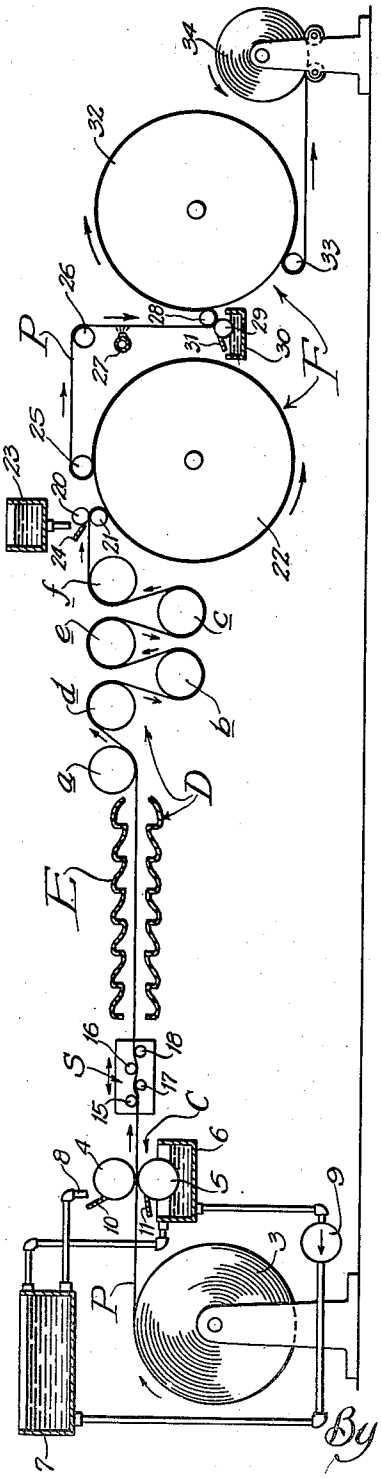
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ART OF COATING PAPER

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ART OF COATING PAPER

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My present invention relates to the application to both sides of a web or sheet of a coating which is thereupon given a finishing treatment, all in one operation. The process herein disclosed is an adaptation and extension of the coating and finishing treatment set forth in my application filed May 1, 1940, under Serial No. 332,675. While the steps and conditions which are special to the present invention will be fully explained hereinafter, there will be no need for a detailed description as to phases of the process which are common to those which have been dealt with at length in my previous application just referred to.

As a primary objective, I am to apply economically and with speed, by the method now to be explained, upon opposite sides of a paper sheet or web, coatings each having a finished surface which will adapt the paper for various purposes, to receive printing being one of them. The coatings on both sides of the paper are uniform, although not necessarily of the same weight. As the result of the treatments to which they are subjected, the coatings are rendered substantially blemish-free. Such a coating on both sides is produced and finished in one operation while the paper in the form of a web is traveling at high speed. The attainment of these objects and advantages is possible by performance of the steps and maintenance of the conditions hereinafter described with the aid of apparatus such as is diagrammatically illustrated in the accompanying drawing to which reference will now be made.

In commercial practice, a web of raw paper stock P, previously wound into a roll 3, is unwound therefrom to be acted upon in succession by various agencies which may include companion upper and lower rolls 4 and 5, respectively, comprised in a double coating unit C. The lower roll dips into a pan 6 containing a plastic coating mixture, whereas a like coating, contained in an upper pan 7, may be flowed from a nozzle 8 onto the upper roll. A circulation system, including a pump 9, connects the two pans so as to maintain uniformity in the plastic mixtures contained therein. Doctors 10 and 11, one associated with each roll, serve to regulate the amount of coating that is transferred upon their peripheries for deposit upon and adherence to opposite sides of the web. The two rolls between which the web is passed and which are accurately and adjustably located in relation to the paper, may be rotated at a peripheral speed which corresponds to, or is more, or less than, the lineal advance of the web. Preferably the rolls have an intaglio surface so as to deposit the coating in the form of small mounds upon opposite sides of the web, the coating so applied being in substantially the exact amount that is to be retained upon each side of the web whereby the removal of any excess of coating becomes unnecessary. Although the coating is uniformly applied, its weight is easily controllable and either side of the web may carry a relatively light or heavy coat, as desired.

