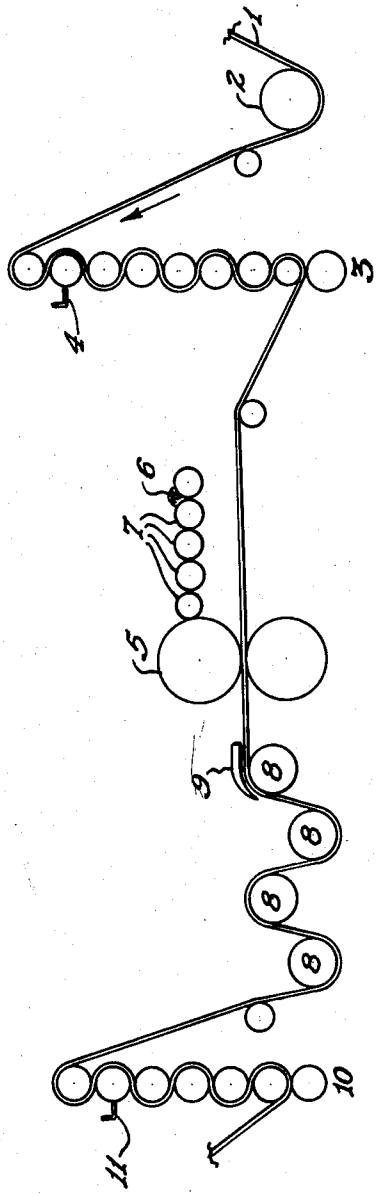
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PROCEDURE FOR MAKING COLORED COATED BOARD BY IMPRINTING

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PROCEDURE FOR MAKING COLORED COATED BOARD BY IMPRINTING

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Our invention has to do with the manufacture of colored, mineral coated paper or paperboard of the class wherein the coating is applied in a very thin layer to the surface of the web by imprinting.

It will be evident that if a suitable coating of mineral-adhesive mixture containing an opaquing agent were applied to a web in sufficient thickness so that the appearance of the coated surface would be determined only by the appearance of the dried coating film itself, the color of the coating would determine the color of the coated surface of the web. However, when a mineral-adhesive coating mixture is applied to a web of paper or board by imprinting, it must be applied in so thin a layer that it becomes impossible completely to mask the effect of the appearance of the surface of the web. In other words, in an imprinted coating of mineral-adhesive mixture, the opacity of the coating cannot be sufficient to obscure any effect of the surface of the web itself. Thus in the formation of white coated paper or board, the brightness of the coated surface will be affected by the reffectivity of the surface of the web beneath; and by the same token, in the formation of colored coated paper or board, the color values of the coated surface will depend not alone on those of the imprinted coating but also to an important extent on those of the surface of the paper or board.

Our invention finds its greatest utility in the manufacture of paper or board which is highly colored as to the coated surface, as compared with very light or faint tints or pale pastel colors. Coated board having very light surface tints is relatively easily made by properly coloring the mineral-adhesive coating mixture, and coloring the top liner or surface of the paper or board to very nearly the same color values. Indeed, if the tint is light enough, often it is not necessary to color the board itself and the color of the dried film of mineral coating suffices to color the surface of the coated board. Nevertheless, our invention is applicable to the production and control even of light or pastel tints since it offers features of control and adjustment not hitherto available in the art.

The matter of color is complex, and involves a number of variables which need to be defined for our purposes. The term "chroma" is used to indicate the brilliancy, strength or intensity of a color. "Hue" is the factor determined by the preponderant wave length of light reflected by a colored material, for example, green or red. "Shade" is ordinarily considered as a color toned with black or with a color having a dulling effect. We include with shade the modifying of a hue by blending it with a small amount of another hue, such as altering a red to a bluish tone of red by the addition of blue. The term "tint" is used for a light color, for example, a pastel color produced by adding a small amount of color to white. "Brilliance" is the antithesis of dullness, whereas brightness is opposed to darkness. The term "brightness" is ordinarily used in a more restricted sense. For white and near white objects, the brightness is taken as the reflectance of light at 458 millimicrons wave length by the

object under test, compared with the reflectance of magnesium carbonate which is taken as 100.

In the manufacture of coated stock there may be variations in the hue, chroma and brilliance of the top surface of the paper or board which is to be coated. Where the coating is done in an exceedingly thin layer by imprinting means, the thickness of the imposed coating of mineral-adhesive mixture will vary sporadically, which not only produces variation in the apparent chroma and brilliance of the applied coating itself, but also produces variation in the effect of the surface of the web beneath the coating in the matter of brilliance as well as color.

