

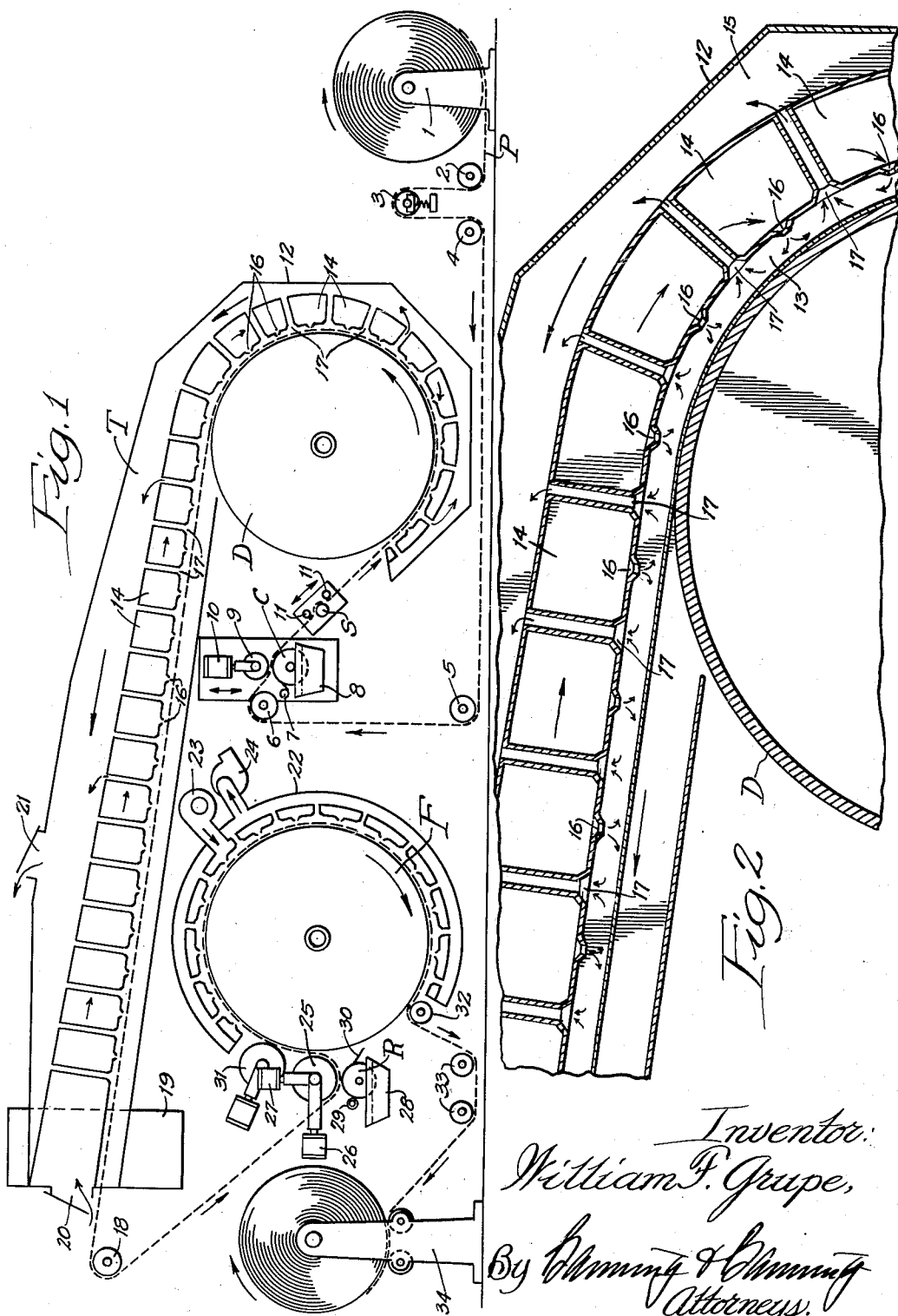
Dec. 15, 1942.