The web which may thus be coated on opposite sides in one operation passes on to a smoothing unit S which is mounted close to the coating unit and desirably is shiftable toward and from the same so as to vary the distance therebetween. The smoothing unit comprises, by preference, a pair of spaced upper rolls 15 and 16 which are in staggered relation to a pair of spaced lower rolls 17 and 18. The spacing and adjustment of the upper rolls relative to the lower rolls is such that the web is required to execute a sinuous movement while passing through the smoothing unit, the coating on the upper side of the web receiving engagement from the upper rolls while the coating on the under side receives engagement from the lower rolls. These rolls are rotated either by frictional engagement of the advancing web or are independently power driven at whatever speed may be found most desirable. By reason of the staggered relationship of the several rolls, the contact of each with the coating on the web while light is sufficient to effect a leveling and even spreading of the coating upon both sides of the web.

From the smoothing unit the web advances through a drying unit D where the plastic coatings are subjected successively to two heating agencies, the first fluid and intangible and the second solid. As shown, the first heating medium operates in an elongated chamber E having opposed surfaces between which the web advances, these surfaces being successively inclined toward each other and then receding abruptly whereby to deflect air currents advancing with the web toward the coating on opposite sides thereof at numerous points lengthwise of the dryer. The web is thus sustained free of contact with the adjacent surfaces. The capacity of this part of the dryer, which is determined by numerous factors including its length in relation to the speed of travel of the web, the temperature and humidity of the air which is circulated therethrough, etc., should be such as to definitely initiate transformation of the coating on both sides of the web to a state of non-fluidity.

The further transformation of the coating to a condition of substantial non-plasticity takes place while the web continues its travel into the second part of the drying unit where it passes over a series of heated drums of which six are shown. Here the upper coated surface of the web is brought into contact with three of the rolls designated as *a*, *b*, and *c*, the lower surface of the web being brought into contact with the remaining three rolls *d*, *e*, and *f*. The travel is first over or around one roll and then the next in such a way that the upper side and then the lower is alternately contacted by one of the heated rolls. A power drive may be used for rotating the rolls at a speed which desirably corresponds with the advance of the web. At the conclusion of the travel of the web past these rolls which constitute the secondary phase of the drying operation, it is expected that the coating on the web will become substantially non-plastic although still in damp condition.

Upon leaving the dryer unit the web passes on to a molding unit F where its two coatings are subjected to a finishing treatment. It enters first between upper and lower companion rolls **20** and **21**, respectively, the latter being maintained with pressure against a revolving finishing drum **22** having a hard smooth surface which is desirably chromium plated. Before entering the nip between the rolls **20** and **21**, water contained in a pan **23** is flowed or otherwise deposited in a controlled amount upon the upper roll **20** with which a doctor **24** may be associated to regulate the amount of the water so transferred to the roll. The wet surface of this roll, upon coming in contact with the upper coated side of the web, effects a remoistening thereof prior to contact of the same coated side of the web with the finishing drum **22**. As a result of this remoistening step, the treated coating is semi-plasticized and conditioned for the ensuing finishing treatment upon the finishing drum. While passing around with this drum which is power driven at a speed corresponding with the advance of the web, the contacted coating is molded (with the aid of additional pressure rolls if desired) so that at the conclusion of its travel the coating is rendered very smooth and blemish-free so as to be conditioned for printing or other purposes. The finishing drum should be heated so as to effect a transformation of the contacted coating from its initial semi-plastic condition to one which is substantially non-plastic at the conclusion of this operation.

