

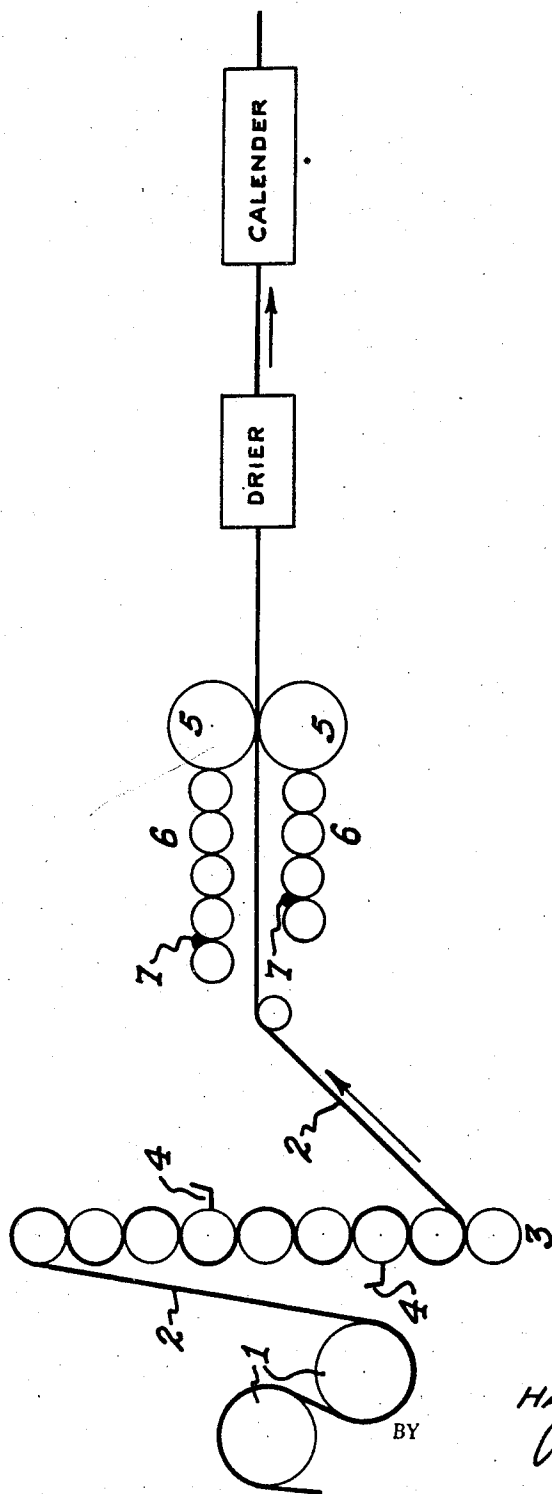
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METHOD OF PRODUCTION OF COATED BOARD AND PAPER

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METHOD OF PRODUCTION OF COATED
BOARD AND PAPER

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This application is a continuation in part of my application Serial No. 406,074 filed August 8, 1941, entitled Method of production of coated board and paper.

The problem of producing a paper board which is coated to receive ink impressions, and which has a fine, smooth finish, within the economical practices which are necessary in order to produce a commercial product, is one which presents a series of problems, based on the natural surface condition of paper board, its natural color due to its composition, etc., making it a difficult starting material on which to produce economically an adequately smooth surface.

It is my object to produce a paper board which, as to its final surface presents in varying degree as fine a surface as characterizes coated paper of the type employed for good printing, and is coated, dried and calendered in a continuous operation.

I have found that an effort to accomplish this end by virtue of repeated thin applications of coating composition (called color coating) which normally consists of finely divided clay with or without other finely divided mineral matter in a binder of starch and water, is not only uneconomical, but presents problems in treatment which make of such practice a delicate operation to control outside of the laboratory.

The difficulty with attempting to apply a color coat on paper board which is thin enough to be economical, is that the coating takes a surface which corresponds to the surface which the material had to start with, and therefore, is rough or smooth depending upon the underlying board. Furthermore, if only a small amount of coating is applied, there is not enough plasticity in the coating to permit of its being smoothed and ironed out in calendering thereby to modify the natural board surface. If enough coating were applied to paper board to permit of such smoothing, the practice is too expensive, and indeed requires a high grade base material and so much coating that difficulties of continuous operation would be insuperable in any industrial scale apparatus with which I am familiar.