W. F. GRUPE

2,304,818

ART OF COATING PAPER

Filed May 1, 1940



Inventor:
William F. Grupe,
By *Humming & Humming*
Attorneys.

UNITED STATES PATENT OFFICE

2,304,818

ART OF COATING PAPER

William F. Grupe, Lyndhurst, N. J., assignor to
John R. Ditmars, New Brunswick, N. J.

Application May 1, 1940, Serial No. 332,675

6 Claims. (Cl. 117—103)

My present invention is concerned with a paper coating process whereby to produce a coating having a superior surface in respect of flatness, smoothness, hardness, freedom from imperfections, etc. The raw paper stock, in web form, may be of any suitable kind, and the ingredients contained in the coating applied thereto 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, all contained in an aqueous dispersion.

It is a primary object of my invention to perform either a coating or a finishing operation, or both, upon a fast traveling web of paper. These operations may be carried out with the aid of separate mechanisms at widely spaced times, or they may be performed in quick succession in a single machine (as diagrammatically illustrated herein), and they may also be performed upon paper as it is freshly delivered from a paper making machine. 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 or classes of paper such, for example, as printing and photographic papers, or paper and paper board.

By the treatment given to the paper web, in accordance with this invention, I produce a finished surface on the coating, either thick or thin, which is uniform, integral and homogeneous, and superior to those now commercially available. This may be accomplished at high operating speeds so as to maintain the cost at a minimum. Many of the factors which are responsible for the advantageous results hereinafter noted are both variable and controllable within certain limits so that it is possible to predetermine to a considerable extent the characteristics of the resulting coating.

In Fig. 1 of the accompanying drawing I have set forth diagrammatically a mechanism suitable for carrying out the steps of the process which characterizes my invention, and in Fig. 2 an enlarged fragmentary detail in section of the jacket which may be associated with the drying system and the finishing drum.

As shown, a web of raw paper stock P is unrolled from a stand 1, passing first over tension rolls 2, 3 and 4, and thence around certain idler rolls 5 and 6 to proceed through a coating unit. This unit may comprise a coating roll C with

which is associated a doctor 7, the coating roll dipping into a pan 8 wherein is appropriate means for circulating the coating mixture while maintained in a plastic state. The web passes over the coating roll and beneath a companion roll 9, of rubber or other yielding material, which is urged toward the coating roll and against the back face of the paper as by a fluid pressure means, desirably a pair of cylinders 10. By this means air which might otherwise be retained in the coating is expelled. The coating unit, i. e. the rolls C and 9 together with their associated mechanisms, is adapted to be shifted vertically, either up or down, whereby to vary the angle at which the web proceeds therefrom in its travel.

Passing from the coater, the web proceeds through a smoothing unit comprising a pair of upper spaced idler backing rolls 11 with an intermediate lower smoothing roll S. The web, coated side down, passes below the backing rolls and over the smoothing roll which contacts the freshly applied coating. The several rolls of the smoothing unit are mounted so as to be shiftable in unison toward and from the coating unit. This is desirable so that the coating and smoothing operations may be timed to take place at intervals which are best suited for smoothing of the coating, the eradication of all lines thereon, etc., depending upon the consistency and composition of the coating itself. The smoothing roll S is also adapted to be power driven at variable speeds, in either direction, for a purpose which will later appear.

From the smoothing roll, the web passes on to enter a dryer system comprising a cylinder D and a tunnel T. Extending around the dryer cylinder for perhaps half its arcuate distance is a jacket 12 wherein (see Fig. 2) is contained an inner chamber 13 in communication with the paper web (coated side) during its travel around the drum, also a series of interconnected closely spaced inlet ducts 14 surrounding this chamber and an outlet duct 15 to the outside of the inlet ducts. Each inlet duct is provided with a plurality of jets 16 in the form of long narrow slots facing the inner chamber whereby fresh air may be delivered thereinto, and at other intermediate places escape passages 17 connect the chamber with the outlet duct to permit air to circulate thereto and therethrough to a point of discharge. Movement of the air into and out of the jacket through the duct system just described may be forced by the means presently to be described. Appropriate means may also be employed to heat the cylinder upon its interior whereby to assist

in drying of the paper web and coating applied thereon.

