

Nov. 7, 1933.

D. B. BRADNER

1,933,963

PROCESS FOR COATING PAPER

Filed Dec. 18, 1931

3 Sheets-Sheet 1

Fig. 1.

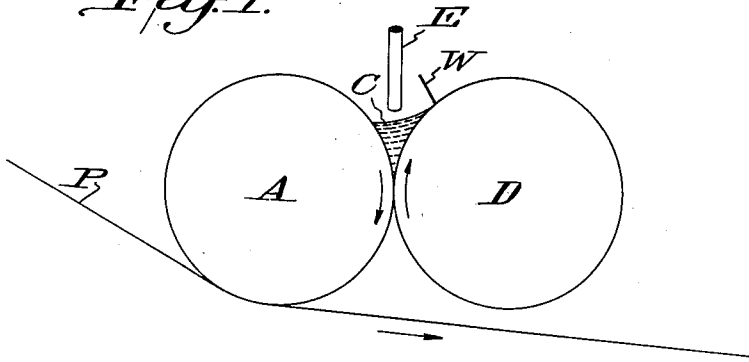


Fig. 2.

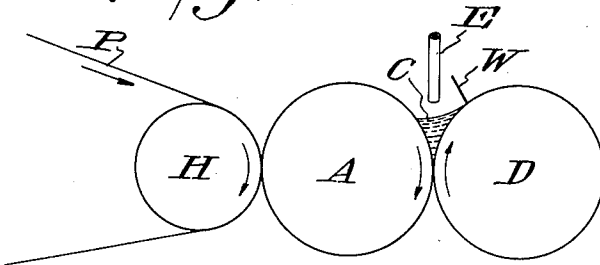


Fig. 4.

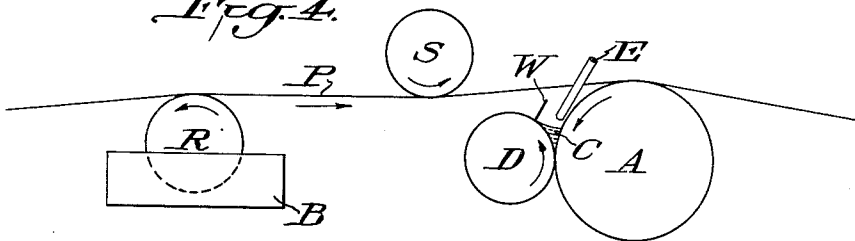
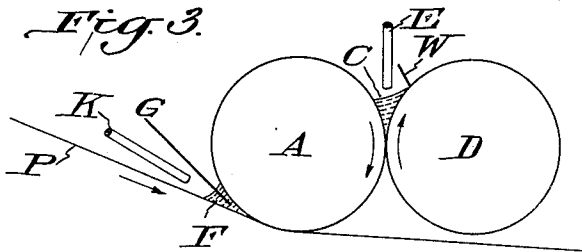


Fig. 3.



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3 Sheets-Sheet 2

Fig. 5.

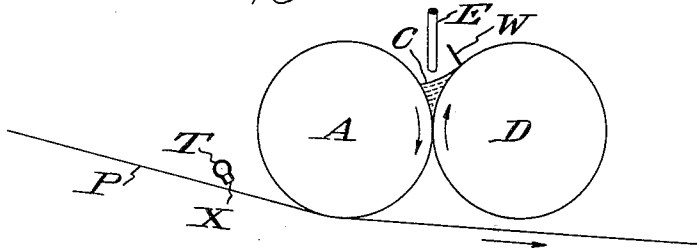


Fig. 6.

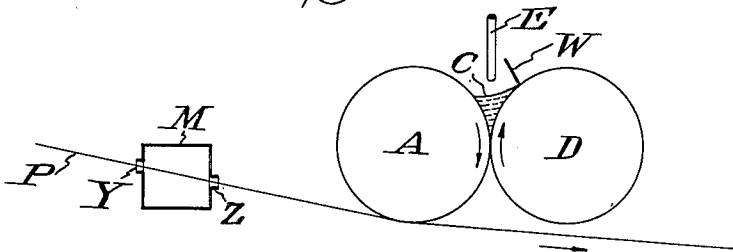
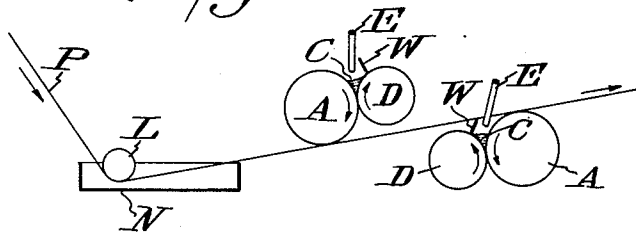


Fig. 7.