In my invention I follow the procedure of applying to paper board, as freshly made, including the normal drying, a preliminary treatment with surface modifying material coincident with the

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application of heavy pressure applied to the board, such as may be applied by a "breaker stack" of calender rolls. This is distinctly not a coating step because of the fact that the structure, more particularly the surface structure, of the board is modified by the pressure accompanied by the presence of the modifying material, whereas in a coating practice there is no such pressure and the coatings are merely smoothed.

One reason for applying the surface modifying material is that it is desired to provide for a paper board surface which after the application of very thin color coat will still be plasticizable in the ultimate calendering operation, and hence the amount of plasticizable material included in the surface treatment imparted under pressure conditions will depend upon the material used, certain water soluble, highly plasticizable materials being preferred, but greater amounts of less plasticizable water-borne materials being satisfactory.

Another reason for applying the surface modifying material is that the coincident pressure as applied to the surface modifying agent, will give a more permanent smoothing effect to the paper board surface, forcing to a maximum extent the modifying material into the surface, so that as compared to a mere pressing treatment without the modifying material, the smoothing action will be retained, and the board better prepared to take on a thin color coat when promptly applied.

For paper board of good color to begin with, it is not necessary for the surface modifying treatment to utilize any pigmenting agent, whereas with darker colored paper board this is a desirable item.

With regard to the subsequent coating, the practice of modifying the surface as indicated permits of the use of color coatings of extreme thinness and this in turn permits of continuous operation from application through drying to calendering without stoppage, which is a great economy in operation. Such a coating can be applied by means of rolls operating in a manner similar to printing rolls, and can be quite thick in consistency. Thus a coating may be used containing water, a binder of a readily soluble starch, and pigment such as, for example, the usual clay coating mineral matter, the water being only around 50% of the whole, which is radically less water than is normally used with such a coating.

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The particular binder or the particular mineral matter in the color coat or "clay coat," as the term is used in the coating art, is not an essential item in my process.

A board given the surface treatment indicated, without any extra drying stage, can be passed immediately between printing rolls to which a film of the aforesaid clay coating is applied, thereby superimposing the coating on the pre-treated web, after which a short, continuous drying stage will prepare the web for the final calendering operation. The color coat will not be of a type which could plasticize sufficiently as to produce a surface independent of the underlying smooth surface which contains a plasticizable material and is water-borne, similarly to the applied coating; this coating associates itself with the underlying material producing a plasticizable surface which can be highly smoothed, giving the effect of what is known as a clay coated board, with much less expense.

A mode of operation of making clay coated board is to calender the paper board in the presence of water after it comes from the paper machine, and dry it. The board is then stored prior to the coating treatment. For coating a slurry of clay coating material is applied in several times as thick a layer as used in the coating above noted, and this thick coating is brushed with brushes, smoothed with rolls, festooned and dried. Thereafter, after a further storing period, the board is passed through calenders to give it a finish. The cost of production of such a board is not comparative with the cost of production of the board made as briefly above indicated. The thickness of the coating is such that the surface of the paper board itself is not a controlling factor in the finished surface, there being enough coating to give a surface which is independent of the starting surface, but the coating requires storage and drying periods and a high grade base product is usually necessary. My application, filed August 8, 1941, Serial No. 406,074, of which this application is a continuation in part, describes as a surface modifying film, a water soluble polyvinyl alcohol and starch composition, among other things. Instead of this the surface modifying treatment may be accomplished by the use of starch alone provided a highly soluble form of starch is used, so that from a physical point of view sufficient starch can be applied in the breaker calender stack, i. e. in the presence of high pressure, so that at the end of the operation there will be a surface of sufficient plasticity to react properly and permanently to the final calendering.

It is necessary that the surface modifying agent should be one which is water-borne, and mainly soluble and dispersible in water, because the color coat is also of this type and the amalgamation of the two is an important aspect of my practice.