Extending from the cylinder jacket 12 is the tunnel T which proceeds in a generally horizontal direction. Within this tunnel the duct system just described also continues. The paper web upon leaving the dryer cylinder passes through this tunnel and, at a point near its opposite end, over an idler roll 18 and thence to certain other mechanism shortly to be described. At the end of the tunnel remote from the cylinder is a chamber 19 wherein is housed a fan (not shown) adapted to blow heated air lengthwise of the tunnel in a direction counter to the travel of the paper web therewithin. To maintain relatively constant conditions of temperature and humidity, the tunnel is provided with damper controlled inlet and outlet openings 20 and 21, respectively. The air is accordingly circulated and recirculated through the tunnel and jacket 12 for discharge against the coating upon the paper web that is exposed to this treatment while traveling through the dryer system.

With the mechanism just described I may also associate a finishing drum F having a smooth, polished, cylindrical surface which is preferably maintained at a temperature of not more than 212° F. so that discoloration and decomposition of the coating binder constituent may not take place. Its exterior surface is desirably plated with chromium which is hard, smooth, highly polished, very enduring, and releasing of the dried coating—properties which make for a superior finish on the paper coating that is subjected to pressure contact therewith. This drum may be located relatively close to the idler roll 18 over which the web passes upon leaving the drying tunnel. Surrounding this drum, for a major portion of its periphery, is a jacket 22 wherein may be a duct system the same as described in connection with Fig. 2 with separate blowers 23 and 24 for maintaining circulation of heated air which is thereby brought into contact with the uncoated side of the web during its travel around the finishing drum.

Upon leaving the idler roll 18 the web is led around a pressure roll 25, desirably of rubber if the treated paper be not too heavy. Associated with this pressure roll I have shown two pair of diverging fluid pressure mechanisms 26 and 27, the former adapted to press the roll 25 against the finishing drum and the latter to advance the same roll toward a remoistening roll R which dips into a pan 28. This remoistening roll may be produced from different materials such as steel, aluminum, various alloys of metals, rubber, composition, etc. For high-speed operation of the remoistening unit I may use an associated doctor 29 and cleaning blade 30.

The paper web travels between the rolls 25 and R, the coated side contacting the remoistening roll, and thence on to the finishing drum where the coated side makes contact with the highly polished surface thereof. If desired, the wetting may take place on the uncoated side of the web, and the water may be applied (to either side) with the aid of a roll (as shown) or by a spray. Once the water has penetrated into the coating mass, it is rendered semi-plastic so as to be moldable upon the highly polished surface of the finishing drum while in pressure contact therewith. The coated side of the paper is pressed with considerable force against the finishing drum by the hydraulic mechanism 26, 75

and also by an auxiliary pressure roll 31 spaced closely adjacent the first roll 25. If desired, additional auxiliary pressure rolls may also be provided, all as will be hereinafter noted.

The paper web travels around with the finishing drum through a distance which may equal most of its periphery, and for a time sufficient for the coating to become non-plastic and dry. At this point it passes off over a stripping roll 32 and thence past some idler rolls 33 to be rewound upon a stand 34 into a roll in accordance with usual practice.