Colored, coated paper or board, especially products having substantial color intensity are ordinarily desired to conform to strict specifications in matters of chroma, hue, and brilliance. It is a fundamental object of our invention to provide a process for the manufacture of colored, coated paper or board in which not only can the end product be held to rigid specifications in these matters, but also in which correction or compensation can rapidly, effectively and cheaply be made for discrepancies in color values.

This and other objects of our invention which will be set forth hereinafter or will be apparent to one skilled in the art upon reading these specifications, we accomplish by that procedure of which we shall now set forth an exemplary embodiment. In describing our invention, we will employ as illustrative a process for the manufacture of a deep yellowish board, it being understood that this color, and the dyes and coloring materials used to obtain it are exemplary only and can readily be modified by the skilled worker in the art to obtain other hues, shades, tints, chromas and brilliance.

The drawing forming part hereof is a diagrammatic illustration of apparatus at the end of a paper or board machine with which our invention may be practiced.

Our invention pertains primarily, as has been indicated, to procedures for making coated paper or board wherein the mineral-adhesive mixture is applied by imprinting; but it is not otherwise limited as to the nature of the coating procedure itself. As set forth in Patent 2,370,344, dated February 27, 1945; in Patent 2,419,206, dated April 22, 1947; and in Patent 2,419,207, dated April 22, 1947, Harry C. Fisher, one of the applicants herein, taught processes of producing coated paper or board by imprinting. These processes were based on the discovery by Fisher that very beautiful finishes could be made on paper or board by thin imprinted coatings of mineral-adhesive substance, if the surface of the web was first "plasticized." The plasticization was accomplished by passing the web through a breaker calender stack, there being water boxes on the stack containing a plasticizing solution such as a solution of starch, or of polyvinyl alcohol or mixtures of these substances with or without other film forming media. The surface of the paper or board is worked by the rolls of the breaker stack of calenders in the presence of a suitable plasticizing solution, and thus prepared for the reception of the very thin imprinted coating of mineral-adhesive mixture, the coating being applied during a persistence of the plasticizing effect i.e. before the surface of the web has completely dried.

We preferably employ the teachings of these patents in the formation of fine types of colored, coated paper or board. The utility of our invention is not confined thereto, however, since the features of control and adjustment hereinafter outlined are not primarily dependent upon plasticization. While it is true that a certain working and smoothing effect will be obtained when paper or board is passed through a breaker stack of calenders with water or a water solution in one or more water boxes thereon, even in the absence of such plas-

ticizing materials as starch, polyvinyl alcohol, and the like, and while this helps to prepare the surface of the web for the reception of a thin imprinted coating, the desirable degree of plasticization, or the use of plasticization at all, will depend very largely on the desired printing qualities of the end product. Coated boards having good appearance can be made by imprinting a suitable coating on the unplasticized surface of the web, and this will be found satisfactory if relatively simple printing is to be done on the coated surface. Where, however, a finer type of printing is desired, as in half-tone work or where it is desired to improve the printing quality generally, we prefer to plasticize the surfaces of the paper or board as hereinabove set forth.

Reference may also be made here to Patents 2,515,340 dated July 18, 1950; 2,578,345, dated December 11, 1951; and 2,611,717, dated September 23, 1952, which patents have to do with variations of processes wherein plasticization is followed by the imprinting of a mineral-adhesive mixture, and which deal with such matters as the formation of coatings which are resistant to wet rubbing, the securing of desired surface finishes, and to the formation of colored coatings.

Briefly, in the practice of the present invention, a paper or board web is formed with a colored surface, as for example by beater-coloring the fibers of the web or of the top liner or liners of a multi-cylinder board or, somewhat less advantageously, by the application of a dye directly to the surface of the preformed web. The web is next passed through a breaker calender stack. In one or more water boxes on this stack, we apply an additional amount of coloring material. Preferably, though not necessarily, plasticizing materials are applied at the same time. The board or web next has imprinted upon its surface a thin coating of the mineral-adhesive mixture, which also is colored as will be set forth hereinafter. If the web surface has been plasticized as set forth, the imprinting of the mineral-adhesive mixture is done during a persistence of the plasticizing effect. In order to attain a desired surface finish, the web may then be passed through a finishing calender stack. Additional color may be applied on the finishing calender stack, but this is ordinarily unnecessary and undesirable.

