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PAPER WITH IMPROVED SURFACE

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Fig. 1.

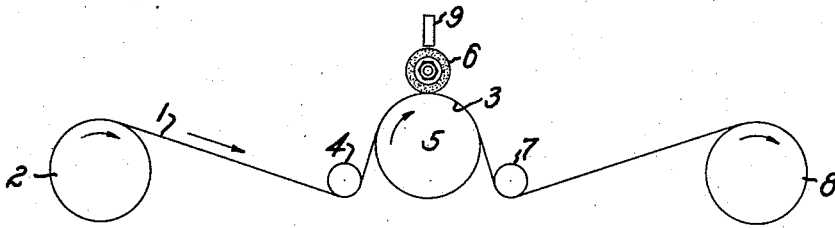
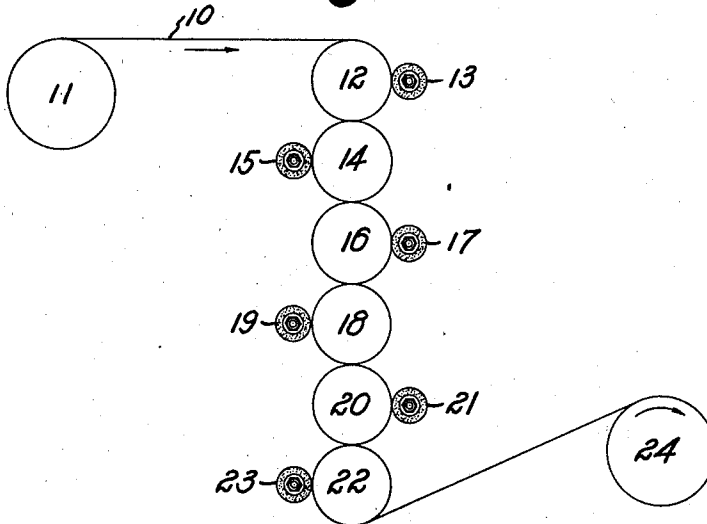


Fig. 2.



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PAPER WITH IMPROVED SURFACE

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12 Claims. (Cl. 92—68)

This invention relates to the art of finishing fibrous webs, e. g., paper and the like, and is particularly concerned with surface treatment both of coated paper and of uncoated paper. The invention has both process and product aspects.

In the practice of making paper it is customary to prepare a fibrous furnish containing fiber and frequently also sizing agents and filling material such as clay or the like; to flow a layer of the fibrous furnish upon a wire screen or the like; to drain off excess water, the solids remaining on the screen in the form of a continuous web; to strip the web from the screen and further dewater it as by pressure followed by application of heat; and then, if desired, to smooth the dried web as by action of a calender. In many cases a layer of coating is applied to one or both sides of the web, either in an operation integrated in the paper-making procedure or in a separate operation after the web has been removed from the paper-machine. Paper coating mixtures vary widely in composition; most frequently they consist of aqueous dispersions of film-forming material such as starch, casein or equivalent, and generally also contain solid mineral matter, e. g., clay, satin white, calcium carbonate bronze or similar metallic powder, and the like, in the form of discrete particles. In some cases, instead of, or in addition to, receiving such a "mineral coating" the paper is coated with a layer of varnish, lacquer, resin, or the like.

An important object of the invention is to provide a novel method for improving the surface of paper or similar sheet material.

Another object of the invention is to provide a method for improving the gloss of paper.

A further inventive object is to provide a method for increasing the resistance of paper to penetration by varnish, lacquer or the like.

It is an object of the invention, also, to enhance the gloss of paper which already has been treated by a conventional finishing process and has a gloss normal for a product of said conventional finishing process.

Another object is to provide paper having the desirable characteristics of normal supercalendered paper but having a gloss higher than that of normal supercalendered paper.

Other objects of the invention include: the provision of uncoated paper having a gloss higher than that of previous uncoated paper; and the provision of printing paper having a gloss higher than that of previous printing paper.

The above, and other, objects of the invention are realized by the carrying out of the process to be described in the following paragraphs.

For carrying out the process of the invention, a paper web is first prepared in any conventional manner. The paper may or may not contain filler and/or size as desired. The web may be

left uncoated or it may be coated with any conventional sizing coat, mineral-coating, and/or lacquer, varnish, or resin as desired. The web should, either during the process of drying or subsequently, be rendered relatively flat. Flattening of the web may be accomplished fairly satisfactorily by drying the uncoated or coated web while it is under tension—or, by drying it in contact with a polished metal surface such as that of the drying drum of a so-called "Yankee machine." In many cases it is preferred to calender the web, or to supercalender it as by passing it through a stack of pressure rolls in which alternate rolls are hard and yielding, respectively.

