Our invention relates to modifications in the practice of imprinting coating of paper and paperboard as set forth in detail in application Serial No. 501,320 of Harry C. Fisher (one of the present applicants), filed September 4, 1943, now Patent No. 2,419,207, dated April 22, 1947.

In coating by imprinting, a desirable practice is to pass the paper board or paper between two rubber coated rolls pressing against each other, one of the rolls having a film of wet mineral coating mixture continuously applied thereto which is picked off by the paper. The vehicle for such coating must, for practical purposes, be aqueous, but the coating may be and should be quite thick in consistency. Thus a normal formula of clay coating but using only 50% water, is acceptably used in such type of coating.

Among advantages of this type of coating is that it may be applied as a continuous step following formation of the paper web and that the coating can be quickly dried after its application. With paper board in particular, however, the advantages of the compressed surface resulting from printing and the advantages of a continuous coated paper making process as last above noted, are not realized unless the board is plasticized previous to imprinting, and the surface smoothed, so that there is a smooth plasticly worked surface conditioned for further plastic working, at the time of printing on the coating.

There are various ways of applying a printable film of coating to one or both of the printing rolls used in imprinting coating, the one selected for illustration in this application being the use of applicator rolls such as are used for applying ink to the inking roll in printing presses.

The Fisher patent, above referred to, relates to the imposition of a plasticizable coating on the web previous to imprinting it and working of this coating, using for this purpose in the illustrated example, a breaker calender stack of rolls, having one or more of the water boxes on such a stack to apply the plasticizable coating. As examples of the plasticizing agent used, Fisher teaches the use of various water soluble plasticizable agents, chemically inert to the paper fibers, such as polyvinyl alcohol, polyacrylic acid, polyvinyl alcohol and starch, converted starches in concentrations such as around 5% solids and upwardly, and water solutions of methyl cellulose of low viscosity, etc. Among other things these water-borne plastic substances will leave the board still able to take up further water, if applied promptly following the working of the treated web to plastically smooth the surface of the same. The coating as imprinted on the web, while the web is still moist from the pre-treatment, or at least freshly dried, will accordingly mix with the pre-treatment substance and bond very thoroughly to the board. In addition to the examples recited in said Fisher patent, other substances found suitable for use as a plasticizable coating on the web previous to imprinting it and working of this coating are the cellulose derivatives carboxymethyl cellulose, the sodium salt, and hydroxyethyl cellulose. The substances are soluble in water and upon evaporation of the solutions form films.

It is our principal object to retain the advantages of the Fisher practice of his said application and at the same time apply a mineral coating to the web which more completely masks the color of the paper material and assumes the color of the coating material itself. It is not our object to perceptibly thicken the over-all coating, as with our practice this would introduce complications in connection with the imprinting operation. Even as little as less than a one-thousandth of an inch of film of mineral coating added to the web before imprinting, will fulfill our purpose.

Fisher speaks in his application of obtaining a brightening of the color of his final product by introducing pigment along with the pre-treatment substance. This complicates the preparation of the pre-treatment substances, and does not gain the results of our practice to be described below.

To facilitate a description of our practice, we refer to the appended drawing in which Figure 1 is a diagram of a set-up suitable for carrying out our process, but not the only set-up which can be used for this purpose.

In the diagram, I may be taken to be the final roll of the dryer roll section of a paper board making machine under which passes the web of paper board. The breaker calender stack 3 is employed having water boxes 4, applied to selected rolls of the stack in one or more of which water boxes is placed a plasticizing substance solution of the type referred to above as having been disclosed by Fisher, Between the calender stack 3 and the printing rolls 8, there is located a device for applying a film of mineral coating mixture to the web 2 of paper board. As shown in the diagram this may be a flow box 6 having an apron 7, which directs the substance onto the web by overflow from the box. Immediately beyond the flow box, or it may be located at some point nearer the printing rolls, is a wiping de-
vice or doctor, here shown as simply a blade, past which the web passes. The position of which blade will be to remove all but a mere film of the coating flowed onto the web, and to smooth it.

Other standard methods of application can be used, such as a reversing turn roll as an applicator and doctor combined, or a set of pipes to flow the coating onto the web just in front of the doctor, or a brush applicator. The point simply lies in applying a thin film of mineral coating mixture in an aqueous vehicle to the board immediately after it has been given the initial plasticizing treatment in the breaker calender stack in the presence of the plasticizing solution, but just before the imprinting roll has been reached, the whole series of steps being continuous and closely related in point of time.

An additional film of coating also can be applied to the web by a supplementary pair of rubber coated printing rolls placed ahead of the principal printing rolls and following the initial plasticizing treatment in the breaker calender stack, being supplied with wet coating mixture from a train of applicator rolls fed from their own gate rolls or taken from the gate rolls or from an applicator roll of the principal imprinting coater.