The coating may advantageously be applied to the paper while pressure is maintained against the coating roll which is desirably formed with an intaglio surface having a multitude of closely spaced symmetrical pockets, preferably rectangular, of small size, say .004" x .004", with dividing walls very thin, perhaps .001". With such a coating roll, a predetermined amount of plastic coating is lifted out of the pan and transferred up for deposit, in the form of small mounds, upon the under side of the paper web. The amount of coating so deposited is determined in part by the aggregate capacity of the pockets in the intaglio roll. The thickness of the mounds of coating so deposited may perhaps range from .003" to .008". The smoothing roll condenses these mounds, eradicating the lines of separation between them, and produces a flat and level coating surface over the paper base, so as to promote a resulting smooth finish which will improve the paper for any of its intended purposes. An important consideration here is the time element between the moments of application and smoothing of the coating. This is a variable, depending in part upon the consistency of the coating, and to compensate therefor, so as to effect a proper leveling of the coating mounds, the smoothing unit should be movable toward or from the coating unit, its operating position being adjusted so as to produce results which are uniform and satisfactory in every case. The coating mix which need contain no setting agent (since this is added at a later stage) may be heated and have a reduced water content which materially decreases the burden of drying with a consequent increase in the operating speed of the process.

As shown, the web in passing through the coating unit is required to twice change its direction of travel, first one way and then the opposite way, due to the rolls 9 and C being so positioned that a line between their axes does not extend transversely of the direction in which the web proceeds from the idler roll 8 to the smoothing unit. It is desirable that the amount of this change in direction of the web travel be variable, and for this purpose the entire coating unit is vertically adjustable. With each such adjustment there is a change in the angle between a line running from the axis of the roll 9 to that of the roll C and the direction in which the web proceeds when leaving the coater. By reason of this angularity, a differential in the speeds of peripheral travel of the coating roll C and movement of the web is set up, and advantage is taken of this condition to slur the freshly applied coating while still in a state of maximum liquidity. The effect of this is to promote smooth and even spreading of the coating and leveling of the mounds, all in advance of contact by the smoothing roll. The amount of slurring may be controlled by adjusting the position of the coating unit whereby to vary the differential in speed be-

tween the web and coating rolls, as just related. At the moment of its application to the paper web, the coating will not be laid entirely smooth, nor is its consistency such that it will not flow to some extent. This condition of fluidity will persist up to the time that a sufficient amount of water has been removed from the coating by absorption or evaporation.

As already indicated, there is a critical point in the consistency of the coating, and if there be any deviation therefrom it may be necessary to shift the smoothing unit toward or from the coater so as to decrease or increase the time element which precedes treatment by the smoothing roll. The smoothing roll is desirably power driven, one way or the other, at a speed which will keep its surface wet. The composition and consistency of the coating, position of the smoothing roll relative to the coater, and the speed of travel of the web are factors that will determine the speed and direction of rotation of the smoothing roll. Preferably this smoothing roll is of relatively small diameter in order to obtain best results.

After coating and smoothing, the uncoated side of the web advances into contact with the heated surface of the dryer cylinder, the coated side being concurrently exposed to the heated air currents which are circulated within the jacket. A rapid heat transfer into the paper and coating takes place. The air impinging on the coated surface acts to break the surface tension of the air and vapor film that tends to cling to the surface of the coating on a fast traveling web. The air itself does not disturb the coating because the latter has already parted with most of its water which is absorbed into the paper web immediately after application of the coating. The coating, while still plastic at this stage, is not sufficiently liquid to be flowed by the air issuing from the jets. While subjected on opposite sides to drying influences operating in the manner just explained, the web continues its travel around with the drum, the plasticity of the coating decreasing gradually all the while.

Upon leaving the dryer cylinder whose drying action is relatively rapid, the paper web continues its travel through the tunnel where it is subjected to the action of hot air currents proceeding along opposite sides of the paper web. The length of this tunnel and the rate of air circulation therethrough, also the temperature of the air (with due regard for avoidance of discoloration and decomposition of the coating), should be so calculated as to assure transformation of the coating to a non-plastic condition by the time the web emerges from the tunnel. The coating will shrink somewhat as the result of the drying operation just described.

