

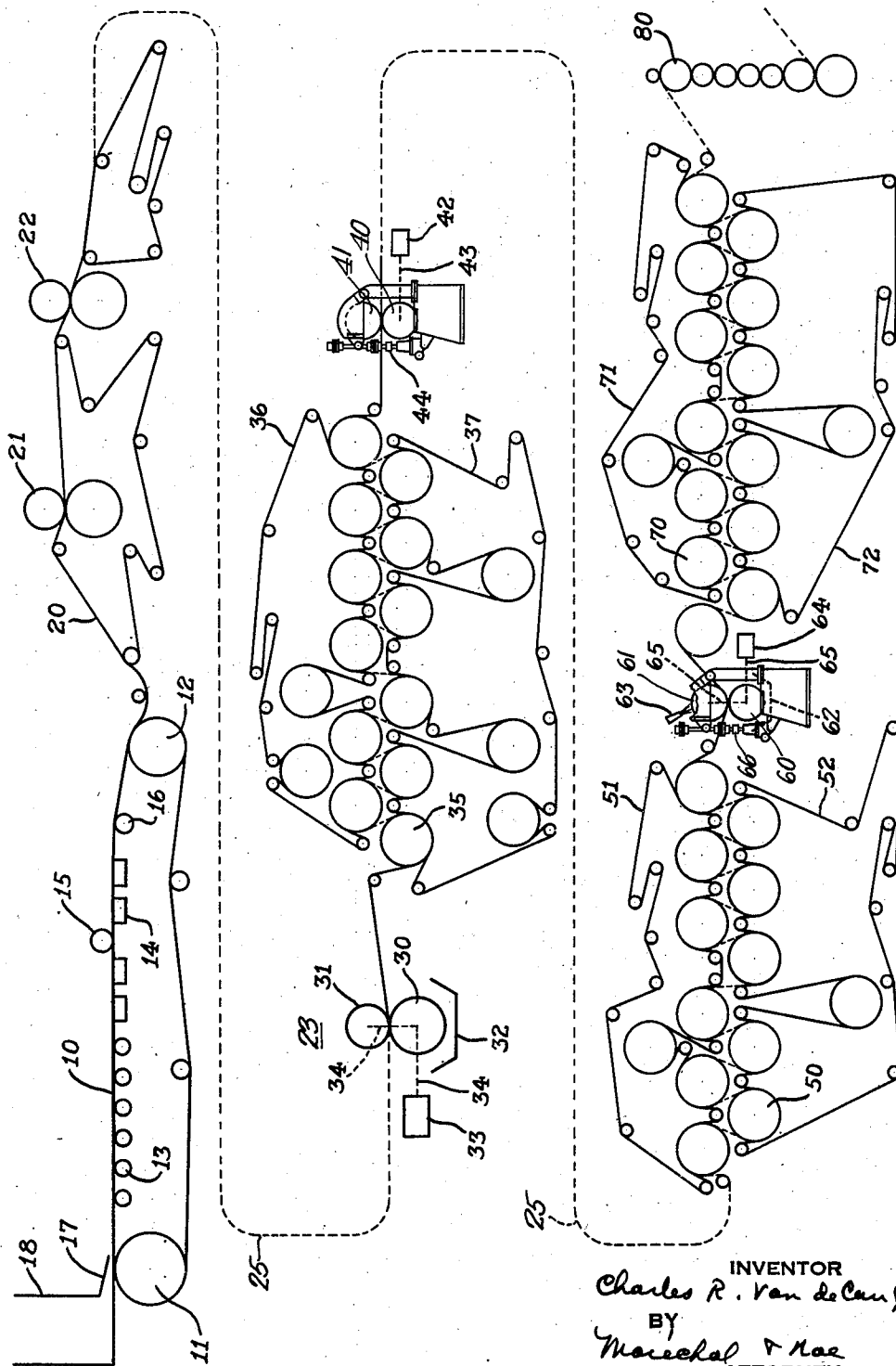
June 12, 1945.

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2,378,113

PAPER MANUFACTURE

Filed March 21, 1938



UNITED STATES PATENT OFFICE

2,378,113

PAPER MANUFACTURE

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Application March 21, 1938, Serial No. 197,168

4 Claims. (Cl. 92—40)

This invention relates to the manufacture of paper, and more particularly to paper for printing, such as so-called book paper, having a mineral coated or treated surface, i. e., a so-called coated or surface impregnated paper.

One of the principal objects of the invention is to provide a method of manufacturing such paper in which the formed web is subjected to processing to provide a coated paper which comes from the paper making apparatus provided with such a coating of desired weight and superior characteristics.