In the drawing, II is a diagram of the principal and supplementary imprinting rolls, 8 and 8A, respectively, being supplied with wet coating mixture from the common pair of gate rolls 13 through contacting trains of applicator rolls 5 and 8A, all of which rotating rolls move in timed relationship with the travel of paper or board web. Due to space limitations, imprinting rolls 5A may be smaller in size and weight than rolls 5 and be provided with means for increasing their nip pressure.

After leaving the principal printing roll 5 of Figure 1, the web passes around heated dryer rolls 10 and thence through finishing calenders 11. Just preceding dryer rolls 10, is shown 12, a hood equipped to blow hot air against the freshly imprinted layer of wet coating to accelerate its drying before it contacts the surface of the first heated dryer roll opposing the coated surface.

Attempts to apply the imprinted film back in the dryer roll section of the board machine, or to board which has not been given a plasticizing treatment or to apply an additional film after the principal imprinting operation, have not given results which are fully commercial or which we require. However, by following our practice of which an example will be given, a very remarkable increase in quality of the finished product is the result, one which seems quite out of proportion to the very small amount of added mineral coating, a fact which we attribute to the combined effect of the previous plasticizing treatment plus the fact that the coating applied immediately following in seconds of time is imposed by means of printing rolls under pressure.

As an example of our process paper board .020" thick, white lined on one side, being made on the multi-cylinder board machine, was passed through the breaker calender stack where by means of upper water box 4 there was applied against the white side a three percent by weight, water solution of converted starch.

The mineral coating mixture in water used at the two points of application to the plasticized white side of the board was the customary heavy consistency creamy variety with fifty to fifty-five percent solids content, suitable for the imprinting process; its mineral matter comprised white coating clay with a small addition of opacifying mineral, titanium dioxide; its binder comprises a starch. Flow of the initial coating was controlled and the doctor adjusted so that in measuring the final thickness of film on the web after the process was completed, the result was a small almost indeterminable increase, as compared with the process using simply the printing rolls without the initial coating, within the allowable tolerances of measurements. The measurements showed that the initial deposit of mineral coating had a surface film with thickness about the same as the subsequently imprinted film, both together adding up to less than one thousandth of an inch, thus being very thin.

As implied above, a control run in connection with this example was made by a practice which simply omitted the step of deposit of initial film of mineral coating between the breaker stack and the imprinting rolls. The finished coated board of white color from our practice and the control when compared for brightness by General Electric reflectance meter ("brightness tester") with filter #1 transmitting wave length of 455 millimicrons, showed a favorable increase in brightness of 7.2% for our new practice. The test of the product of the new practice with the control showed an increase in smoothness of 27.2% by the Beck smoothness instrument.

The board coated by our practice was then tested with letter press non-aqueous colored printing inks to judge its response to printing to give smooth unstreaked solid colors. The results of our practice as outlined above was to give a flat ink printing without pattern with non-gloss inks and a glossy but unmarked printing with gloss inks. Where the doctor was applied quite close to the imprinting roll, thus giving the initially applied mineral coating a chance to solidify slightly, we did not obtain an unmarked a colored ink printed impression as when the mineral coating was applied immediately ahead of the doctor.

As will be evident, with an initially applied mineral coating of somewhat greater moisture content (or greater flowability), the doctor size might be increased to improve the initial mineral coat, and hence doctoring at any point before the imprinting section is reached will be proper depending upon the factor of flowability of the initial mineral coating.

The coating on the imprinting rolls was a film of the same coating mixture as applied with the use of the doctor, applied to the surface of the top roll by the spreading and applicator rolls, same being supplied to the latter from the fountain or gate rolls at 13 of Figure 1. Indeed, the practice used except for the application of the initial mineral coating did not differ from the standard practice according to the Fisher patent referred to above.

In another practice, paper board .025 inch thick, white lined on one side, being made on the multi-cylinder board machine was passed through the breaker calender stack where by means of upper water box 4 there was applied against the white side a six percent by weight water solution of converted starch.

The mineral coating mixture in water used at the two points of application was the customary heavy consistency creamy variety with fifty to fifty-five percent solids content, mineral matter comprising clay with small addition of titanium.
dioxide and binder of converted starch, suitable for the imprinting process.

Coating mixture was transferred by roll from the applicator roll adjoining the second gate roll and imprinted as an initial coating on the plasticized surface of web at a position closely following breaker stack of calenders but preceding the principal imprinting coater. The final thickness of film on the web after the process was completed, showed a small almost indeterminate increase, as compared with the process using simply the principal imprinting rolls. Measurements showed that the initial imprinted mineral coating had a surface film with thickness about the same as the principal imprinted film, both together adding up to less than one thousandth of an inch, thus being very thin.