In the practice of our process there are essentially three applications of color. One is an application to the top surface of the web itself as in the beater-coloring hereinabove mentioned. The second is an application of color on the breaker stack of calenders; and the third is an application of color in the mineral-adhesive mixture. These color applications are not the same, nor do they have the same effect. If an attempt were made to keep the hue constant in all of the color applications, so that the chroma of the finished sheet would be the sum of the chromas of the several color applications, a non-uniform and unsatisfactory result would be obtained. Moreover, it would be impossible from the practical standpoint consistently to match the color of any given sample, or to hold the end product to strict specifications of color value.

Thus, in the practice of our invention we first impart to the paper or board a color which differs in hue or shade or both from the desired ultimate color of the product. This is most conveniently done by coloring the pulp from which the product is made in the beater, in known ways. It is possible to secure a somewhat similar result by applying a color coating to the felted sheet during the process of manufacture, i.e. before complete drying or just subsequent thereto; but a better and more uniform result is obtained more conveniently and with more exact control by coloring the pulp. In the case of a multi-cylinder board product, which will constitute the exemplary embodiment of the invention, color need be formed only in the top liner or liners of the product, as will be readily understood.

The nature of the top liner and coloring material in it may be conceivably varied in accordance with the desired final brilliance of the color coated sheet, as hereinabove defined, but the hue will normally be substantially lighter than the desired final hue, or the shade will be substantially different and lighter, it being a feature of our procedure that the hue and/or shade of the color, as well as the chroma, will be substantially modified by subsequent color applications, as hereinafter taught. By way of example, in the manufacture of the deep yellow coated board which will serve as the exemplary embodiment of this invention, the top liner of the board itself is beater-colored to a relatively light yellow hue and is later modified to a very much deeper hue, tending more toward the orange, although properly describable as a deep yellow.

The dried, beater-colored board in the exemplary embodiment is next passed over a stack of breaker calender rolls, and to its colored surface thereon we apply a color coating along with, if desired, a plasticizing solution. As explained above, the extent of the plasticization may be determined by the desired printing qualities of the ultimate product; but whether or not a plasticizing solution is applied at this point, there will be a color application by means of one or more water boxes on the breaker stack, which color application will be different in hue and/or shade from the color of the dried, beater-colored stock. The amount of coloring substance applied in this way onto and into the paper surface may be varied from slight to great because of the well-known capability of solutions of dyestuffs to reflect the degree of concentration of the dyestuff in the liquid when applied to a paper surface by the water box or boxes on a stack of calenders; but the colored product as it comes from the breaker stack of calenders will vary in hue and shade from the color of the beater-colored stock. The strength of the color will normally be very substantially increased, and the product if dried and examined at this point, while rather uniform in general appearance, will ordinarily be found non-uniform upon closer examination.

Next, a colored mineral-adhesive coating mixture is imprinted upon the colored surface of the treated board in a very thin layer. Normally, this color coating will likewise differ in hue and/or shade not only from the color-appearance of the beater-colored stock, but also from the color value of the coating applied on the breaker calender stack.

We have discovered that, first, when beater-colored stock receives a color application of a different hue and/or shade on a breaker calender stack and then is coated by imprinting with a colored, mineral-adhesive mixture, the result is a colored product of great uniformity of chroma, hue, shade and brilliance. The tendencies of the individual color applications to be formed or to deposit in such a way as to give a non-uniform result appear to counterbalance each other entirely.

Second and of equal importance, is the fact that compensatory changes and adjustments in the hue, shade and chroma of the final product can readily be made with great rapidity by modifying the color application on the breaker calender stack. If, in order to match an exacting color standard, changes had to be made either in the beater furnish or in the nature of the mineral-adhesive coating mixture, it would be a matter of hours before any such changes would be effective in altering the appearance of the finished product. However, the appearance of our finished product may be altered or adjusted in a matter of a few minutes by varying the color application on the breaker calender stack; and this is one of the many valuable features of our procedure. As has been indicated above, this feature of color adjustability and control would not be possible if the breaker calender stack operation did not result in a coloring differing substantially in hue and/or shade from the color produced by the beater-coloring operation.

After the application of the colored mineral-adhesive

composition by imprinting, the board is dried, and then may be passed over a finishing calender stack. Here a suitable finish may be applied to the board in any suitable way. Moreover, in many operations it will be desirable on the finishing calender stack to apply to the board a substance tending to insolubilize the adhesive of the mineral-adhesive composition in order to prevent wet rubbing.

