This invention relates to an improved method of and apparatus for applying a filler of opaquing pigment or the like to the partially formed web of paper as it travels along on the wire of a Fourdrinier type of paper making machine, and more particularly to a method and apparatus wherein the conventional dandy roll of the Fourdrinier is utilized in applying the filler to the web.

In paper used for printing or writing, it is desirable that the impression on one side of the sheet be prevented from showing through on the opposite side. In light and medium weight papers the fibrous structure is not sufficiently opaque to accomplish this, and opaque pigments such as titanium dioxide are often mixed with the pulp in the beaters before the stock mixture is run onto the paper machine. When this is done, from twenty to fifty per cent of the pigment may be lost in the white water leaving the machine. With pigment costing from ten to twenty cents per pound, this loss is costly, especially when the paper made may have a market value as low as four cents per pound.

In addition to increasing opacity, pigments and fillers add to the brightness of the sheet, and the closer the particles are to the surface the greater their effect is.

In order to avoid the loss mentioned and to retain in the paper web substantially all of the pigment, many devices have been proposed to add the pigment to the partially formed web as it is carried on the wire of the Fourdrinier section of the paper making machine. Some of these proposals involved the application of a liquid suspension of the pigment by spray or flow to the dandy roll, others directly upon the wet web adjacent the dandy roll. These devices, however, have not proved successful because the distribution of the pigment was not sufficiently uniform and resulted in the finished sheet having a streaky or mottled appearance.

The more opaque the pigment, the more apparent is any lack in uniformity of distribution, with the result that there is no satisfactory paper on the market today produced in accordance with these prior proposals, even though the attempts to do so have been innumerable.

One object of the present invention is to provide an economical, effective and convenient method of and apparatus for opacifying a sheet of paper by applying an aqueous suspension of pigment to the web at the dandy roll of the Fourdrinier part of the paper making machine in avoidance of the objections and difficulties heretofore encountered.

Another object resides in the provision of a spillway or chute adjacent and coextensive with the dandy roll for conveying an aqueous suspension of pigment to the roll, together with means associated with the spillway for regulating and equalizing the flow so that the suspension is supplied to the roll in a uniformly distributed sheet.

A further object is to supply an aqueous suspension of pigment in the form of a uniformly distributed sheet to the dandy roll in a direction opposed to the direction of its rotation, and to so control and regulate the flow thereof that a substantially stationary rod-like pool is formed on the surface of the dandy from which the interstices in the surface thereof are continuously supplied with a complete and even filling of said suspension as the dandy rotates in contact with said pool.

Other objects and advantages reside in certain novel features of construction, arrangement and combination of parts which will be hereinafter more fully described and particularly pointed out in the appended claims, reference being had to the accompanying drawings forming a part of the specification, and in which:

Figure 1 is a diagrammatic side elevation of the conventional Fourdrinier paper making machine at the couch roll end of the wire showing the method of and one form of apparatus embodying the invention;

Figure 2 is an enlarged diagrammatic side elevation showing the detail of the pool formed on the surface of the dandy roll at the delivery end of the spillway;

Figure 3 is a fragmentary front elevation of the header box and spillway shown in Figure 1;

Figure 4 is a section taken on the line 4-4 of Figure 3; and

Figure 5 is a top plan view, partly broken away, of the header box and spillway.

According to the present invention, a liquid suspension of pigment or filler containing sufficient adhesive such as boiled starch is distributed from a spillway or chute in the form of a smooth uniform sheet over the entire length of the conventional dandy roll so that the interstices or meshes in the surface thereof are completely filled as they pass under the spillway. As the dandy rotates, the filled area passes downward and the suspension comes in contact with the wet web, the fine capillaries of the web in contact with the large capillaries of the wire
mesh on the dandy roll cause the passage of the water suspension of pigment therefrom and the deposit on the surface of the paper through the filtering action of the paper web. In order to render the paper web sufficiently receptive for the extra volume of water added in this way, an additional suction box is used in the area just before the web reaches the dandy roll so that, if one or two were used before, two are now used; and if two were used before, three are now used, when applying the water suspension of pigment. Usually the number of suction boxes following the dandy roll remains the same as herefore.

