well above the pond of coating composition.

6. A process of making coated paper which comprises applying to a web of paper from a pond of a fluid coating

composition an excess of the composition, said composition comprising a liquid vehicle containing in aqueous suspension a pigment and an adhesive, applying such composition by moving said web upwardly on a rotating resiliently covered backing roll which forms a boundary of the pond, moving said web upwardly into the pond through a constricted gap which is closed by said composition and said web, subsequently after the web has passed from the surface of the pond but while the said composition is still fluid and the web is on the backing roll, blading excess coating composition from the said moving web by a flexible blade in pressure engagement with the backing roll and web and spaced well above the pond of coating composition, and limiting the excess of coating composition carried to the flexible blade by a roll which is positioned in the surface of the pond of composition and which roll is rotated in an angular direction which is opposite to that of the backing roll.

References Cited by the Examiner

UNITED STATES PATENTS

1,983,982	12/34	Knollenberg	118—414 X
1,993,055	3/35	Gerstenberg	118—261
2,038,607	4/36	Sauer	118—413 X
2,257,373	9/41	Fanselow	118—413 X
2,328,183	8/43	Barrett	118—413
2,796,846	6/57	Trist	118—413 X
2,946,307	7/60	Warner	118—414 X
3,079,889	3/63	Jacobs et al.	118—413 X
3,097,107	7/63	Martinek	118—123 X

FOREIGN PATENTS

637,354	10/36	Germany.

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