The result of the drying and final calendering operations will usually be a change in the chroma of the colored stock. This does not interfere with the feature of adjustment and control aforementioned, since the operator will normally compare the finished stock with his color standard and make such adjustment in the breaker stack coloring solution or suspension as will be required.

It does not constitute a departure from our invention to apply color to the stock on the finishing calender stack. This, however, is not ordinarily necessary. Where practiced it also does not interfere with the control and adjustment feature described.

We shall now outline the practice of our process in an exemplary embodiment. Reference is first made to the drawing wherein the board coming from the multicylinder board machine is indicated by the numeral **1** and is shown as passing under the last of the board machine driers indicated at **2**. The product next passes through a breaker stack of calender rolls **3** having at least one water box **4** where the aforesaid color application is made. The board next is imprinted by the roll **5** with a very thin layer of the mineral-adhesive coating composition, this composition, **6**, being applied to the imprinting roll **5** by a series of transfer rolls **7**. If a plasticizing solution has been used on the breaker calender stack, the imprinting is done during a persistence of the plasticizing effect, i.e. before the plasticized surface of the board has completely dried.

Next, the treated board is dried as by a combination of roll driers **8** and an air blast **9**, after which it is passed through a finishing calender stack **10**, preferably having at least one water box **11**.

The exemplary product had a top liner with a beater furnish as follows, this being made up with fresh water and in the proper sequence of additions to the proper consistency for running the paperboard machine, as is well known by papermakers,

1500 lbs. long fibred bleached pulps
1500 lbs. short fibred bleached pulps
100 lbs. starch
100 lbs. clay
15 lbs. rosin size, 60% solids basis
175 lbs. papermaker's alum
22 lbs. Erie Yellow YP Conc. dyestuff
10 lbs. soda ash to pH 7.0 or above

The Erie Yellow YP Conc. is a direct type of dyestuff of the class listed as No. 365 in Colour Index of the Society of Dyers and Colourists by Rowe, first edition, January 1924.

The particular exemplary board had an inner liner also colored yellow in the beater, with color strength just slightly less than the top liner obtained by using 20 pounds of the Erie Yellow YP Conc. dyestuff per 3000 pounds fibers, and with the fibers divided equally between groundwood pulp and a mixture of bleached and unbleached chemical wood pulp fibres.

In the particular board the filler plies were made of newspapers and the back liner was made of newspapers strengthened with kraft fibres.

In the exemplary embodiment a coloring solution only was applied to the top liner on the breaker stack by means of the water box **4**. This solution had the following composition:

6 lb. 2-oz. Tartrazine N 8686 dyestuff
1 lb. 1-oz. Orange AD dyestuff
100 gal. water

The named coloring matters are water soluble dyestuffs and are listed as Nos. 640 and 161 in the Colour Index. Had the coated board been designed for fine printing, a plasticizing solution would have been employed on the top liner, applied either in combination with the coloring matter solution or by means of a separate water box or boxes. Such a solution would have comprised polyvinyl alcohol, converted starch, or mixtures thereof in water solution.

It was found that a sufficiently smooth surface for the printing requirements of this particular board was achieved through the action of the calender rolls in the presence of the water solution of coloring matter. A water solution of polyvinyl alcohol of, say, 5% concentration, or of the same concentration of chlorinated starch, applied to the top liner alone or in connection with the dyestuff, would have enhanced the plasticizing effect.

Whereas the dried, beater-colored board at the end of the paper machine was a light uniform yellow, the application of color by means of the water box **4** very substantially deepened the color, giving a yellow surface tending toward the orange. The "color strength" of the beater-colored board was, in the particular example, about 50%. The application of color at the breaker stack brought the "color strength" up to about 90% of that of the color sample to be matched.

The colored mineral-adhesive composition in water was made up in a Baker Perkins type of mixer to the following formula, using the mixing procedure for mineral-adhesive compositions well-known to the art, and including the usual small amounts of a dispersing agent for the minerals, plasticizers, etc.

Dry casein as percent of dry minerals---percent--	18.8
Ratio dry yellow to dry orange coloring matters--	5 to 1
Dry colors as percent of dry minerals---percent--	8.7
Solids content of completed colored mineral coating mixture----------percent--	52.5
Brookfield viscosity of completed colored mineral coating mixture at 98° F. with No. 7 spindle at 20 r.p.m.----------centipoises--	29,000

The mineral matter was a high grade domestic clay in an extremely fine state of subdivision testing:

Brightness G. E----------	83
Particle size----------	82% below 2 microns
Residue ----------	On 200 mesh screen 0.1%; on 325 mesh screen 0.015%.