The web breaks contact with the finishing drum when passing over a stripping roll **25** from which point it continues on to and past an idler roll **26** after which the unfinished coating may be lightly sprayed as at **27**. Proceeding on, the web passes between a second pair of companion rolls **28** and **29**, the latter dipping into a pan **30** containing water or other rewetting agent. A doctor **31** associated with the roll **29** is adapted to regulate the amount of water that is carried by the roll surface into contact with the coating on the under side of the web. This coated side of the web is remoistened in consequence, just prior to its application to a second finishing drum **32** against which it is pressed by the roll **28** with the aid of hydraulic or other pressure means, as desired. Additional pressure rolls may also be employed, should this be advisable, to assist in molding of the remoistened coating during the period of its contact with the finishing drum which is also heated the same as is the drum **22**.

Upon completion of its travel around the second finishing drum, the coated side of the web in contact therewith will have become relatively dry and non-plastic so that it is fit to be stripped therefrom with the aid of a roll **33** preliminary to its further travel to a stand where it is rewound into a roll **34**.

Summarizing, the treatment which is imparted to the web, by the process herein described, is the application, in one operation, of a plastic coating to both sides of a traveling web, the accelerated setting of the coating in response to successive fluid and solid drying influences, the coating being thereby rendered substantially non-plastic but without complete reduction of its moisture content, the application to the coating on one side of the web of a rewetting agent whereby to semi-plasticize such coating in preparation for finishing treatment upon a heated finishing drum which renders the coating so treated substantially non-plastic, and, promptly thereafter, the application to the coating on the other side of the paper of a remoistening agent whereby such coating is rendered semi-plastic in preparation for treatment by a second finishing drum whereon molding takes place while the web concludes its travel through the apparatus.

The coating process herein described is applicable to raw paper stock of any suitable kind, preferably in web form, and the ingredients contained in the coating may be chosen from a number of different materials now commercially in use. The coating mixture may include, for example, a mineral pigment such as clay, baryta, or satin white, and a binder of casein, gelatine, starch, glue, or other suitable material, usually contained in an aqueous dispersion. By the term "paper," as used herein, I mean to include any and all materials in sheet form whereon a coating may be applied and treated in accordance with the present invention, and no distinction is intended between various kinds and classes of papers such, for example, as printing and photographic papers, or paper and paper board.

The term "semi-plastic," as used herein, refers to an intermediate condition of the coating at the time of its application to the finishing surface. In this condition the coating, while somewhat plastic and integral and homogeneous, is definitely below the liquid stage or free flowing point. It is tempered and softened to the extent at least that its binder constituent is soft, swollen and tacky so as to have capacity for adhering to and molding upon a finishing surface. Also the water content is very substantially reduced from that obtaining in the initial condition of plasticity. This reduction in water content is probably a half or more.

In the method of coating and finishing herein disclosed, there is, of course, need for close control over the condition of the coating from the moment of its application in a fluid condition, through the succeeding stages (1) where an accelerated partial drying to a substantially non-plastic condition is induced, (2) where the coating, after becoming non-plastic, is then changed back to a semi-plastic condition which is conducive to molding upon a finishing surface, with the aid of heat and pressure, and (3) where the coating is again transformed to a substantially non-plastic condition in which the moisture content is greatly reduced, thereby facilitating its ready stripping from the finishing surface. The close control necessary for these operations may

be maintained while the paper web is traveling at speed.

In any coating process wherein the applied coating on both sides is so wet as to saturate the sheet, accelerated drying cannot be achieved by a heat transfer medium which operates upon only one coated side of the paper. If one freshly coated side of the paper be pressed against a heated finishing surface, the other side whereon the coating is still soft and plastic is liable to be rendered coarse and unpolished when brought into contact with the usual pressure roll of rubber or other material. For reasons such as this it has been impossible, with previous coating practices, to coat and finish both sides of a traveling paper web either simultaneously or sequentially.