When the paper web arrives at the remoistening unit, the coating need not be dry. It is substantially non-plastic, however, and therefore not conditioned for molding upon, or for receiving a smooth finish from, the finishing drum. The remoistening treatment swells and softens the coating and also transforms the coating from its non-plastic to a semi-plastic condition in which it readily responds to the desired finishing treatment. When passing around and under the pressure roll 25, the coating is disposed to the outside so as to receive contact from the remoistening roll therebelow. If the coating be still damp, this contact, while only momentary, may be sufficient for the remoistening agent to be absorbed with great rapidity throughout the non-

dry coating mass. It is important at the moment of remoistening that the coating be not dry, otherwise the binder would have a horn-like consistency that would defy rapid softening. Should the coat be dry it would then be necessary to apply in advance some preliminary dampening treatment in order to condition the coating for the remoistening operation. Dampness, or a moderately wet condition, in the coating at the time of remoistening, will permit an accelerated transformation of the coating to a state of semi-plasticity wherein the binder is rapidly softened, with resulting swelling and tackiness. Being damp, the coating has the property of instantly absorbing an applied liquid. The drier the coating, at the moment of remoistening, the slower is the rate of absorption. The pan into which the remoistening roll dips may contain water or any other liquid capable of rendering the coating semi-plastic. Desirably a fixing agent, such as formalin to the amount of perhaps 10 per cent by volume, is contained in the pan so as to assure chemical fixing of the coating.

The presence of such an agent in the water tends to rapidly set the coating, and it might be supposed that this tends, to some extent at least, to interfere with the objective of rendering the coating semi-plastic in preparation for the finishing treatment. Again, the time element must be reckoned with. The speed of travel of the web is relatively fast and the distance between the points of remoistening of the coating and of contact thereof with the finishing drum is relatively short. So that molding of the coating upon the finishing surface may be hastened, it may be found useful, particularly in high-speed operation, to employ one or more auxiliary pressure rolls 31, all assisting in smoothing and flattening the coating during the initial stage of the web travel around the drum. Perhaps agents other than formalin may be used with greater advantage, if the conditions so require. For example, a slower acting agent such as hexa-methylene tetramine, in the form of salt, may be added to the remoistening water. As setting of the coating with such an agent is slow (relative to formalin when used free), the smoothing and flattening action of the auxiliary pressure roll (or rolls) 31 should probably be more effective. At this point it should be noted that transformation of the coating from a non-plastic to a semi-plastic state, following application of the remoistening agent, takes place very rapidly due to the already damp condition of the coating. It is the coating first, and then the paper base, into which the remoistening agent penetrates. The coating tends to soften almost at once, due, first, to application of the water thereto, and, secondly, to the applied heat from the finishing drum which softens or lowers the viscosity of the binders. But this change in the direction of further plasticity is quickly halted, probably well before the paper has completed even a fourth of its travel around with the drum. While at its point of maximum softness the coating is most amenable to molding upon the finishing surface. This point of maximum amenability is variable depending upon such factors as speed of travel, amount and character of the binders, kind of setting agent in the remoistening medium, etc., and I wish it understood that in the practice of my invention due allowance and proper compensation should be made for all such conditions in any of the various ways hereinbefore set forth.

Application of the remoistening agent may be

made in any one of several ways. It may also be applied to the uncoated side of the web. Because of the damp condition of the web and coating at the time this operation takes place, there is an almost instantaneous penetration of the remoistening agent. As an example of an alternative method of application, water to which a setting agent has been added may be sprayed on to the pressure roll 25 for transfer to the uncoated side of the web, the moistening roll R being then dispensed with. If desired, the setting agent may be separately applied, as through the second pressure roll 31.

As a result of the finishing treatment, the coating is molded upon the finishing surface. This means that the smoothness and polish of such a surface is transferred to the coating itself. There should be a 100 per cent contact of the coating with the finishing surface. While each little imperfection and blemish in such a finishing surface is ordinarily reflected permanently upon the coating surface that is brought into contact therewith, the semi-plastic (as distinguished from a fully plastic) condition which obtains at the moment of maximum amenability of the coating during the finishing treatment is not characterized by any such degree of fluidity as to permit the transfer of minute and almost indiscernible marks and holes to the coating surface. The resulting finish upon my processed coating is therefore definitely superior to that which is produced when finishing is performed upon coatings while in a distinctly fluid state.