I am aware that it is old to apply a starch size to paper board, when passing such paper board through a calender stack at the end of a paper board machine operation. This has been done in order to facilitate the smoothing effect of the calenders on the paper board. The amount of starch used in such operations has been small, principally because of its tendency to pull fibers, causing the paper to stick to the calender rolls, and its tendency to discolor the paper surface making it of a browner cast, and its tendency to make the surface of the board hard, and too ink resistant for some purposes.

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However, by my practice I use preferably amounts of starch which the experienced operator of a board mill of the past would rebel against using. I am able to do this because I immediately follow the surface treatment with the application of the color coat with the result of again wetting the surface, which is still quite damp from the original imposition of the starch solution. This eradicates the defective spots which it is not practical to avoid due to the amounts of starch used, were the latter applied and the board thereafter dried before subsequent coating.

It is because the polyvinyl alcohol will impart the required ultimate plasticity of surface to the freshly coated web, with relatively very small amounts of starch or none at all, that I prefer to use surface modifying solutions in which character giving amounts of polyvinyl alcohol are used.

In general, the preliminary treating composition should have the following characteristics. It should be (1) capable of going into solution or dispersions of equivalent character in water, (2) capable of penetration into the surface of the board sufficiently to coat and condition the surface thereof, (3) capable of being plastically spread after being applied to the board, (4) when applied and plastically spread, giving a surface which can be evenly and uniformly wetted with water, and having wet strength, (5) capable of becoming intimately attached to the subsequently applied and dried mineral coating in aqueous vehicle, (6) sufficiently low in cost to make commercial use practical in the concentrations required.

The wide range of plasticizable organic substances of resinous character, or behaving like the resins, will no doubt include many substances suitable for my purpose except for the fact that their behavior in relation to water as a solvent or dispersing vehicle is not suitable. There are at present available industrially certain organic, plasticizable substances which will go into water solution or dispersion in water and these are satisfactory for my purpose although in varying degrees. The polyvinyl alcohols, methyl-cellulose alginate compounds and polyacrylic acid are instances. It is found that polyvinyl alcohol is considerably superior. Polyvinyl alcohol has been applied to paperboard and other paper products but its properties in preparation of a smooth surface without uneconomical mechanical work, which will take a very smooth and uniform color coat in aqueous vehicle and upon final calendering, continue to exhibit plastic flow so as to produce a most admirable printing surface, has neither been known nor developed.

While there is no desire to be limited to any particular mode of application, it is required that the material used with the board should be applied ahead of any suitable mechanism which will smooth the resulting surface of the material on the board, or in direct connection with any suitable mechanism which will smooth the resulting surface of the material on the board, which mechanism will be ahead of the point where the color coating is to be applied, preferably as a continuous operation timed with the preparation of the board. For example, and without limitation, the material might be applied on a size press in the drier section of a paper machine, or on a calender stack immediately following the drier section.

Thus in describing a practice reference will be made to the known technique of applying

treating materials in the nip or bite of rolls in a breaker stack of calender rolls which follows the driers in a cylinder paper board machine. Such practice has been used for sizing applications, the coloring of paper and board, starch treatments, and similar treatments, and need not be detailed in this specification.

Thus in the appended drawings is shown in diagram a set-up of machinery with which my process can be employed.

In the drawings, the figure illustrates the end of a paperboard machine by the rollers 1. The web of board is indicated at 2. A so-called "breaker stack" or preliminary calender stack is indicated at 3, around which stack of calender rolls, the web of board passes. The boxes 4 are used to apply the sizing or coating material to the web while it passes through the calender stack. From the calender stack the sheet passes directly to a coater for applying a color coating. This is illustrated as one which applies a thin coating of fairly thick consistency, by means of rolls 5, which are supplied with a surface film of color coating material as by means of spreading rolls 6, 6, to which a suitable fountain apparatus 7 supplies the color coating material. As showing the imprinting coater of this type I refer to Massey Patent 2,105,981 of January 18, 1938. From the coating step, the board passes around driers and finally to the ultimate calendering operation, as illustrated by the two blocks in the diagram. When only one side is to be treated appropriate portions of the apparatus will be employed.