According to the present invention, the two coated sides of the paper are brought simultaneously to a condition of substantial non-plasticity by a drying agency which comprises first an intangible fluid heating medium which acts simultaneously upon both coated faces of the paper while free of contact with surrounding surfaces, and then, after setting has commenced, by a tangible solid heating medium which effects a transfer of heat alternately to the coatings on the two sides of the paper, both coatings being, in consequence, rendered non-plastic at substantially one and the same time. From this point on, the two coatings are treated separately, first one and then the other being rewet and finished. At the moment of first rewetting, both coatings are in a substantially non-plastic condition. Due to the relatively high moisture content which is then remaining in the paper and coatings, only a small amount of water is needed for rewetting of the proximate coating with a consequent semi-plasticization thereof. It is expected that the travel of the web will be sufficiently fast to prevent the moisture entering through the coating on one side from penetrating the sheet to render the coating semi-plastic on the other side, before contact with the finishing surface takes place and moulding is completed.

After the web has completed its travel around the first finishing drum, it may be advisable to apply a first moistening, as with the spray **27**, this constituting the first stage of the rewetting treatment to which the second coated side of the web is subjected. By so proceeding the coated surface is tempered and prepared to receive a second moistening from the roll **29** just prior to molding upon the finishing drum **32**. The effect of this two stage moistening treatment is to restore to the unfinished coating a moisture content about the same as it held prior to molding of the first coating on the finishing drum **22** when the binders were slightly swelled. Due to the slow rate of swelling, consequent upon remoistening of a dry coating, a preliminary spray moistening may be necessary, particularly with high speed operation, otherwise the second coating may not be moldable promptly in response to a single remoistening. When molding of the coating on the second side is proceeding, insufficient time will have elapsed for the remoistening agent to penetrate through to the finished coating on the first side. This finished coating will accordingly not be softened to the extent of incurring liability to marring when receiving contact from the pressure roll. The moisture which enters the coating last finished will eventually pass through the paper and be dissipated therefrom without detrimentally affecting the finish upon the outer coating.

My improved coating and finishing method which comprises the two steps of first setting the coating and then softening it again it admirably suited to the production of a paper having a finished coating upon each of its sides for the reason that the web can pass right from the first finishing drum onto the second drum. While the two coatings are finished in sequence, instead of simultaneously, they are, in effect, treated in one and the same operation because the second pass follows immediately after the first pass with no halting or interruption therebetween.

In the case of a web which is rewet to substantially increase its normal moisture content and then subjected to pressure contact with a finishing surface, the result is a hard finished surface. At the time of this treatment the paper is in a soft condition, due to remoistening, so that it is readily moldable upon a finishing surface. The coating itself may be so light as to be comparable with a so-called "machine coating" in that its weight need not exceed five pounds; in fact it may be much less, perhaps not more than three pounds. The pressure required for molding a softened paper having such a light coat is also definitely less than that required for calendering which usually runs higher than 500 pounds per lineal inch. The result is a hard finished surface with the paper body not condensed to any such degree as is characteristic of a machine coated paper whose coating is not molded to acquire the perfection of finish impartible only by a finishing treatment and whose base is not crushed, often detrimentally, in response to any such pressures as obtain in a calendering machine.

A further feature of advantage in a coated paper produced according to the present method is the relative hardness or density of the coatings. From start to finish, none of the coating is squeezed off or removed from the sheet. The full weight of the applied coating remains on the paper to the end. None of it is expressed out during the finishing operation. At the time of finishing, the coating has a relatively high viscosity, requiring a high pressure to produce flowing and molding. Such a pressure which is applied during the step of finishing serves to thoroughly condense and compress the coatings, resulting in their acquiring thereon relatively non-porous surface films.

A setting agent may be added to both coatings at or subsequent to the time of the second rewetting operation. The action of such an agent is both penetrating and rapid so that its introduction just before final finishing will not adversely affect the bond between the coating particles and between the coating mass and the paper base. The coatings so treated will be harder, in consequence, and relatively insoluble in water.

I claim:

1. A method of successively molding aqueous mineral coatings applied to opposite sides of a web which coatings are in substantially non-plastic condition, comprising the steps of moistening the exposed surface of one coating to render it semi-plastic, then subjecting the surface of the semi-plastic coating to pressure contact with a heated finishing surface to mold the engaged coating while the coating on the opposite web side remains substantially non-plastic, moistening the exposed surface of the

coating last named to restore thereto some of the moisture content thereof yielded during molding of the first named coating to render the second named coating readily receptive to moisture, thereafter again moistening the exposed surface of the second named coating to render it semi-plastic, and then subjecting the exposed surface of the second named coating to pressure contact with a heated finishing surface to mold the second named coating before its added moisture content penetrates to the first named molded coating.