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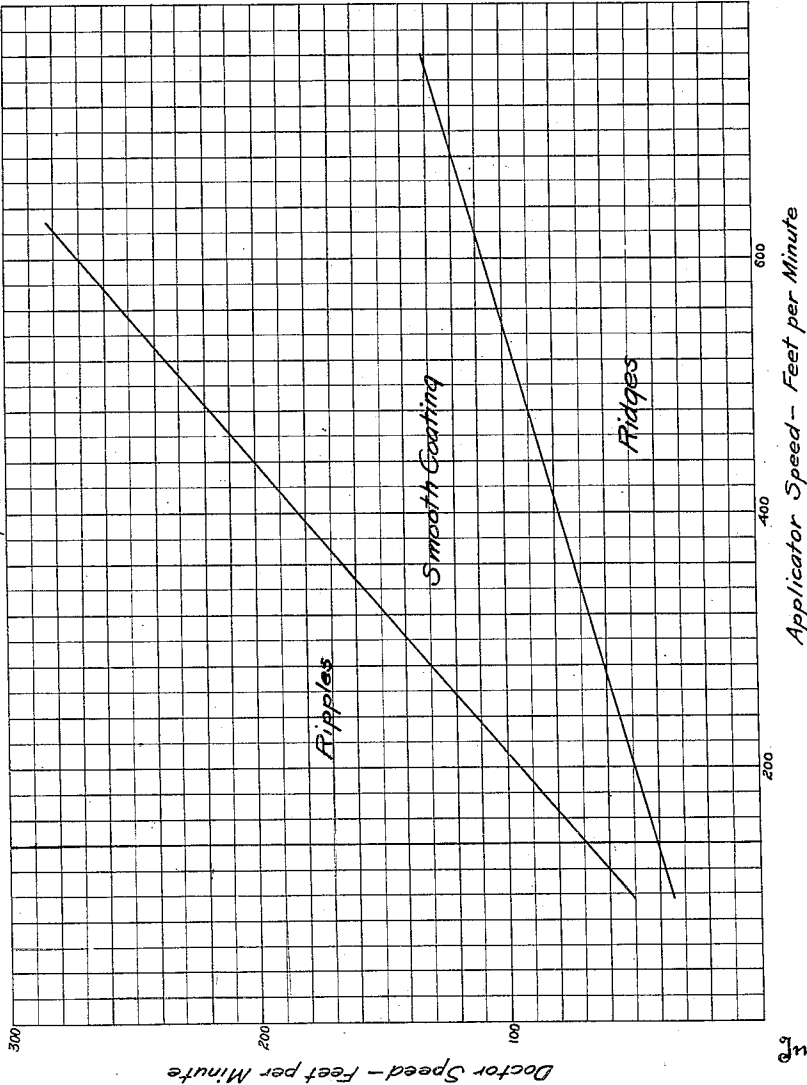
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3 Sheets-Sheet 3

Fig. 8.



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UNITED STATES PATENT OFFICE

1,933,963

PROCESS FOR COATING PAPER

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Champion Coated Paper Company, Hamilton,
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Application December 18, 1931

Serial No. 581,955

7 Claims. (Cl. 91—68)

This invention relates to a process of making mineral coated paper, and apparatus for carrying out the process.

By mineral coated paper I mean paper, including postcard, cardboard and the like, coated with an aqueous coating composition which on the dry basis comprises at least two-thirds by weight of mineral pigment (for example, clay, satin white, blanc fixe and the like) and not more than one-third by weight of adhesive (for example, casein, starch, glue and the like). Such paper is commonly used for high grade printing purposes.

It has been proposed to coat paper by applying an excess of coating to the smooth moving surface of an applicator member (for example, a rotating roll), then wiping a portion of the coating off of the applicator member by means of a doctor member (which may also be a roll the surface of which travels in the direction opposite to that of the surface of the applicator member), and transferring the residual layer of coating on the applicator member therefrom to the paper by contacting the paper with the applicator member while moving the contacting surfaces thereof in the opposite directions. With coating compositions of the varnish type, such as lacquers, asphaltic compositions, viscose and the like, no particular difficulty in securing uniform coating is involved. This is because any inequalities in thickness of the coating which may result from the doctor action, readily flow out either upon the applicator member or upon the paper itself.