If a size press is used for the operation of applying the coating previous to the breaker stack, again, any standard mechanism may be employed which will be understood without additional illustration.

Polyvinyl alcohol (PVA) possesses qualities requisite for conditioning the surface of paperboard for the reception of coatings as described. (For the chemistry of polyvinyl alcohol read "The Chemistry of Synthetic Resins" by Ellis, volume 2, page 1054 on, edition 1935.) It is water soluble and therefore can be handled cheaply on the paper machine calenders, size presses, etc., and forms a tough, plastic coating or film upon and during evaporation of the water from the solution and, therefore, in connection with the calendering operation, fills and covers the surface of the board to present a smooth, even, compact surface with uniform rate of water absorption and with wet strength. This, in turn, exercises control of the quality of overlying color coating, e. g. clay coating, since water is absorbed evenly from it to produce, first, a damp coating layer of uniformity, and, upon drying, a dried coating layer of uniformity. A tendency apparently exists for PVA from the coating or film to merge into the layer of color coating. Further, the final calendering of the dried coated board may be aided by the plastic nature of the PVA treatment imposed between the paper board and the clay coating and here, again, the effect of moisture, such as steam on the finishing calenders, may be made more effective because of the moisture-sensitive nature of the imposed PVA thus permitting additional movement of coating mix under the great pressure of the finishing calenders.

The incorporation of finely-divided mineral matter, such as titanium dioxide, into the PVA solution to whiten and opacify the film, or clay, or other finely-divided mineral matter for the same purpose, and of organic dyes and pigments

to color it, have been practiced. The toughening effect of finely-divided mineral loading materials upon plastic material is recognized. The use of plasticizers from the polyhydroxy alcohols, for example, glycerine and others, is known. Methods of insolubilizing the PVA as by treatment with formaldehyde, chromium compounds, etc., of extending the PVA by mixing its water solution with a water solution of jelled starch, etc., are known. All of these procedures may have utility providing that they do not change the fundamental characteristics imparted by PVA or its equivalent, namely, to fill, compact, smooth, and make uniform in surface finish and water absorptivity the surface of the board later to receive the clay or mineral coating mixture in water.

It has been found by experiment that a surface of paper board treated to be water repellent, as by wax size on the calenders, will resist uniform "lay" of clay coating to such extent that the coating will crawl or ball up into tiny patches on the board. A film of printing ink imposed thereover shows corresponding defects. This occurs despite the fact that the wax is plastic and is worked into the surface of the board. I have discovered that plasticity under pressure of the calenders must be accompanied by water absorptivity. Thus, where such a wax size is altered to reduce the amount of wax and increase the agent, such as protein, used to disperse the wax in water, a corresponding increase in water absorption and its rate will occur but with decreases in over-all plastic nature of the dried wax size, thus resulting in a board surface less satisfactory for reception of subsequently applied clay or mineral coating than otherwise. Similarly, a starch film will be water sensitive but less plastic than polyvinyl alcohol.

A five per cent concentration of polyvinyl alcohol, by weight, has been found ample for breaker stack application as described. Also dilution with a jelled solution of converted starch is practical. I have gone so far as to use one part by volume of the five per cent polyvinyl alcohol solution with four volumes of a six per cent converted starch solution (by weight). This will vary with the nature of the surface of the board, its fiber and sizing composition, degree of calendering permissible, etc. Starches converted to give low viscosity in solution are preferred. Higher proportions of polyvinyl alcohol solution in this combination are desirable. By converted starch is meant one which has been modified to have low viscosity in solution as by chlorination, oxidation, enzymic treatment, etc.

Polyvinyl alcohol is obtainable commercially in different kinds and with various viscosities. Some grades are less soluble in hot water than cold and vice versa; some grades have low viscosities in water solutions and others, high. A grade more soluble in hot than in cold water and with low viscosity in solution produces good results when used as described herein. A four per cent water solution of such a grade of polyvinyl alcohol has a viscosity of 20° C. of about 5 centipoises. Due to its lesser viscosity in solution, low viscosity polyvinyl alcohol handles more easily and with less danger of sticking on the calender rolls or other equipment of the paper machine and, therefore, can be used in higher concentration, and is preferred for that reason. On the other hand, films of higher viscosity polyvinyl alcohol are stronger and tougher and are to be preferred if that property proves to be necessary.