Another object is to provide such a method in which the web as it passes through the paper machine is subjected to processing to provide such a coating on the surface, giving superior characteristics with respect to subsequent calendering.

Another object is to provide apparatus for carrying out such process in satisfactory manner to produce such superior coated web.

Other objects and advantages will be apparent from the following description, the appended claims and the accompanying drawing.

The drawing illustrates diagrammatically a preferred form of apparatus for carrying out the invention.

For many years it was the general practice in the paper industry in the making of coated paper to do the coating operation as a "converting" step. In such practices a suitable grade of book paper, generally rather highly sized (i. e., a so-called "hard sized" paper) was provided by the paper maker to the coating mill. In the coating mill the paper would be "converted" by passing it through a coating machine wherein the coating "color" would be applied to the surface of the paper and then brushed to spread this material in a uniform and smooth film over the surface. Such coating color consisted of a finely divided white mineral or pigment suspended in suitable amounts of water with admixed adhesive (casein, etc.); and after being applied to the paper the brushes would spread it, somewhat as varnish or paint is spread by a brush. Thereafter the paper would be hung up in loops—or "festooned"—to dry; and could then be calendered or not, according to whether a polished or dull surface was desired.

Subsequently the coating material was otherwise applied, as in another process which was put into use by some manufacturers, in which the color was applied to the traveling web by rolls which served to apply the desired uniform and continuous film on the sheet; and in this process

the coated paper was passed over drying drums or cylinders heated internally by steam to effect drying, in place of the more usual festooning arrangement. This coated paper also was made from a suitable finish book paper and could be calendered or not according to the desired finish.

The above procedures, which were the only ones used until recently, were converting processes. That is, the paper was first made upon the paper machine and thereafter it was coated by the desired, proper procedure and materials in a coating mill, as a separate and independent operation.

More recently various efforts have been made to coat the paper on the paper machine so that the desired coated paper will be delivered from the paper machine as a continuous operation. And in such referred to more recent processes and machines the coating color has been applied to the web of paper within the dryer section of the machine. In the copending application of James O. Mason, Serial No. 73,423, now Patent No. 2,186,874 (assigned to the assignee of this present application), is shown such a process. It was found, in commercial use of said process, that under certain conditions and for producing certain desired end products great operating difficulties were encountered which, for a considerable time, precluded satisfactory and commercially feasible production of such products. I have discovered how to avoid such difficulties and how satisfactorily to produce the desired coated papers of superior characteristics at regular paper machine speeds.

In the drawing is shown, diagrammatically, a preferred embodiment of a combined paper making and coating machine according to my invention and for carrying out the process thereof.

In that drawing the paper forming part is illustrated as a Fourdrinier machine having a wire 10, supported upon the breast roll 11 and the couch roll 12. The usual table rolls 13, suction boxes 14, dandy roll 15, and guide roll 16 are provided. The paper making stock or furnish is fed onto the traveling wire 10 through the inlet 17 of the head box 18. This stock or furnish will be of proper materials and character to produce the end product desired. It may comprise all chemical pulp—a so-called "free sheet"—or a mixture of chemical pulp and ground wood—a so-called "ground wood sheet"—and will or will not contain mineral filler and size as desired and proper.

The formed web, which has considerable water removed therefrom on the wire by gravity flow

as well as by the suction boxes 14 and the suction couch roll 12 (when a suction couch roll is used as in the installation illustrated) is transferred to the felt and carried through the press rolls where more moisture is expelled. As shown three sets of press rolls are used, the felt 20 carrying the paper through the first and second sets—21, 22—of these after which the web is of such strength that it will support itself and is removed from the felt and passes through the third press, 23. The web of paper 25 is indicated in dotted lines on the drawing where the machine, on account of its length, is shown in three sections; but it is to be understood that this is merely for convenience in illustration and that in actual practice the entire machine ordinarily will be located for straight line production.