The flat sheet is then subjected to the polishing action of a rapidly moving, comparatively soft, resilient polishing means bearing on its surface or having interposed between its surface and the surface of the paper a layer, or coating, of a composition containing as an essential component a finely powdered abrasive material. The web is continuously advanced past the polishing means, which moves in a direction parallel to the direction of movement of the web and hence of the grain of the paper, and is supported during the polishing operation by a roll or equivalent supporting device. The polishing means is also preferably in the form of a roll, suitably a roll having a periphery composed of cotton or other fabric. A satisfactory roll can be made by treading discs of fabric over a central core, and keying or clamping them firmly in place so that they will not turn on the core, but at the same time leaving the outer edges of the discs pressed together relatively lightly, so that the peripheral surface they present is resilient and relatively soft. Cloth polishing rolls of the type used for polishing metal have been used satisfactorily.

Merely polishing the paper surface with a soft surface, such as that described above, has little effect. It is essential that an abrasive material shall lie between the surface of the paper and the surface of the polishing roll in order to obtain polishing. Moreover, it has been found that merely to supply dry abrasive powder between the surface of the paper and the surface of the polishing roll does not achieve the desired result. It appears to be necessary that the abrasive powder shall adhere to the polishing-roll to some extent. Suitable binders or adhesives used in connection with the abrasive accomplish this purpose excellently. Obviously, the binder or adhesive used should be of such nature that it will not injure or mar the surface of the paper sheet being polished. It has been found that abrasive powder mixed with a little stearic acid can be blown against the roll, or into the nip between the roll and the paper, by means of a current of air, preferably a current of air sufficiently warm to soften the stearic acid, and that the powder will

then adhere to the roll sufficiently for the polishing to be carried out satisfactorily. Alternatively, abrasive powder and adhesive in liquid form may be fed separately so that they mingle on the surface of the roll; satisfactory adhesion may be secured by such procedure. If desired, abrasive powder and adhesive may be mixed and cast into the form of sticks or bars; such bars may then be pressed—either continuously or intermittently—against the polishing roll as it rotates. Still another way of supplying the abrasive is to coat, as by means of an air-brush coater, for example, the web surface to be polished, with a very thin layer of abrasive held by a small quantity of suitable adhesive, the so-applied abrasive coat subsequently being removed by means of a polishing roll. In some cases it may suffice to dampen dry abrasive powder with water or other liquid to make it adhere to the polishing roll, although such practice at times may act to soften the paper surface unduly. In general, however, the preferred binding for the abrasive is a thermoplastic composition such as one containing resin or wax; and of this class probably the most generally satisfactory composition is one of a waxy nature such as one containing paraffin, stearic acid, tallow, or the like, which may actually act as a lubricant.

Abrasives suitable for use in the present relation include: very finely divided oxides of aluminum, chromium, iron, silicon and the like; silicon carbide; and naturally occurring siliceous matter such as diatomaceous earth or tripoli. Generally speaking, in polishing paper of white or light color it is preferred to use an abrasive which is also light in color to avoid danger of discoloring the paper surface by particles of abrasive which might be retained in microscopic crevices of the paper surface.

In polishing the paper it is preferred that the peripheral speed of the polishing roll relative to the speed of paper travel shall be about 20 feet per second or more. The polishing roll may rotate in a direction the same as, or opposite to, the direction of paper travel as desired; obviously, in the former case the rotative speed must be somewhat higher than in the latter case if an equivalent differential between paper travel and roll speed is to be maintained. The paper may be re-passed under the polishing roll as many times as desired, or it may be passed in succession into contact with a plurality of polishing rolls. If it is desired to polish both sides of the paper, the polishing equipment may easily be arranged so that one or more of the polishing rolls contact each side of the web as the latter makes one passage through the apparatus. The degree of pressure of the soft resilient polishing surface against the paper surface to be polished is difficult of numerical definition. The polishing surface preferably contacts the paper so lightly as to allow considerable slippage while positively bringing the finely divided abrasive into engagement with the paper surface.