Water solutions of methyl cellulose (a water-soluble cellulose ether), also perform in the manner of polyvinyl alcohol on the breaker stack of calenders before the clay coating operation, although not so satisfactorily. A water solution containing three and one-half per cent methyl cellulose, by weight, deposits in and on the surface of the board a layer or film comparable with that from polyvinyl alcohol solutions as regards smoothness, evenness, uniform sensitivity to water, etc., as described. Methyl cellulose of low viscosity, e. g., 15 centipoises as measured in a 2% aqueous solution at 20° C., is a typically usable grade; here again, the low viscosity grades offering advantages of ease of operation.

A practical problem encountered in the use of methyl cellulose is the necessity of keeping the solution relatively cold at the point of application on the calenders else the methyl cellulose is precipitated out of solution, being more soluble in cold than in warm or hot water. Methyl cellulose also can be extended or blended with various materials including starch, can be colored, opacified, etc., as described above in connection with PVA.

A resinous material akin to polyvinyl alcohol and likewise water soluble, is polyacrylic acid (see "Chemistry of Synthetic Resins" by Ellis, volume 2, pages 1070-1073). Applied to paper or board from water solution in the calender box or prior thereto, it should condition board for the reception of clay coating since the quality of water-receptivity of the coating remains on the calendered sheet.

Extension of PVA solutions on the breaker calender stack by inclusion of jelled starch or the like does not alter the fundamental character of the PVA effect. Such effect is to prepare the board surface for uniform and smooth reception of the water vehicle clay or other color coating by imposing and compacting thereon a tiny film or layer containing PVA material. Thus, it would appear that the fundamental sensitivity of the PVA treatment to water in subsequently applied coating would be constant in character.

In a typical operation, paper board 2, from the driers 1, and moving continuously from a cylinder board making machine was caused to pass between the calender rolls 3 of a breaker stack, and one of the boxes 4, used ordinarily for applying water or starch size by flowing the same into the nips of the calender rolls was supplied in one nip against the top side of the board with the starch jelly and the PVA together in water solution—one part by volume of five percent PVA solution (by weight) mixed with four parts by volume of a six percent solution of converted starch (by weight). The board had a patent white top, news back furnish, finished thickness of .022 inch, and about three to four percent moisture in it when it reached the breaker stack. The treatment on the top of the board in the breaker stack resulted in a product which was drawn rapidly and directly to a coating stage 5, where it was coated economically with a suitable clay coat as described. Such clay coats as were used contained a starch binder. Also when reaching the color coating step this board contained more moisture in the surface than throughout the remainder of the board. Then the coated product was dried and calendered by passing it over heated drier rolls 8 and through additional stacks of calenders.

The resulting coated board was then printed with various printing inks, including letter press

inks of the oxidizing and/or polymerizing type and for gloss or flat printing. It was found that the coated surface of the board took these inks to produce printing of great uniformity and high quality and that the coating on the board had a good wax pick test, was even, continuous and smooth without hills, valleys, pit marks, etc., resulting from uneven reception and finishing of the coating material, without specks or fuzz, and decidedly improved over one which was treated only with water or a starch solution in the breaker stack, without the polyvinyl alcohol.

When it is not possible to obtain the polyvinyl alcohol or some other plasticizable, water-borne agent of similar characteristics, starch alone may be used, within a certain range. If too little is employed, the desired effect is not gained. If too much is used, it will be unmanageable. A typical raw starch like the "pearl" grade of corn starch will not serve because it can be used on the breaker stack only in a maximum concentration of a couple of percent by weight, which is not sufficient for my purpose.