In the use of aqueous mineral coating compositions, however, certain difficulties arise which are not encountered in the use of the varnish-like coating compositions. Aqueous mineral coating compositions which broadly comprise dispersions in water of mineral pigments and adhesives are characterized by an almost total lack of ability to "flow out". Ridges and other such surface irregularities are nearly as prominent on the finished coated paper (i. e. after drying but without calendering) as they are in the coating on the applicator member.

One object of the present invention is to provide a method of operation whereby smooth coatings may be formed of the aqueous mineral coating compositions.

Another object of the invention is to provide a method of making mineral coated paper whereby a superior mineral coated product is obtained.

In essence the invention resides in carrying out the method above referred to with proper control, to be described hereinafter, of the relative speeds of the surfaces of the applicator member and the

doctor member and, under certain circumstances, with prewetting of the paper web.

The invention will be described by reference to the accompanying drawings, in which:

Fig. 1 is a diagrammatic representation of one form of coater suitable for carrying out the process.

Fig. 2 is a diagrammatic representation of another form of apparatus suitable for carrying out the process in which the paper web is pressed against the applicator member by means of a press roll.

Figs. 3 and 4 diagrammatically represent apparatus for carrying out two modifications of the invention in which the paper is moistened previous to the deposition of coating thereon by the applicator member.

Figs. 5 and 6 illustrate apparatus for conditioning or pre-wetting the paper prior to the application of the coating composition by steaming.

Fig. 7 illustrates a coater designed to moisten and coat the paper on both sides, and

Fig. 8 is a graphic representation of conditions associated with the coating operation.

Referring to Fig. 1, P is the web of paper to be coated, travelling as indicated by the arrow and contacting with the applicator roll A. The applicator roll rotates in the direction indicated by the arrow, its surface moving in the direction opposite to that of the paper.

Aqueous coating composition C is supplied through the pipe E to the surface of the applicator roll in excess of that required for coating the paper. In the drawing it is shown forming a pool between the applicator roll A and the doctor roll D. Doctor roll D is adjustable to vary the distance between its surface and the surface of the applicator roll whereby to regulate the thickness of the layer of coating to be applied to the paper. It does not contact with the applicator roll. The doctor roll rotates in the same angular direction as the applicator roll, as indicated by the arrow, that is, the surface of the doctor roll and the surface of the applicator roll travel in opposite linear directions at the point of closest approach hereinafter referred to as the nip.

Each of the rolls A and D is smooth, round, straight, concentric with its journals, and fabricated from a material such, for example, as steel, which is not absorbent to aqueous mineral coating compositions. Each of the rolls A and D is provided with any known means for rotating it at any desired speed.

W is a wiper whose function is to remove substantially all of the coating from the surface of

the roll D prior to its approach to the applicator roll A. The wiper W may be of rubber, soft metal or other suitable material.

End plates (not shown) to restrain the coating composition from flowing over the ends of the rolls and help maintain the pool between the rolls A and D are desirable.

The layer of coating on the surface of the applicator roll after passing the nip between rolls A and D is transferred to the paper by a wiping action. It is not essential that all the coating on the applicator roll be transferred to the paper in order to obtain satisfactory results. I have obtained very close control of the weight of coating applied to the paper as well as equally smooth coatings even when an appreciable film of coating was allowed to remain on the applicator roll after its contact with the paper. After application of the coating to the paper it may be dried in any suitable manner known in the art, for example on festoons.

The character of the film of aqueous mineral coating composition on the applicator roll after passing through the nip between rolls A and D determines the nature of the coating film deposited on the paper. Thus if the film of coating is smooth and uniform on the applicator roll, the coating on the paper will also be smooth and uniform. If the film is streaky or ridged on the applicator roll, it will be streaky or ridged on the paper. Very little smoothing action occurs in the transfer of the coating from the applicator roll to the paper.

In order to obtain a satisfactory coating of aqueous mineral coating composition in the manner described, I have found that it is necessary to operate the coater under certain predetermined conditions. I have carefully investigated the various factors affecting the operation of the coater, and by controlling these factors in the manner hereinafter described, I have succeeded in quite uniformly making mineral coated paper which is superior to the best mineral coated paper which can be made by means of the so-called brush coater now in common use and the operation is free from many of the faults and difficulties inherent in existing coating methods.