It is preferred, though not essential, that the spillway or chute deliver the pigment containing fluid in a direction opposed to the direction in which the surface of the dandy roll is moving at the point of contact. In this manner there is a sharp cut-off and the line of demarcation between the empty mesh of the approaching wire surface of the dandy roll and the completely and uniformly filled mesh is a straight line and not wave-like in configuration. When the spillway delivers the water in the same direction the line of formed wafering, with the result that the application is impaired.

Referring to the drawings and more particularly Figure 1 thereof, which is a diagrammatic side elevation of the conventional Fourdriner paper making machine at one edge of the wire, 1 designates the suction couch roll, 2 the suction boxes, 3 the Fourdriner wire, 4 some of the guide and supporting rolls for the wire, and 5 the conventional wire mesh dandy roll.

The water suspension of the pigment is supplied by header 10 through depending discharge branches 10a provided with valves or cocks 10b into a trough or header box 11 mounted forwardly of and slightly above the dandy roll 5.

The header box extends transversely of the machine and is coextensive with and is so placed as to cover the area of the dandy roll. It is provided with an inclined bottom wall which, as shown, is continued forwardly of the header box providing a rigid smooth inclined plane or spillway 12 terminating closely adjacent the surface of the dandy roll, but out of contact thereof with flexible gates 13 disposed in the forward wall of the header box and may be adjusted in its own plane and in and from the spillway 12 by means of screws 14 and hand nuts 14a and may be further adjusted at spaced intervals throughout its length transversely of said plane by means of manually operable screws 15. By means of these screws 15 the sludge may be distorted or warped under the influence of forces of compression or tension imparted through proper adjustment of the screws 15.

Thus, the space or header box outlet between the sludge 13 and the solidly built spillway or inclined plane 12 may be accurately controlled by adjustment of the sludge in its own plane and transversely thereto so that only the desired amount of fluid passes under the sludge down over the spillway in uniformly distributed flow.

It is difficult to maintain a uniform flow down an inclined surface for any great distance, however, because of variations in the wetability of the surface, minute irregularities of surface, etc. It is therefore proposed to provide means for equilibrating any suction branches, such means being shown in the drawings in the form of barriers which may be perforated plates, woven wirescreens, or even rows of projections like the teeth of a comb, which act as a multitude of weirs in backing up the flow until the head back of each barrier is sufficient to cause a flow through the width required for the uniformity of the width of the spillway. Usually one barrier or weir is not sufficient and occasionally two will not entirely equalize the flow across the entire length of the spillway or the width of the paper machine.

With three barriers such as at 16 equally spaced and connected as shown, the flow is equilized for any range of conditions encountered in practice.

The space immediately preceding each barrier constitutes a continuous flow box common to all of the weir openings in the barrier so that all have the same head of fluid and consequently each delivers the same volume per unit time across the entire length of the spillway or the width of the paper machine.

In practice, close adjustment of the sludge and appropriate positioning and spacing of the weirs, a smooth, equalized, uniformly distributed flow in the form of a sheet is obtained at the delivery end of the spillway, and when the volume and rate of flow of said sheet are properly correlated with the surface speed of the dandy roll, a uniform surface of contact of such sheet with the surface of the dandy roll is obtained, and is complete and uniformly filled with the pigment suspension which is held in the mesh by the capillary action of the interstices, and as the dandy roll rotates this filled area passes downward, and as the suspension comes in contact with the wet web the fine capillaries of the web in contact with the large capillaries of the wire mesh cause the transfer of the pigment suspension therefrom onto the web.