Converted or thin boiling starches, which are available on the market, and result from treatment with enzymes, chlorine, acids, etc., may be boiled and jelled in water to give solutions of comparatively high solids content with low viscosity of solution, and concentrations up to some 12% solids by weight, can be used without significantly "picking" the paper surface or sticking to the rolls of a machine calender stack. The use of a small amount of dispersed wax in the starch will reduce its stickiness and not militate against the conditions which my practice requires. In practice some five pounds wax solids to 100 pounds converted starch solids, has been used advantageously.

Instead of the use of starch in relatively high concentrations resulting in discoloring the finished coated board, as would be expected from prior experience with board not coated, I have used chlorinated starch from around 5% concentration up to 10% concentration in water with results comparative to those obtained by the use of polyvinyl alcohol, as already described. Whether a starch could be produced which had sufficiently low viscosity at higher than around 10% concentration to permit of application in a calender stack, I do not know, and hence do not wish to set forth any upper limits to the concentration. The low limits are that the starch must be of the low viscosity type, such as the converted starches so called in the trade, and should be used in concentrations of around 5% solids by weight, and upwardly.

Others have suggested many surface treatments for paper and paper board directed to imparting water- and grease-proofness, using among other ingredients polyvinyl alcohol, methyl cellulose, etc., but in these cases there has been no subsequent coating of the paper as with the clay coatings which I employ although with less than normal water content. My essential discovery is that a clay coating for paper may be applied in a thin film, and the ultimate surface be plasticizable enough to give a highly smooth result, if the preliminary treatment such as I have described is imparted to the web. This provides a way of making a highly finished coated paper by a continuous operation from raw materials to finished product.

Variations of practice over the above, which is given merely as an example, can be employed to vary the suitability of the coated sheet for dif-

ferent kinds of printing. Gloss ink printing, because of the tacky nature of the ink, requires a physically strong color coating; the more of the polyvinyl alcohol used, the more suitable is the color coated sheet for gloss ink printing chiefly because the adhesive bond between color coating and paper surface is improved but also because the color coating itself is improved.

In like manner, the surface of the paper or board to be coated can be conditioned prior thereto so that printing ink will lend itself more readily to a flat finish than to a gloss. The inclusion of a penetrating or wetting agent, hereafter termed "penetrating agent," in the water solution of PVA, serves to condition the surface of the board so that clay or color coating applied thereon calenders out to a finish of such quality that printing thereon is more suitable for the flat than the glossy variety.

One such penetrating agent is butyl carbitol, the monobutyl ether of diethylene glycol, a colorless and practically odorless liquid. The sodium salts of sulphuric acid esters of the higher fatty alcohols are useful as penetrants also. This control of gloss in printing is covered in a companion case, whether the penetrating agent is used with the plastic water soluble material or by itself or with other materials.

Paperboard, conditioned and coated as described, on one or both surfaces, can be converted into cartons and containers, printed sheets, etc., by the usual process of printing, scoring, cutting, bending, gluing, etc., these articles being of particular value because of their superior quality.

Having thus described the invention, what is claimed as new and desired to secure by Letters Patent is:

1. A process for treating of paper which consists in applying an aqueous polyvinyl alcohol solution to the surface of a web thereof, passing the same through rolls to plastically smooth the resulting surface, and then while retaining the dampened condition of the web surface, imprinting onto the web a mineral coating in an aqueous vehicle and finally drying and calendering the coated product.

2. A process for treating of paper which consists in applying an aqueous polyvinyl alcohol solution to the surface of a web thereof, passing the same through rolls to plastically smooth the resulting surface, and then while retaining the dampened condition of the web surface, imprinting onto the web a mineral coating in an aqueous vehicle and finally drying and calendering the coated product, the mineral coating being applied in a relatively thin film and relatively drier as applied than normal mineral coating, and all of the steps being applied to a continuously moving web.

3. A process for treating of paper webs which consists in passing a freshly made paper web through rolls, and at the nip thereof applying thereto an aqueous solution of polyvinyl alcohol, and then while retaining the dampened condition of the web surface, imprinting onto the web a mineral coating in an aqueous vehicle, and finally calendering the coated web.