The coated side of the paper which is presented to the smooth surface of the finishing drum remains in contact therewith throughout most of its rotative travel, and while so engaged is subject to the heat which is transmitted through the drum walls from within. The paper is also subject to the currents of heated air which are delivered into the jacketed space around the drum. The coating is accordingly molded as the result of its pressure contact with the finishing surface of the drum, and at the conclusion of its travel therearound is rendered once more non-plastic and in condition to free itself from the drum at the point where the stripping reel is positioned. At this point it will be found that the thickness of the molded coating will have become reduced to its minimum. The remainder of the movement of the web, and its rewinding into a roll, may proceed in accordance with usual practice.

For the coating roll, and also for the pressure rolls in contact with the remoistening roll and the finishing drum, I have mentioned fluid pressure mechanisms. Probably hydraulic cylinders will be found most satisfactory. These should be used in pairs, one acting against each of the opposite bearings of the roll, and both cylinders operating under equalized pressures. The advantages of such a fluid pressure mechanism are several. In the first place the pressures at opposite ends of each roll will be the same, hence the pressure delivered by each such roll will be equalized from end to end. Then also, if any such roll should be off-center, be it ever so slightly, it will continue to deliver a uniform pressure at every point in its rotative movement, due to the fluid character of the pressure medium. And again, the diameters of all such rolls are not constant, because of changing temperature conditions, but the pressures delivered by such changeable diameter cylinders remain constant when a fluid pressure medium

is employed in the manner just suggested. In the event of variations or inequalities in the thickness of the paper base or of the coating consistency, such hydraulic mechanisms will automatically adjust themselves to maintain a constant pressure. In view of the desirability for maintenance of complete control over, and compensation for, varying conditions which may obtain during practice of the present process, the use of fluid pressure means, as suggested, will contribute toward improved results.

The terms "plastic," "semi-plastic" and "non-plastic," as used herein, denote relative, and not absolute, conditions. This observation applies with special force to "semi-plastic." By plastic, I refer, of course, to a fluid state of the coating whose consistency at the time is such as to adapt it for ready application to the paper web and for rapid setting thereupon. Most coating mixtures are aqueous so that setting requires drying, usually accelerated with heat. The condition of non-plasticity, where the coating is relatively hard and fit for handling and use, is one familiar to the industry.

"Semi-plastic," the intermediate condition of the coating at the time of its application to the finishing surface, is not so easy to define. By this term I mean a condition which is neither plastic nor non-plastic, as these expressions are generally understood, but one in which the coating, which is integral and homogeneous, is definitely below the liquid stage or free flowing point, and is not hard or set, but is softened to the extent at least that its binder constituent softens, swells and becomes tacky. In this condition the coating as a whole is softened and swelled so as to adhere to and be moldable 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.

This intermediate condition of semi-plasticity is important to the very superior results produced according to this invention. Transformation of the coating, in the presence of heat, to a non-plastic condition is effected free of contact with any physical surface. Because of this absence of pressure, the coating solidifies with only such internal tension as is natural. In consequence, the coating tends to arrive at a non-plastic condition as an integral film on the paper surface.

Because of the high-speed possibilities of the present coating process, the feasibility of applying the coating to a traveling paper web whose moisture content is in excess of 10 per cent by weight, and flexibility in control over certain of the operating conditions, the process may be performed upon paper as it emerges from the delivery end of a paper making machine. Instead of subjecting the freshly made paper to the action of dryers which reduce the moisture content to less than 10 per cent, as is now the practice, the web may leave the paper making machine with a full 10 per cent or more of moisture and pass at once into the coating unit of my invention to receive treatment by the various agencies hereinbefore described. The upper limit of moisture content in the paper to be coated is determined largely by the strength of the web and its condition to withstand handling. To compensate for added moisture content in the web, there should preferably be a reduction in the water content of the coating

mix, and with this one change the several operations may proceed as already explained at length.