In usual practice a steam or air shower 18 is inserted in the dandy roll to keep the mesh from filling up with fiber debris, filler, scum, etc., and to prevent pick-up of the web. This shower is useful and should be retained when adding a pigment suspension since it aids in the uniformity of the grade of the suspension in accordance with the present invention in that the differential capillary attraction of the fine capillaries in the web over that of the larger capillaries of the wire surface of the dandy roll is rendered even greater. It is always observed, however, that the dandy roll runs cleaner when distributing pigment suspension than it does when not, and while adding pigment it is never necessary to clean the dandy in the midst of making a run of paper whether it is of several hours or several days duration.

In order to obtain a strong sheet of paper of desired opacity under present practices, a relatively costly pigment must be used. While opacity may be obtained by the use of such materials as clay and talc, common paper fillers, it is necessary, in order to attain a high degree, to use such materials in relatively large amounts, and this impairs or destroys the strength of the paper. Thus in all cases where strength is an essential requirement in the finished paper, it is necessary to select a pigment which is not only effective in producing opacity, but which may be used in relatively small quantities. For such purposes only one of the more costly pigments having a high refractive index may be successfully used, for example titanium dioxide or zinc sulfide or...
blends thereof in varying proportions with the sulfates of barium or calcium.

The present invention is being used in actual practice and has proved highly successful in obtaining maximum distribution and surface effect from a minimum amount of opacifying material, resulting in great economy and close control of the very important factors of weight, strength and appearance in the finished paper. For example, in practice it has been found to be feasible when using titanium dioxide as a filler, which, as is well known, is markedly effective as an opacifying pigment, to accomplish the desired opacity and produce a satisfactory paper with as little as one and one-half per cent by weight of titanium dioxide or thirty pounds of titanium dioxide to the ton of two thousand pounds of finished paper.

Thus, in the case of paper weighing twenty pounds to the ream—500 sheets 24" x 36"—a ton would contain one hundred reams, or three hundred thousand square feet, over which the thirty pounds of titanium dioxide would be uniformly distributed. Expressions in this respect for purposes of emphasis, this would be thirty pounds of titanium dioxide distributed over approximately seven acres of paper. It will thus be seen that the invention is especially valuable in the application of relatively costly pigments as an opacifying pigment by reason of the great economy which results. The suspension should preferably be of a ratio of between approximately two and ten parts of solids to a total of one hundred parts solids and water. Special applications may, however, greatly vary this range.

The following is given as an example of the fluid balance before and after the dandy when a very substantial amount of coating is added:

**Conditions**

100 inch trim. ream weight 24 x 36—500 = 28 pounds.

Machine speed—600 ft. per min.

Production—41.67 pounds/min.

Solids in coating added—5 pounds/ream; 20% of weight finished paper; 8.33 pounds/min.

Water in sheet approaching dandy—633 pounds/min.

Water added at dandy—417 pounds/min.

Total solids in sheet leaving dandy—3.8%.

Decrease in solids content before and after dandy—1.2%.

It is readily apparent that in the neighborhood of the dandy the amount of water added even in this extreme example with a solids suspension of only two per cent is not excessive and well within the capacity of one or two extra suction boxes.

While the application of pigment to a web of paper is mentioned as the principal use of the invention, it is obvious that it may be used for the addition of other substances suspended in water or other liquids, solutions, and even mixtures of liquids or pure substances in fluid form. The opacity, color, luminescence, radio activity, ink absorption, impermeability and many other properties of paper may be controlled.

It will be understood that while the invention has been shown and described in combination with the dandy roll of a Fourdrinier type of paper making machine, it will be obvious to those skilled in the art that it is not so limited. In its broader aspects the invention may be used with equal facility and advantage in combination with a similar wire mesh roll entirely separate and apart from the dandy. Thus such a roll might be mounted in advance of or following the dandy in

the Fourdrinier section of the machine or in the press roll section thereof beyond the Fourdrinier and the filler or coating supplied thereto and deposited on the web of paper in the same manner as herein described without in any wise departing from the principle or teachings of the invention.