4. A process for treating of paper webs which consists in passing a freshly made paper web through rolls, and at the nip thereof applying thereto an aqueous solution of polyvinyl alcohol, and then while retaining the dampened condition of the web surface, imprinting onto the web a mineral coating in an aqueous vehicle, and

finally calendering the coated web, the mineral coating being applied in a relatively thin film and relatively drier as applied than normal mineral coating, and all of the steps being applied to a continuously moving web.

5. A process for treating of paper which consists in applying a plasticizable, film forming water-borne substance chemically inert to the fibers to the surface of a web thereof, passing the same through rolls to plastically smooth the resulting surface, and then while retaining the dampened condition of the web surface, imprinting onto the web a mineral coating in an aqueous vehicle and finally drying and calendering the coated product.

6. A process for treating of paper which consists in applying a plasticizable, film forming water-borne substance chemically inert to the fibers to the surface of a web thereof, passing the same through rolls to plastically smooth the resulting surface, and then while retaining the dampened condition of the web surface, imprinting onto the web a mineral coating in an aqueous vehicle and finally drying and calendering the coated product, the mineral coating being applied in a relatively thin film and relatively drier as applied than normal mineral coating, and all of the steps being applied to a continuously moving web.

7. A process for treating of paper webs which consists in passing a freshly made paper web through rolls, and at the nip thereof applying thereto a plasticizable, film forming water-borne substance chemically inert to the fibers, and then while retaining the dampened condition of the web surface, imprinting onto the web a mineral coating in an aqueous vehicle, and finally calendering the coated web.

8. A process for treating of paper webs which consists in passing a freshly made paper web through rolls, and at the nip thereof applying thereto a plasticizable, film forming water-borne substance chemically inert to the fibers, and then while retaining the dampened condition of the web surface, imprinting onto the web a mineral coating in an aqueous vehicle, and finally calendering the coated web, the mineral coating being applied in a relatively thin film and relatively drier as applied than normal mineral coating, and all of the steps being applied to a continuously moving web.

9. A process for treating of paper which consists in applying an aqueous polyvinyl alcohol solution to the surface of a web thereof, passing the same through rolls to plastically smooth the resulting surface, and then while retaining the dampened condition of the web surface, imprinting onto the web a mineral coating in an aqueous vehicle and finally drying and calendering the coated product, the said aqueous polyvinyl alcohol solution comprising up to four parts by volume of a converted starch to one part of the alcohol.

10. A process for treating of paper which consists in applying an aqueous polyvinyl alcohol solution to the surface of a web thereof, passing the same through rolls to plastically smooth the resulting surface, and then while retaining the dampened condition of the web surface, imprinting onto the web a mineral coating in an aqueous vehicle and finally drying and calendering the coated product, the mineral coating being applied in a relatively thin film and relatively drier as applied than normal mineral coating, and all of the steps being applied to a con-

tinuously moving web, the said aqueous polyvinyl alcohol solution comprising up to four parts by volume of a converted starch to one part of the alcohol.

11. A process for treating of paper webs which consists in passing a freshly made paper web through rolls, and at the nip thereof applying thereto an aqueous solution of polyvinyl alcohol, and then while retaining the dampened condition of the web surface, imprinting onto the web a mineral coating in an aqueous vehicle, and finally calendering the coated web, the said aqueous polyvinyl alcohol solution comprising up to four parts by volume of a converted starch to one part of the alcohol.

12. A process for treating of paper webs which consists in passing a freshly made paper web through rolls, and at the nip thereof applying thereto an aqueous solution of polyvinyl alcohol, and then while retaining the dampened condition of the web surface, imprinting onto the web a mineral coating in an aqueous vehicle, and finally calendering the coated web, the mineral coating being applied in a relatively thin film and relatively drier as applied than normal mineral coating, and all of the steps being applied to a continuously moving web, the said aqueous polyvinyl alcohol solution comprising up to four parts by volume of a converted starch to one part of the alcohol.

13. A process for treating of paper which consists in applying a solution in water of starch of at least substantially 5% concentration to the surface of a web thereof, passing the same through rolls to plastically smooth the resulting surface, and then while retaining the dampened condition of the web surface, imprinting onto the web a mineral coating in an aqueous vehicle and finally drying and calendering the coated product.