The colors were:

YH 5750 Yellow (20% paste in water) and
YH 5890 Orange (20% paste in water)

These are Hansa Yellows, known as azo colors of the aceto-acet-arylide series.

The coating composition was imprinted on the top liner at the rate of 4.1 lbs. per 1,000 square feet on the wet basis or 2.15 lbs. solids per 1,000 square feet, dry.

In finishing the board on the finishing calender stack **10**, the water box **11** contained a solution as follows:

8 gal. glyoxal (30% solids)
33 lb. dry papermaker's alum
92 gal. water

This resulted in a waterproofing of the coating to the extent of making it resistant to wet rubbing.

It will be noted that the adhesive in the above example is casein, the waterproofing solution comprising alum and glyoxal. Starch could have been employed as the adhesive, and to achieve resistance to wet rubbing, a melamine or similar resin could have been employed together with a catalyst. In employing a mineral-adhesive coating and an insolubilizing agent or agents, it is preferable to make the applications separately to avoid a

premature setting up of the composition. Thus, with starch as the adhesive, the resin might be imposed on the breaker stack and the catalyst on the finishing stack, or vice versa. With casein, the insolubilizing material is preferably imposed on the finishing stack since otherwise there may be a tendency for the coating composition to harden or set up on the imprinting roller 5.

The particular example which has been given resulted in the production of an excellent board of deep yellow color and uniform appearance with a surface quality suitable for ordinary printing. The product exhibited no fade after 48 hours in the fadeometer. It cleared 9A on the wax pick test. As a test for water fastness, a drop of distilled water was allowed to remain on the coated board surface for 20 seconds, after which the surface was rubbed 5 strokes with facial tissue. Only a very slight yellow color appeared on the tissue.

The product was very exactly matched in production to a color standard. This was accomplished by adjusting the strength of the color applied on the breaker stack 3 by dilution with plain water or by the addition of more color as required. These changes could be made almost instantaneously so that there was negligible waste in the run due to the production of board which did not match the color standard.

The example given above, while directed to the manufacture of a yellow coated board, will clearly be instructive to those skilled in the art in the manufacture of boards of other colors through the choice of different dyes and coloring materials. While acid dyestuffs preferably should be used on the breaker calender stack, dyes or pigments or both may be employed both in beater-coloring the liner or liners of the stock and in making up the mineral-adhesive coating composition.

Modifications may be made in our invention without departing from the spirit of it. Having thus described our invention in an exemplary embodiment, what we claim as new and desire to secure by Letters Patent is:

1. In a process of producing a colored coated paper or board stock, the steps of producing a stock having a beater-color, passing said stock through a breaker calender stack, and imposing on its surface a water solution of coloring material of substantially different hue, and then imprinting on the colored surface of the stock a colored mineral-adhesive composition.

2. The process claimed in claim 1 wherein the color of the resultant product is continuously adjusted by controlling the color application on the said breaker calender stack, the chroma, hue and shade of the finished product being composites of the chromas, hues and shades of at least the said three coloring steps.

3. The process claimed in claim 1 wherein the beater-colored surface of the product is plasticized on the said breaker calender stack and wherein the mineral-adhesive coating is thinly imprinted thereon during a persistence of the plasticizing effect.

4. The process claimed in claim 2 wherein the beater-colored surface of the product is plasticized on the said breaker calender stack and wherein the mineral-adhesive coating is thinly imprinted thereon during a persistence of the plasticizing effect.

5. The process claimed in claim 4 wherein the product after coating with the mineral-adhesive coating material is dried and passed through a finishing calender stack, and including the step of imposing on said material on said finishing calender stack a coating of insolubilizing material for the adhesive of the said mineral-adhesive coating composition.

6. In a process of producing a coated colored web including the steps of manufacturing a web, at least an outer surface of which is colored, and imposing upon said colored surface an imprinted layer of colored mineral-adhesive composition, the control step of imposing upon the surface of said web a coloring solution by means of a water box on a calender stack and varying the hue of the said coloring solution to match the final color value of said web to a predetermined color standard.

7. In a process of making a colored coated web, the steps of producing a felted web having at least a surface portion beater-colored to a relatively light color value, imposing on said web by imprinting a relatively light coating of mineral-adhesive coating substance colored to a relatively deeper color, and intermediate the said operations passing the said web through a calender and imposing upon its surface a coloring solution producing a color of different hue than the said beater-color.

8. The process claimed in claim 7, including the step of adjusting the final color of the web by varying the application thereto of color on the said calender.

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