I claim:

1. In combination, a roll having an intersticed surface rotating in engagement with a web of paper, a liquid suspension header box, and a spillway associated therewith and so arranged relatively to said roll as to deliver said suspension gravitationally onto the surface of the latter in a direction opposed to the direction of rotation thereof and along a line substantially parallel to the axis of rotation of the roll on the down side thereof at a point between the upper crest of the roll and a horizontal plane passing through said axis, said spillway at its delivery end terminating in close proximity to but out of contact with the surface of said roll.

2. In combination, a roll having an intersticed surface rotating in engagement with a web of paper, a liquid suspension header box, a spillway associated therewith and so arranged relatively to said roll as to deliver said suspension gravitationally onto the surface of the latter in a direction opposed to the direction of rotation thereof and along a line substantially parallel to the axis of rotation of the roll on the down side thereof at a point between the upper crest of the roll and a horizontal plane passing through said axis, said spillway at its delivery end terminating in close proximity to but out of contact with the surface of said roll, and means for imparting a uniformly distributed sheet-like character to said suspension as it flows from said box.

3. In combination, a roll having an intersticed surface rotating in engagement with a web of paper, a liquid suspension header box, a spillway associated therewith and so arranged relatively to said roll as to deliver said suspension gravitationally onto the surface of the latter in a direction opposed to the direction of rotation thereof and along a line substantially parallel to the axis of rotation of the roll on the down side thereof at a point between the upper crest of the roll and a horizontal plane passing through said axis, said spillway at its delivery end terminating in close proximity to but out of contact with the surface of said roll, means for imparting a uniformly distributed sheet-like character to said suspension as it flows from said box, and means in said spillway beyond said box for equalizing any irregularities arising in the flow of said suspension over said spillway in its travel to said roll.

4. The method of incorporating an insoluble filler material in a web of paper during its formation in a Fourdrinier paper making machine which consists in forming on the surface of a rotating wire mesh dandy roll longitudinally thereof and substantially parallel to the axis of rotation thereof, an elongated rod-like pool of a liquid suspension of said filler material at a point on the roll surface where the forces due to the rotation of the roll and due to gravity react upon said pool to maintain it freely riding on the surface of said wall at a substantially fixed point in the path of travel of the roll surface, and continuously supplying to said pool uniformly throughout the length thereof a quantity of said suspension sufficient to replenish that
adhering to the roll surface after passing through said pool.

5. The method of incorporating an insoluble filler material in a web of paper during its formation in a Fourdrinier paper making machine which consists in forming on the surface of a rotating wire mesh dandy roll longitudinally thereof and substantially parallel to the axis of rotation thereof an elongated rod-like pool of a liquid suspension of said filler material at a point on the roll surface where the forces due to the rotation of the roll and due to gravity react upon said pool to maintain it freely riding on the surface of said roll at a substantially fixed point in the path of travel of the roll surface, and continuously supplying to said pool substantially uniformly throughout the length thereof a quantity of said suspension sufficient to maintain substantially constant the volumetric contents of said pool and to replenish the liquid suspension removed from the pool by adherence to the roll surface passing through said pool.

8. The method of uniformly filling the surface interstices of a revolving wire mesh roll with a liquid suspension of solids for transfer to a web of paper, which consists in directing a continuous uniform sheet-like flow of said suspension upon the surface of said roll along a line extending longitudinally thereof generally parallel to the axis of rotation of the roll and on the down side of the roll between the upper crest thereof, and a horizontal plane passing through said axis and correlating the rate of flow of said suspension with respect to the surface speed of the roll to produce a pool of said suspension floating freely on the surface of said roll at a substantially fixed point in the path of movement thereof and from which pool said interstices are filled.

GERALD D. MUGGLETON.

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