The finished coated board of white color from our practice and from a companion control run where the initial imprinted coating was omitted, when compared for brightness by the General Electric reflection meter with filter #1, showed a favorable increase in brightness of 5.1% for our new practice. A similar comparison of smoothness by the Bekk smoothness instrument showed an increase of 14.5% favoring the double imprinting practice.

While printed with oil base letter press ink the double-coated board showed normal behavior.

While our practice is addressed primarily to two applications of the same coating mixture to the web of paper board it can be employed with coating mixtures that differ from each other in content of minerals, binder or etc. Thus, by way of example but without limitation, the initial coating can be rich in opacifying mineral like titanium dioxide to assist in masking the underlying color of the paper surface of the web and the imprinted coating over it can be rich in less expensive coating clay, the two coatings together giving an unusual degree of opacity without altering the normal printing character of the upper coating. Similarly, the second coating may be richer or poorer in binder or contain a different binder substance than the initial coating for particular purposes.

In our process superior results obtain when the teachings of Fisher Patent 2,419,207 are followed. However, the plasticically worked smoothened or plasticized surface of the web will serve in our process when the content of plasticizable substance applied to it from water solution, as on the breaker stack of calenders, is markedly reduced in concentration in that solution or is omitted. The close incidence of the initial mineral coating mixture which may be doctored or otherwise smoothened over the plasticized paper surface compensates, at least in part, for the reduction in plasticizable substance on the plastically worked paper surface.

Where no initial mineral coating is applied and the plasticizing effect of water alone on the paper surface of web is employed, a further reduction in quality of imprinted coated surface results although even this mineral coated surface is of better quality than one having received no plastic working and smoothing prior to imprinting it with mineral imprinting mixture coating, in addition to its principal utility in providing for the imposition of more than one deposit of mineral coating on the web our process provides, as another object, for a wider utilization for the range of plastic working of the paper surface of the web before imprinting it with mineral coating mixture.

For a description of the General Electric reflection meter ("brightness tester") we refer to booklet entitled "Instruction for Using the General Electric Reflection Meter ("Brightness Tester")" compiled by The Institute of Paper Chemistry of Appleton, Wisconsin, April 1937.

For a description of the Bekk smoothness tester we refer to Paper Trade Journal 54, No. 26 of June 30, 1932.

Having thus described our invention, what we claim as new and desire to secure by Letters Patent is:

1. That method of coating paper and paper board which comprises continuously applying a plasticizable water-borne substance to the surface of the fiber web and plastically working the same between rolls, continuously applying to the plasticized surface of the web a thin film of waterborne mineral coating material and immediately thereafter continuously imposing under pressure by means of a coated roll, another film of water-borne mineral coating material and then drying the coated web continuously, whereby to attain a coated product having a greater surface smoothness and a greater surface brightness than a product similarly plastically worked and then coated under pressure by means of said coated roll with a single layer of a thickness equivalent to the combined thickness of said two films.

2. The method of claim 1 in which the first noted thin film is applied by imposing said mineral coating substance on the plastically worked surface of the web and doctoring it to make it a smooth and thin film before the material has perceptibly dried.

3. The method of claim 1 in which the first noted film is applied by imposing said coating mineral substance onto the plastically worked surface of the web and doctoring it immediately to make it a smooth and thin film.

4. The method of claim 1 in which all steps are performed within a space through which the web moves without fully drying out between steps.

5. That method of coating paper and paper board which comprises continuously applying aqueous liquid to the surface of the fiber web and plastically working the same between rolls, continuously applying to the plasticized surface of the web a thin film of water-borne mineral coating material and immediately thereafter continuously imposing under pressure by means of a coated roll another film of water-borne mineral coating material, whereby to attain a coated product having a greater surface smoothness and a greater surface brightness than a product similarly plastically worked and then coated under pressure by means of said coated roll with a single layer of a thickness equivalent to the combined thickness of said two films.

6. That method of coating paper and paper board with multiple layers of water-borne mineral coating mixture which comprises continuously applying a plasticizable water-borne substance to the surface of the paper web and plastically working the same between rolls, continuously imposing on the plasticized surface of the web under pressure by means of a coated roll a thin film of water-borne mineral coating material, and thereafter, immediately the foregoing film is set, applying a second thin film of water-borne mineral coating material by means of a coating roll under pressure and finally dry-
ing the coated web and calendering it, whereby to attain a coated product having a greater surface smoothness and a greater surface brightness than a product similarly plastically worked and then coated under pressure by means of said coated roll with a single layer of a thickness equivalent to the combined thickness of said two films.

HARRY C. FISHER.
BRAINARD E. SOOY.

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<tr>
<th>Number</th>
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