In using the coater illustrated in Fig. 1, I have found that if the speeds of the applicator roll and the paper are maintained at certain values and the doctor roll D is rotated relatively very slowly in the same angular direction as the applicator roll A, the coating is distributed on the applicator roll and on the paper in the form of spaced relatively thick longitudinal ridges alternating with intermediate thinly coated areas. As the speed of the doctor roll D is increased, the speeds of the applicator roll and the paper remaining constant, these ridges gradually become less pronounced and closer together and finally disappear, giving a very uniform film of coating on the paper. If the speed of the doctor roll D is further increased, the film of coating takes on a peculiar streaky appearance and at still higher speeds the coating assumes a wavy or rippled appearance. These ripples may be heavy and broad, or small and numerous, or comet-shaped, depending upon the relative speeds of the doctor roll and the applicator roll, the nip opening, and the particular character of the aqueous mineral coating composition employed. Still further increase in the doctor roll speed causes the ripples to become smaller and closer together until eventually they are no longer separately distinguishable, but at this point the coating becomes frothy

and marred by pin holes. In other words, as the speed of the doctor roll relative to that of the applicator roll is increased, the coating on the paper is first ridged, then smooth, then rippled, and finally smooth but frothy. These effects may be accomplished by maintaining the applicator roll at a constant speed and increasing the doctor roll speed, or by maintaining the doctor roll at a constant speed and decreasing the applicator roll speed, the paper speed remaining proportional to that of the applicator roll.

The transition from one condition of coating to another is usually a very gradual one. For example, starting with a heavily ridged coating and increasing the doctor roll speed, the ridges become progressively thinner and fainter, gradually fading out until they are no longer discernible to even an experienced observer. Notwithstanding this difficulty in determining the exact transition points, the results obtained on repeated experiments have been found to be quite accurately reproducible, indicating that accurate control over the various factors involved is possible.

At higher applicator roll speeds the transition from ridges to smooth coating occurs at a higher relative doctor roll speed than for lower applicator roll speeds. But the transition from smooth to rippled coatings also occurs at a relatively much higher doctor roll speed so that the zone of smooth coatings is wider at high applicator roll speeds than at low applicator roll speeds. This occurrence of ridged, smooth and rippled coatings is shown graphically in Fig. 8. On this graph abscissa represent applicator roll surface speeds and ordinates are doctor roll surface speeds in feet per minute for a coating operation using a mineral coating composition of casein, clay, and water, said coating composition containing about 44% solids and having a viscosity of about 26 seconds (Stormer) and a specific gravity of 1.34. Of the solids content of said coating about 87% is clay and 13% casein. It will be observed that the zone of smooth coating is roughly wedge-shaped, broadening out at higher applicator roll speeds. It will be observed from the said graph that in operating in accordance with the process of the present invention, using the illustrative conditions set out above, smooth coatings are obtained by controlling the speed of the doctor roll with relation to the speed of the applicator roll, as follows:

Applicator roll speed	Doctor roll speed range
Feet per minute	Feet per minute
200	50-95
400	78-182
600	108-270

The transition from rippled coating into the smooth frothy coating has not been plotted on the graph. At 120 feet per minute applicator roll surface speed ripples disappeared between 900 and 1400 feet per minute doctor roll surface speed.

It will be understood that the numerical values of the doctor roll-applicator roll speed ratios depends to some extent on the physical and chemical nature of the particular aqueous mineral coating composition used. Nevertheless it may be stated as a generality (based upon the results of many hundreds of tests using a wide variety of mineral coating composition and a wide variety of paper stocks) that ridges occur below a critical doctor roll-applicator roll speed ratio and

ripples occur above another critical doctor roll-applicator roll speed ratio and between these two values the layer of coating is extremely smooth and uniform. In general it may be stated that 5 ridges occur when the doctor surface speed is less than one-seventh the applicator surface speed and ripples are produced when the doctor surface speed about equals that of the applicator surface speed. Between these extreme limits 10 there may readily be found by simple tests for any particular set of conditions (including kind of coating composition employed and width of nip between applicator member and doctor member) a somewhat narrower range of doctor surface speeds for any particular speed of applicator member at or in which smooth coatings occur.

In order to obtain the proper transfer of the coating from the applicator roll to the paper the paper speed should be less than the applicator roll surface speed, preferably amounting to from about one-half to about two-thirds of the applicator roll surface speed.

In Fig. 2 I have shown a somewhat different method of contacting the paper with the applicator roll. Instead of relying upon the tension of the paper web to obtain the necessary contact and transfer of coating from the applicator roll to the paper, a press roll H is used to bear the paper in contact with the applicator roll. The 30 press roll H should have a resilient surface (e. g., rubber) and rotate in the same angular direction as the applicator roll. Aside from roll H the apparatus illustrated in Fig. 2 is identical with that illustrated in Fig. 1.