The effect of the treatment described is to increase the gloss of a paper over the gloss possessed by it before treatment. The effect is, practically speaking, confined entirely to the surface of the sheet. The surface is closed up and densified so that its resistance to penetration by spirit or oil varnish, lacquer or the like is remarkably increased, but the underlying portions and bulk of the sheet are effected little if at all by the polishing treatment. Consequently some of the papers

produced by the process are products heretofore entirely unknown.

In the past it has been possible to produce varnishable uncoated paper according to the process of Cates Patent No. 2,088,893 by which a well-formed, relatively dense, paper was heavily moistened on the surface and immediately supercalendered. By the present process any uncoated paper may be treated to increase its ability to hold up varnish, and most papers so treated may become satisfactory varnishable papers.

The effect on the gloss of the paper is likewise striking. In the past the customary method of producing uncoated printing paper with considerable gloss has been to pass the web through a supercalender, i. e., a stack of pressure rolls in which hard or metal rolls usually alternate with yielding or fiber rolls. When properly carried out, supercalendering compacts and densifies the sheet very desirably; it levels the surface sufficiently to make the same suitable for being printed upon; and it gives a good gloss to the surface. But supercalendering can easily be carried to such excess that it produces deleterious results: too severe supercalendering blackens the paper, making the product dingy and unsatisfactory for use; moreover, it weakens the paper seriously, as may be shown by the usual strength tests for burst, fold, tear, etc.; and such severe supercalendering may undesirably decrease the thickness and opacity of the paper. Supercalendering is the usual practice in producing printing paper intended for fine half-tone reproductions, and supercalendered paper provides the generally accepted standard of excellence for printing papers. The chief defect of supercalendering that is properly carried out, i. e., what may be called "normal supercalendering," is that it fails to produce as high a gloss as may be desired in some cases. Polishing the paper as described will, generally speaking, develop a gloss, as measured on the glossmeter, at least 10 points higher than normal supercalendering will develop on the same paper stock. Uncoated printing papers have not in the past been produced with a gloss as high as 55. My treatment easily produces a gloss of 55 to 60 on uncoated paper, and in many cases a gloss of 75 or over can be obtained on such paper. In the case of mineral-coated papers, normal supercalendering has not produced paper with a gloss as high as 75 as measured on the glossmeter. My process easily produces a gloss of 75 to 80, and in many cases from 90 to 95 or more on mineral-coated printing paper.

In many cases it is desired to apply spirit varnish or similar material over the surface of printed paper to protect the printing, or to make the sheet water-resistant, or for other reasons. In the case of mineral-coated papers, e. g., paper coated with a mixture of pigment such as clay, calcium carbonate, satin white or the like, and adhesive such as casein, starch, glue or the like, it is usually found that "normally sized" coated paper (i. e., paper having a coating in which the quantity of adhesive is just enough to bind the pigment so that the sheet can be printed without "picking" on a printing press) is so badly penetrated by spirit varnish applied thereto that the result is entirely unsatisfactory. Consequently, the past practice in making varnishable mineral-coated paper has been to use in the coating an excess of adhesive amounting to from about 25% to about 100% of the quantity required for normal sizing, the excess adhesive being required to obtain the requisite impene-

trability to varnish. The increased quantity of adhesive, however, both adds to the cost of the paper and, at the same time, seriously detracts from the printing quality of the sheet. My invention for the first time provides a varnishable mineral-coated printing paper having only normal sizing.

Supercalendered paper, either uncoated or coated, provides a most satisfactory base-stock upon which to practice the polishing procedure of this invention. Supercalendered paper polished according to the invention retains all of the desirable qualities of supercalendered paper: it remains desirably densified and compact, and its printing quality remains equal to, or may even be improved over that of, supercalendered paper. In addition, the gloss is substantially increased and the resistance of the supercalendered paper to penetration by varnish is improved.

As was suggested hereinbefore, the process may be practiced with very satisfactory results upon paper less dense and compact than supercalendered paper; for example, paper—either uncoated or coated—which has been glazed by being dried in contact with a polished metal surface such as the drier of a so-called Yankee machine, shows remarkable improvement in gloss and/or resistance to penetration by varnish after being polished according to my procedure. The gloss of friction-calendered paper, lacquered paper, and in fact of paper treated by almost any known finishing process may be improved by being subjected to abrasive polishing as disclosed herein.

The increase in gloss and/or varnish impenetrability may vary to a certain extent depending upon the particular abrasive and binder used and upon the relative proportions of the two. Increasing the proportion of binder to abrasive in many cases increases the varnish impenetrability.