2. In the art of continuously coating paper, the steps of applying an aqueous mineral coating in plastic state simultaneously to both sides of a moving paper web, of then subjecting both coatings on the paper web to a drying treatment to transform the plastic coatings on both sides thereof to a substantially non-plastic condition, of then moistening the exposed surface of one coating to render it semi-plastic, then subjecting the surface of the semi-plastic coating to pressure contact with a heated finishing surface to mold the engaged coating while the coating on the opposite web side remains substantially non-plastic, moistening the exposed surface of the coating last named to restore thereto some of the moisture content thereof yielded during molding of the first named coating to render the second named coating readily receptive to moisture, thereafter again moistening the exposed surface of said second named coating to render it semi-plastic, and then subjecting the exposed surface of said second named coating to pressure contact with a heated finishing surface before its added moisture content penetrates to the first named molded coating.

3. The method of treating a paper web having a highly damp non-plastic aqueous-mineral coating on each side thereof, comprising the steps of moistening the exposed surface of the coating on one side of the web to render it semi-plastic, then immediately thereafter subjecting such exposed surface of the semi-plastic coating to pressure contact with a heated finishing surface to mold the coating thereon before moisture from said semi-plastic coating can penetrate through the web to the coating on the reverse side of the web, then moistening the exposed surface of the still non-plastic coating on said reverse side of the web to render it semi-plastic, and then immediately thereafter subjecting the exposed surface of the coating on said reverse side of the web to pressure contact with a heated finishing surface to mold the coating thereon before the moisture content therein penetrates through the web to the first named molded coating.

4. In a machine for operating upon a traveling paper web having an aqueous mineral non-plastic coating on each side thereof, means for moistening the coating on one side of the web to render it semi-plastic, a heated finishing drum adjacent said moistening means for molding said semi-plastic coating, means spaced from said drum in the direction of travel of the web for restoring moisture to the coating on the other side of the web yielded during molding of the first coating, means spaced from the moisture restoring means in the direction of travel of the web for moistening the second coating to render it semi-plastic, and a second heated finishing drum adjacent said last moistening means for molding the second coating.

5. In a machine for operating upon a traveling paper web, a pair of vertically aligned rolls for engaging opposed sides of the web and applying an aqueous mineral plastic coating thereon, a plurality of rolls adjustably spaced from the first rolls in the direction of travel of the web for engaging opposed sides of the web and smoothing the coatings thereon, a drying unit spaced from the smoothing rolls in the direction of travel of the web for rendering the coatings on both sides of the web substantially non-plastic, means spaced from the drying unit in the direction of travel of the web for moistening the coating on one side of the web to render it semi-plastic, a heated finishing drum adjacent said moistening means for molding said semi-plastic coating, spray means spaced from said drum for restoring moisture to the coating on the opposed side of the web yielded during molding of the first coating, means spaced from said spray means in the direction of travel of the web for moistening said second coating and rendering it semi-plastic, and a second heated finishing drum adjacent said last moistening means for molding the last named coating.

6. In a machine for operating upon a traveling paper web, means for applying an aqueous plastic mineral coating to opposite sides of the web, a plurality of rolls spaced from the first rolls in the direction of travel of the web for engaging opposed sides of the web and smoothing the coatings thereon, a drying unit spaced from the smoothing rolls in the direction of travel of the web for rendering the coatings on both sides of the web substantially non-plastic, means spaced from the drying unit in the direction of travel of the web for moistening the coating on one side of the web to render it semi-plastic, a heated finishing drum adjacent said moistening means for molding said semi-plastic coating, means spaced from said drum in the direction of travel of the web for moistening said second coating and rendering it semi-plastic, and a second heated finishing drum adjacent said last moistening means for molding the last named coating.

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