14. A process for treating of paper which consists in applying a solution in water of starch of at least substantially 5% concentration to the surface of a web thereof, passing the same through rolls to plastically smooth the resulting surface, and then while retaining the dampened condition of the web surface, imprinting onto the web a mineral coating in an aqueous vehicle and finally drying and calendering the coated product, the mineral coating being applied in a relatively thin film and relatively drier as applied than normal mineral coating, and all of the steps being applied to a continuously moving web.

15. A process for treating of paper webs which consists in passing a freshly made paper web through rolls, and at the nip thereof applying thereto a solution in water of starch of at least substantially 5% concentration, and then while retaining the dampened condition of the web surface, imprinting onto the web a mineral coating in an aqueous vehicle, and finally calendering the coated web.

16. A process for treating of paper webs which consists in passing a freshly made paper web through rolls, and at the nip thereof applying thereto a solution in water of starch of at least substantially 5% concentration, and then while retaining the dampened condition of the web surface, imprinting onto the web a mineral coating in an aqueous vehicle, and finally calendering the coated web, the mineral coating being applied in a relatively thin film and relatively drier as applied than normal mineral coating, and all of the steps being applied to a continuously moving web.

17. A coated paper board product, consisting of paper board having on its surface a thin layer of independently plasticized, smoothed and spread polyvinyl alcohol, and superposed upon and merged into said layer, a layer of mineral coating dried from an aqueous vehicle, the whole having a subsequently applied calendered finish.

18. A coated paper board product, consisting of paper board having on its surface a thin layer of independently plasticized, smoothed and spread plasticizable, film forming, water-borne substance inert to the fibers, and superposed upon and merged into said layer, a layer of mineral coating dried from an aqueous vehicle, the whole having a subsequently applied calendered finish.

19. A coated paper board product consisting of paper board having on its surface a thin layer of a chemically inert substance, having the property of forming a solution or dispersion in water, and yet being plastic in the sense that it can be spread and smoothed into an integral layer and water wettable after spreading and smoothing, said layer being independently plasticized, smoothed and spread, and superimposed upon said layer, a layer of mineral coating dried from an aqueous vehicle merged into the underlying layer, the whole having a calendered surface.

20. The process of preparing a paper or paper board for printing, by successive steps applied to a continuously moving web, which consists in first plastically sealing the surface of the web with a solution of film forming substance water wettable when formed, then immediately imprinting thereon a controlled coating of wet mineral mixture of thick consistency, and finally drying and calendering the product.

21. The process of preparing a paper or paper board for printing, by successive steps applied to a continuously moving web, which consists in first treating the freshly formed paper surface with a solution of film forming substance water wettable when formed, capable of plastic deformation, plastically sealing the paper surface of the web by smoothing, pressing, compacting and driving the solution into the paper surface, immediately imprinting thereon a controlled coating of wet mineral mixture of thick consistency, and finally drying and calendering the product.

22. The process of preparing a paper or paper board for printing, by successive steps applied to a continuously moving web, which consists in first treating the freshly formed paper surface with a solution of film forming substance water wettable when formed, capable of plastic deformation, plastically sealing the paper surface of the web by smoothing, pressing, compacting and driving the solution into the paper surface, immediately imprinting thereon a controlled coating of wet mineral mixture, and finally drying and calendering the product.

23. A coated paper board product consisting of paper board having on its surface, and in intimate attachment thereto, a thin layer of independently plasticized, smoothed and spread substance comprising polyvinyl alcohol and starch, and superimposed upon and intimately attached to said layer, a coating of finely-divided mineral matter with starch binder dried from an aqueous vehicle, the whole having a calendered finish.

24. A coated paper board product consisting of paper board having on its surface and in adhesive contact therewith a thin layer of a chemically inert substance, having the property of forming a solution or dispersion in water, and yet being plastic in the sense that it can be spread and

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smoothed into an integral layer and capable of imparting wet strength to the layer containing surface, said layer being independently plasticized, smoothed and spread, and superimposed upon said layer, and in intimate adhesive contact therewith, a layer of mineral coating dried from an aqueous vehicle, the whole having a calendered surface.

HARRY C. FISHER.

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