Although the apparatus illustrated in Figs. 1 and 2 may be used with certain papers and coating compositions to give satisfactory one-side mineral coated paper, it is advisable in most instances to treat or "condition" or pre-wet the 40 paper preliminary to its contact with the applicator roll. Otherwise the paper may not become completely coated, small "skips" occurring on the sheet. In coating both sides of the paper in rapid succession (double coating), this skipping on the 45 second side of the paper may become so serious that conditioning becomes essential. This skipping is apparently caused by air being entrapped in "valleys" or low areas in the paper surface. Presumably in applying coating composition to 50 only one side of the paper, the air entrapped in these valleys may escape through the sheet, but in double coating the air cannot readily penetrate the film of wet coating on the other side, and thus has no ready escape in this direction. 55 The result ordinarily is an incompletely covered sheet or a coating containing skips.

In Fig. 3 one form of apparatus for conditioning the top side of the sheet is illustrated. In this apparatus coating composition supplied 60 through pipe K is contacted directly with the paper at F behind the guard G which allows the paper to become wetted across its entire width prior to its contact with the applicator roll. This guard may be a metal plate and is advantageously 65 provided with independent adjustments by which it can be moved to and from the applicator roll and also to and from the paper. The apparatus of this figure is otherwise like that of Fig. 1.

This form of apparatus functions as follows: 70 Coating composition is supplied at F through the pipe K and passes under the lower edge of the guard plate G. As it does so, it wets the paper and displaces any air which might become entrapped in the hollows, valleys or depressions in 75 the sheet. Applicator roll A contacts with the

paper and picks up all of the coating composition from the sheet, except a very thin film, and carries it around to the nip between roll A and the doctor roll D. Under normal operation the thin wetting film of coating left on the paper by the 80 described operation may amount to about 1 or 2 pounds. (In all figures of weights of paper or coating mentioned in this specification, values refer to the weight of a ream of 500 sheets of paper 25 x 38 inches). The doctor roll D per- 85 mits only a predetermined amount of coating composition to pass through the opening or nip between it and the applicator roll A. Any excess is carried around on the doctor roll D and removed by the wiper W and returned to the main 90 coating supply. The smooth layer of coating composition formed on the applicator roll A by the action of doctor roll D is transferred to the paper by the wiping contact described in connection with Fig. 1. It is not necessary that all of the 95 coating composition be supplied at F; if desired, some of the coating composition may be supplied at F and some may be supplied at C by a pipe E as in Fig. 1. It will be noted that this form of apparatus differs from that shown in Fig. 1, 100 in that provision is made to wet the paper before it comes in contact with the applicator roll. The applicator roll serves the double purpose of removing the coating composition applied to the paper to wet it and of then applying the desired 105 smooth coating to the wetted paper.

Fig. 4 illustrates a form of apparatus for wetting the lower side of the web of paper. In this case the wetting roll R rotates, preferably so that its surface at the point of contact with the 110 paper travels in the direction opposite to that of the paper and dips into coating composition in the container B thereby wetting the lower side of the paper. If desired, all of the coating composition may be supplied by the roll R, or coating 115 may also be supplied through the pipe E. Instead of wetting the paper with coating composition, water alone may be used as the wetting agent. Or in certain cases it may be advisable to wet the sheet with an adhesive solution, such 120 as, for example, a solution of casein or starch. Or solutions of dyestuffs can be used for this preliminary wetting. In case it is desirable to prevent the preliminary wetting agent from diluting or contaminating the coating composition, 125 any convenient means, such as a pair of squeeze rolls (not shown), may be employed to remove the excess of wetting agent.

In the apparatus illustrated in this figure it will be noted that although the relative positions 130 of rolls A and D are reversed compared to their positions in Figs. 1, 2 and 3, and the paper passes over instead of under roll A, their action in forming a smooth coating on roll A and transferring it to the paper is essentially the same. The pipe 135 E must, of course, deliver coating composition to the nip between rolls A and D from the side so as not to be in the path of the paper web P. S is a guide roll for tensioning the web of paper and thereby regulating its contact with the applicator 140 roll A.

Another method of accomplishing the conditioning of the paper is to subject the paper to the action of steam prior to its contact with the applicator roll. The steam presumably helps in 145 two ways: (1) the heat causes some of the air to be driven out of the paper by expansion; and (2) condensation of the steam replaces some of the air with water.