It appears from this that in some cases at least a very thin film of wax or other binder employed in the composition may be left upon the surface of the polished web; but such film is not sufficient to affect the printing quality appreciably—contrary to the effect of the considerably quantity of wax that is present in usual friction glazed coatings.

Examples of the degree to which various paper may be increased in gloss by polishing in the manner described are given below, all gloss figures being readings obtained by use of a Bausch & Lomb glossmeter:

Paper sample	Gloss before treatment	Gloss after treatment
A high grade, varnishable supercalendered uncoated paper	45	70-75
A third grade, supercalendered, uncoated book paper	26	52
An English finish, uncoated, lithographic printing paper	15	40
A high grade, glossy supercalendered, mineral-coated printing paper	63	97
A fourth grade, glossy, supercalendered, mineral-coated printing paper	34	80
A yellow, supercalendered, mineral-coated box liner	58	92
A friction-calendered, white coated box liner	65	80
A machine-glazed, white, uncoated paper	23	38
A machine-glazed, white, coated paper	83	100
A high grade, flint-glazed, white, coated paper	95	99

When numerical figures are stated as indications of gloss at any place in the specification or claims, the figures refer to readings obtained in

the usual manner upon a Bausch & Lomb glossmeter.

The term "varnishable paper" as used throughout the specification and claims means paper having varnishing qualities substantially equivalent to those of a usual varnish quality coated paper.

"Normally sized mineral-coated paper" means paper having in its coating a quantity of adhesive sufficient to bind the pigment so firmly that the paper can be printed with an ink of a quality commonly used for printing glossy coated paper, under normal conditions on a letter-press, without picking or marring of the coated surface, but having substantially no excess of adhesive over the amount required for such printing use.

The invention as described above provides a method of polishing a moving web of paper or the like by means of a rapidly moving resilient surface bearing on its surface a somewhat adherent but movable film comprising abrasive powder together with a readily deformable binder and/or lubricant. Paper products are obtained thereby which have properties or combinations of properties not previously found in known papers.

Two operable manners of carrying out the process of the invention will now be described specifically with reference to the accompanying drawing, in which

Fig. 1 is a diagrammatic representation of apparatus operable for polishing one surface of a web, and

Fig. 2 is a diagrammatic representation of apparatus operable for simultaneously polishing both surfaces of a web.

In accordance with the showing in Fig. 1, a web 1, e. g., a web of coated paper preferably previously calendered, is carried continuously from unwind reel 2 under guide roll 4, over a smooth supporting surface 3 provided by roll 5, and under guide roll 7, and is wound up on reel 8. While web 1 is supported upon supporting surface 3 the reverse side of the web is polished by abrasive powder held against the web by the rapidly moving resilient polishing surface provided by roll 6 which rotates in a plane parallel to the direction of travel of web 1. The abrasive material is applied from bar 9 comprising abrasive powder and binder. Bar 9 may, as desired, be held against roll 6 continuously or applied intermittently (by means not shown). Roll 6 may rotate in a direction the same as, or opposite to, the direction of paper travel, but it is essential that there be considerable slippage between the polishing surface and the paper surface. Roll 6 has a resilient, relatively soft surface and may advantageously be built up from discs of cotton fabric or similar material threaded on a central shaft. Roll 6 is caused (by means not shown) to rotate at a peripheral speed, relative to the speed of paper travel, of at least 20 feet per second.

In the interest of time-saving, especially in cases where both sides of the web are to be polished, it is preferable to use apparatus in which both sides of the web can be completely polished during one passage of the same over the equipment. One such arrangement is shown diagrammatically in Fig. 2. In accordance therewith, the paper web 10 is unwound from reel 11, carried over rolls 12, 14, 16, 18, 20, and 22, and wound up on roll 24. One side of the web is polished in succession by the action of rotating polishing rolls 13, 17, and 21 and the reverse side

is polished by the action of similar rotating polishing rolls 15, 19, and 23, which polishing rolls are supplied with powdered abrasive by any desired means (not shown).

I claim:

1. A method of treating the surface of a paper web to increase the gloss thereof, which comprises polishing the surface with a composition consisting essentially of powdered abrasive and a deformable carrier therefor, the composition containing a substantial proportion of the powdered abrasive.

2. A process of increasing the gloss of paper, which comprises continuously advancing a paper web, supporting a side of the web, and simultaneously rubbing the opposite side of the web with a composition consisting essentially of abrasive powder and lubricant, the composition containing a substantial proportion of the abrasive powder.