The process herein disclosed is advantageous not only from the standpoint of high-speed operation, with low operating cost, but also because of the superior coating that is produced. Perhaps the most outstanding characteristic is the conditioning of a coating by first bringing it to a state of semi-plasticity before the commencement of its finishing treatment upon a finishing drum. The moisture content of a freshly applied coating is very considerable, and any attempt to concurrently dry and finish such a coating presents numerous difficulties. The operation is slow for one thing. The addition of a setting agent to the plastic coating is detrimental to the bond, and the advantages sought to be attained thereby are largely offset in consequence. By contrast, the coating which is treated according to my invention is applied and dried under the most favorable conditions. In the first place, the coating in a predetermined amount may be metered on to the paper web by an intaglio roll, with the aid of a companion pressure roll, thereby obviating removal of any excess material. When so applied, the distribution of the coating over the surface of the web is substantially uniform, and such further smoothing and leveling of the coating as may be desirable is thereafter effected by the smoothing roll before the paper web advances into contact with the dryer cylinder. During the ensuing drying operation the coating is allowed to become non-plastic naturally and free of pressure, and its integrity and homogeneity is preserved, due to its absence from contact with any solid surface.

When first subjected to the remoistening operation, the non-plastic coating may still be very damp, yet it is substantially set and fit for handling. Even after being remoistened, the water content of the coating is still only a fractional amount of what it was originally. So many variable factors enter into this phase of the operation that it is probably impossible to determine exactly what will be the content of the water introduced by the remoistening operation. It will probably be less than half of the original content of the water. Whatever be the amount, the coating again is placed in a sufficiently plastic condition for molding when subjected to pressure contact with the finishing drum.

As an alternative procedure, a close control may be maintained over the coating, during travel of the web through the drying system, to ensure a semi-plastic condition of the coating, without the application of any remoistening agent, at the moment the coating is brought into contact with the finishing drum. In such a case, the setting agent may be added to the coating mix, if cold, or to the coating when it first engages the drum.

In the molding operation which ensues upon the finishing surface the coating is caused both to flow somewhat and condense. In consequence voids, pin-holes and blemishes in the preformed coating (if any there be) are removed, and the bond between the coating particles, and between the coating and the web, is improved. This results from the fact that, upon becoming semi-plastic, the binder materials soften and swell sufficiently to mold upon and adhere to the polished surface of the finishing drum. During this operation, while pressure is applied, there is no expressing of the coating, whether it be thin or

whether it have a heavy binder constituent, as in the case of photographic papers. Upon drying, the binder materials condense, lose tack, and set up an internal tension in the coating. If this drying be rapid, as in the present process where only a small quantity of moisture remains in the coating at the time of its treatment upon the finishing surface, a contracting tension is set up rapidly both in the paper and coating sufficient to force a release of the coating from the cylinder.

Adding or applying the setting agent to the coating while in a semi-plastic state and immediately before or at the time it is subjected to molding pressure upon the finishing surface permits the highest possible bond between the coating particles and between the coating mass and the paper sheet, the adhesive properties of the binder being then at their full value. By contrast with other practices, if the setting agent be mixed with the coating solution the adhesive properties of the binder are lowered. It will be apparent, therefore, that by the process of my invention, the coating requires less binder for a given value, and is, in consequence, in condition to receive the maximum molding effect with less pressure. A further characteristic of the present coating, to which the setting agent is added at the time of finishing, is that it is relatively insoluble in the presence of water.

Throughout the specification and claims the term "molding," as used herein, means a change which is imposed on the form, shape or surface finish of a thin spread of damp aqueous coating composition, while in a non-free-flowing, yet semi-plastic and pliable state, by pressure contact with a hard, smooth finishing surface against which the coating composition is maintained while undergoing thereon transformation to a substantially non-plastic state wherein it is freely releasable therefrom.