The treatment of the paper with steam may 150

be accomplished by simply applying a jet or jets of steam to the surface of the paper to be coated or by passing the paper through a steam box or chamber just before it contacts with the applicator roll. This steam treatment obviously may serve to condition one or both sides of the paper either simultaneously or successively. Apparatus for steam conditioning the paper by means of a steam jet and by means of a steam chest is illustrated in Figs. 5 and 6, respectively. In Fig. 5 the apparatus is identical with that illustrated in Fig. 1, excepting that the steam pipe T provided with a longitudinal slit X is positioned to impinge a stream of steam against the web of paper just prior to its contact with the applicator roll A.

In Fig. 6, M represents a steam chest provided with slits Y, Z, through which the paper web passes on its way to contact with applicator roll A.

Fig. 7 as stated above illustrates apparatus for conditioning and coating both sides of a web of paper. As will be apparent the apparatus comprises two coaters like those illustrated in Figs. 1 and 3 for applying coating to the upper and lower sides of the sheet, respectively, with a tank N containing a suitable wetting liquid and a guide roll L for guiding the web through the liquid. Squeeze rolls (not shown) may serve to remove excess of wetting liquid from the web before it leaves the tank N.

In all these various conditioning methods the essential point is believed to be the removal of air from depressions or pores in the paper.

In the claims the terms "wetting" or "wetted" are intended to include all such methods of wetting as are mentioned above.

In the drawings the applicator member and the doctor member have been illustrated as rolls.

In place of rolls either the applicator member or the doctor member may be in the form of a belt, which may be of metal.

The invention will, therefore, be seen to comprise a method of making mineral coated paper by applying an aqueous mineral coating composition in excess to a moving applicator member, wiping off a portion of the coating by means of a doctor member whose surface approaches close to, but does not touch, the applicator member and travels in the opposite linear direction to the surface thereof at the point of closest approach and at such a regulated speed as to produce a smooth coating on the applicator member, and finally transferring the smooth layer of coating from the applicator member to a web of paper contacting with and travelling in the opposite direction to the applicator member surface. The paper may be preliminarily conditioned or prewetted to allow complete coverage by the coating.

This application contains subject matter in common with my prior applications Serial No. 259,262, filed March 5, 1928, and Serial No. 290,093, filed July 3, 1928.

I claim:

1. Process of making mineral coated paper which comprises applying aqueous mineral coating composition to a moving surface, removing a portion of said coating composition by means of a

second surface moving in the opposite direction, transferring substantially all the remaining layer of coating to a web of paper moving in the opposite direction to the said first moving surface and in contact therewith, continuously cleaning the second said moving surface and predetermining the character of said coating on the paper by regulating the relative linear speeds of said surfaces.

2. Process of making mineral coated paper which comprises applying aqueous mineral coating composition to a moving surface, removing a portion of said coating by means of a second surface moving in the opposite direction thereto at a speed which will leave the coating remaining on said first surface without apparent ridges or ripples, continuously cleaning said second surface and contacting said first surface with a moving web of paper moving in the opposite direction thereto.

3. Process of making mineral coated paper which comprises applying an excess of aqueous mineral coating composition to a moving surface on which a predetermined layer of said composition is to be formed, removing all except the desired weight of said coating composition by means of a doctor member whose surface is at a predetermined distance from the aforesaid moving surface, which doctor member surface moves in a direction opposite to that of the aforesaid moving surface and at a predetermined speed which with respect to the speed of the aforesaid moving surface has a ratio greater than one-seventh and not greater than one, transferring the resulting layer of said composition onto the surface of a moving web of paper by contacting said moving surface with said web of paper moving in the opposite direction thereto, and continuously cleaning the surface of said doctor member.

4. Process of making mineral coated paper which comprises applying aqueous mineral coating composition to a moving surface, removing a portion of said coating by means of a second surface moving in the opposite direction thereto at a linear speed which is more than one-seventh and less than equal to the linear speed of the first said surface, continuously cleaning said second surface, and contacting said first surface with a web of paper moving in the opposite direction thereto.

5. Process as defined in claim 4 in which the ratio of the speed of the paper to the speed of the first named surface is maintained at from about one-half to about two-thirds.

6. Process as defined in claim 4 in which the web of paper is prewetted.

7. Process of making mineral coated paper which comprises applying aqueous mineral coating composition to a moving surface, removing a portion of said coating by means of a second surface moving in the opposite direction thereto, continuously cleaning said second surface and contacting said first surface with a web of prewetted paper moving in the opposite direction thereto.

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