3. A process of increasing the gloss of paper, which comprises continuously advancing a paper web, supporting the web on one side thereof, and rapidly rubbing the opposite side of the web, while so supported, with a resilient polishing surface bearing an adherent film of abrasive powder and binder, the amount of binder used being sufficient to cause the abrasive powder to adhere to said polishing surface.

4. A process of increasing the gloss of paper, which comprises forming a paper web, supercalendering said web, and polishing said web with abrasive composition consisting essentially of abrasive powder and a readily deformable carrier therefor, the composition containing a substantial proportion of the abrasive powder, whereby to increase the gloss of the paper.

5. A process of increasing the gloss of paper, which comprises forming a paper web, coating said web with a mineral coating, supercalendering the coated web, and polishing the coated and supercalendered web with abrasive composition consisting essentially of abrasive powder and a readily deformable carrier therefor, the composition containing a substantial proportion of the abrasive powder, whereby to increase the gloss of the paper.

6. In a process of increasing the gloss of paper, the steps of forming a paper web, and then polishing the web with a composition consisting essentially of abrasive powder and a thermoplastic binder therefor, the composition containing a substantial proportion of the abrasive powder.

7. A process of treating a paper web, which comprises polishing the web with a composition consisting essentially of abrasive powder and paraffin the composition containing a substantial proportion of paraffin.

8. A process of improving the gloss and the varnish-impenetrability of a coated and flattened paper web, which comprises continuously advancing the web in contact with the periphery of a soft and resilient polishing roll, rotating the polishing roll at such a rate that the peripheral speed of the same with respect to the linear speed of the web is at least 20 feet per second, and supplying to the periphery of the polishing roll a composition consisting essentially of finely divided abrasive particles in a readily deformable lubricant menstruum in amount sufficient to cause the abrasive particles to adhere to the polishing roll.

9. Paper product having compactness, density and printability characteristics at least equal to those of supercalendered paper, a surface of which paper product has been abrasively buffed, in the direction of the grain of the paper, by means of a polishing composition consisting essentially of powdered abrasive and a deformable carrier therefor, to produce a buffed surface characterized by a gloss, as measured on the Bausch & Lomb glossmeter, at least 10 points higher than the same paper would have if normally supercalendered and by being substantially less penetrable by varnish than the same paper would be if normally supercalendered, said buffed surface being further characterized by the absence of any scratches extending across the grain of the paper and by the presence of occasional minute difficultly discernible scratches extending only in a direction parallel to the grain of the paper.

10. An uncoated printing paper product having compactness, density and printing characteristics at least equal to those of supercalendered uncoated paper, a surface of which paper product has been abrasively buffed, in the direction of the grain of the paper, with a polishing composition consisting essentially of powdered abrasive and a deformable carrier therefor, to produce a buffed surface characterized by a gloss, as measured on the Bausch & Lomb glossmeter, in excess of 55.

11. A varnishable mineral coated printing paper product consisting of a paper base and a layer of wax-free mineral coating composition essentially consisting of mineral pigment and adhesive, said product having compactness, density and printing characteristics at least equal to those of mineral coated supercalendered paper, a surface of which mineral coated paper product has been abrasively buffed, in the direction of the grain of the paper, with a polishing composition consisting essentially of powdered abrasive and a deformable carrier therefor, to produce a buffed surface characterized by a gloss, as measured on the Bausch & Lomb glossmeter, of at least 75, said buffed surface being further characterized by the absence of any scratches extending across the grain of the paper and by the presence of occasional minute difficultly discernible scratches extending only in a direction parallel to the grain of the paper.

12. A normally-sized, mineral-coated printing paper product consisting of a paper base and a layer of wax-free mineral coating composition essentially consisting of mineral pigment and adhesive, said product having compactness, density and printing characteristics at least equal to those of normally sized mineral coated supercalendered paper, a surface of which mineral coated paper product has been abrasively buffed, in the direction of the grain of the paper, with a polishing composition consisting essentially of powdered abrasive and a deformable carrier therefor, to produce a buffed surface characterized by a gloss, as measured on the Bausch & Lomb glossmeter, of at least 90, said buffed surface being further characterized by the absence of any scratches extending across the grain of the paper and by the presence of occasional minute difficultly discernible scratches extending only in a direction parallel to the grain of the paper.

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