I claim:

1. In the art of producing mineral coated paper, the steps of applying to a paper web a coating comprising an aqueous mineral composition, of evenly distributing the coating over the surface of the web, of then expelling from this coating a substantial portion of its moisture content to transform the same to a state of substantial non-plasticity wherein the evenly distributed coating still remains in a highly damp condition, of then adding moisture to the non-plastic coating while still highly damp to quickly swell the same to the point of pliability for molding under pressure, of promptly thereafter molding the swelled coating by subjecting the same to pressure contact with a heated finishing surface, and of then expelling moisture from the molded coating to a degree where it is freely releasable from the finishing surface

2. In the art of producing mineral coated paper, the steps of applying to a paper web a coating comprising an aqueous mineral composition, of evenly distributing the coating over the surface of the web, of then expelling from the coating more than fifty per cent of the moisture content to transform the coating to a substantially non-plastic highly damp condition, of then swelling the coating to the point of pliability for molding under pressure by adding moisture thereto while still highly damp, of thereafter promptly molding the swelled coating by subjecting the same to pressure contact with a heated finishing surface, and of then drying the molded coating to a point where it is freely releasable from the finishing surface.

3. In the art of producing mineral coated paper, the steps of applying to one face of a paper web a coating in the form of a multitude of mounds of an aqueous mineral composition, of then smoothly and uniformly spreading the applied composition over the surface of the web by frictionally but lightly contacting the composition with a smooth relatively moving and constantly wet surface, of then expelling from the coating a substantial portion of its moisture content to transform the same to a substantially non-plastic but highly damp condition, of then swelling the coating to the point of pliability for molding under pressure by adding moisture thereto while still highly damp, of thereafter promptly molding the swelled coating by subjecting the same to pressure contact with a heated finishing surface, and of then drying the molded coating to a point where it is freely releasable from the finishing surface.

4. In the art of producing mineral coated paper, the steps of applying to a paper web a coating in the form of a multitude of small mounds of an aqueous mineral composition and concurrently slurring the applied mounds, of then smoothing the slurred composition over the surface of the web, of then expelling from the coating a substantial portion of its moisture content to transform the same to a substantially non-plastic but highly damp condition, of then swelling the coating to the point of pliability for molding under pressure by adding moisture thereto while still highly damp, of thereafter promptly molding the swelled coating by subjecting the same to pressure contact with a heated finishing surface, and of then drying the molded coating to a point where it is freely releasable from the finish surface.

5. In the art of producing a mineral coated paper, the steps of applying to a traveling paper web a coating comprising a measured aqueous composition in the form of closely spaced mounds and concurrently slurring the applied mounds, of then smoothing the slurred composition over the

surface of the web by subjecting the same while the web is in motion to light contact with a constantly wet smoothing roll rotated at a differential speed relative to the movement of the web, of then expelling from the smoothed and evened coating a substantial portion of the moisture content to transform the same to a substantially non-plastic but highly damp condition, of then uniformly swelling the smooth and partially dried coating to the point of pliability for molding under pressure by adding moisture thereto while still highly damp, of promptly thereafter molding the swelled coating by subjecting the same to pressure contact with a heated finishing surface, and of then expelling the moisture from the molded coating to a degree where the coating is freely releasable from the finishing surface.

6. In the art of producing mineral coated paper, the steps of applying to a paper web a measured coating in the form a multitude of mounds of an aqueous mineral composition while in a state of high fluidity and concurrently slurring the mounds to spread and redistribute the coating composition over the surface of the web, then after absorption into the web of a part of the moisture content of the redistributed coating composition of smoothing the coating by frictionally but lightly contacting the same with a smooth wet relatively moving surface, of then expelling from the smoothed coating a substantial portion of its moisture content to transform the same to a state of substantial non-plasticity wherein the coating still remains in a highly damp condition, of then adding moisture to the non-plastic highly damp coating to quickly swell the same to the point of pliability for molding under pressure, of promptly thereafter molding the swelled coating by subjecting the same to pressure contact with a heated finishing surface, and of then expelling moisture from the molded coating to a degree where it is freely releasable from the finishing surface.

WILLIAM F. GRUPE.