As shown the web is treated to apply mineral material to be incorporated into and upon the wire side to effect modification of that side to a predetermined coordinated condition with respect to the upper or felt side; and this is accomplished, as shown, at the third press 23—which has the rolls 30—31—as described in said patent of James O. Mason. When this portion of the apparatus is in use the lower roll 30 of the press dips into a pan or trough 32 containing a suspension of mineral filler or coating material and rotates with the travel of the paper. As the paper travels between the rolls 30—31, the lower roll 30 carries the mineral suspension up against and into incorporating contact with the wire side of the web. The mineral suspension in the pan 32 is replenished as demanded in use, and drive means shown diagrammatically, as comprising a motor 33 and suitable driving connections 34, such as a chain of gears, is provided for positively driving both the top and bottom rolls at predetermined speeds—in the apparatus illustrated the top roll 31 and the lower roll 30 are driven at a speed coordinated with and substantially corresponding to that of the paper in place of being merely allowed to turn as a result of contact with the paper web and the lower roll. Suitable means (not shown, but which may be similar to the pressure means hereinafter described) are likewise provided for adjusting the pressure effective at the nip. By properly controlling the composition and solids content of the color, the pressure, and the character and receptivity of the web a predetermined amount of such mineral may be incorporated into and upon the wire side of the web. In this manner there is a preconditioning treatment of the wire side with reference to surface impregnating or light weight coating, properly to balance the surface appearances and characteristics of the opposite sides with respect to each other and to prepare these sides for the subsequent coating on one or coordinated coating on both sides as described in said Mason application, and thus a two stage heavy coating may be applied also. When desirable the preliminary step may be performed in accord with the patents Bair 1,875,208, Carruth 2,111,089.

The web then passes to the first of the drier rolls 35 of the first drier section—upper and lower felts 36 and 37 being shown to convey the paper through this section of driers. These driers are of such number and so operated as to drive off a considerable part of the moisture contained in the paper web as it comes to the driers; in fact the paper may be dried down to substantially the normal end percentage of moisture before the next operation. The drier section as shown is arranged to dry the paper web to a moisture con-

tent of approximately 35–38% and very satisfactory results in commercial operations have resulted. But equally good results have been secured with moisture of 26%, and generally the range (with properly coordinated paper character, consolidation pressures, softness or responsiveness to the consolidating action, etc.) may be down to the order of 5–8%; but with the character of paper herein illustrated a moisture content of the order of 35–38% and with comparatively moderate pressures and easily attained operating conditions has been found in commercial use to give the unusual and very satisfactory operating results which flow from use of this invention.

The paper, dried to within said range, is passed through a calender or stack of rolls, shown diagrammatically as composed of two rolls 40—41, for smoothing its surface irregularities and breaking down any looseness of formation to effect retained predetermined pre-smoothing and consolidation of formation. This treatment affects both sides as to smoothness, and it has been found especially desirable to break down the felt, or upper side, which though appearing generally smoother and generally of finer texture than the wire side nevertheless has been found to have comparatively large and deep pits or crater-like depressions irregularly occurring thereover which are quite objectionable for the present method of coating. The pressure to be applied is dependent upon the character of the web, the moisture content, the coating or surface treating material to be later applied and the calendering to which the coated sheet is subsequently to be subjected; as hereinafter explained.

The rolls 40—41 are satisfactorily made of chilled iron. By cooling the surfaces of the rolls below the condensation temperature of the vapor from the drying paper, as by water cooling, moisture condenses on their surfaces and this seems to affect the action of the rolls on the surfaces of the paper to aid in the smoothing and breaking down or consolidating action. A regular calender stack may be satisfactorily used, the number of rolls and extent of treatment depending on the character of the sheet as to constituent materials, its relative moisture content, its surface characteristics, its resistance to consolidation and with reference to the subsequent treatment. Suitable driving means, illustrated diagrammatically as a motor 42 and a gear transmission 43 to the lower roll, are provided. Suitable means indicated diagrammatically at 44 is provided for varying the pressure between the rolls and effective at the nip of the rolls. It has been found that with papers of certain character and certain moisture content, it may be desirable to reduce the pressure below that which would result from the weight of the upper roll alone, this being accomplished by raising the top roll to hold it properly spaced away from the lower roll. This same means provides for using increased pressures above that which results from the weight of the roll, the adjusting means preferably using spring loading means to accommodate operating conditions and irregularities.

From the rolls 40, 41 the paper web passes over the drying rolls 50 of the second drier section, which has the usual upper and lower felts 51, 52 and as it passes through these drier rolls it is preferably dried to a moisture content of 5–10%.

The paper web is then passed between the color applying rolls 60, 61. The color may be applied to the rolls as desired. As shown the

lower roll dips into a pan or trough 62 of color or mineral coating suspension and the same sort of suspension is supplied to the upper roll in suitably controlled quantity by means of a feed pipe 63. Means for controlling the pressure at the nip between these color applying rolls is indicated diagrammatically at 66 this means being like the means 44 described above. It has been found that for a given operation there is a critical pressure which should be exceeded in order that the coating upon the paper as it leaves the color applying rolls shall be smooth and free from ridges and irregularities, as set out in said patent of James O. Mason and by suitably maintaining this pressure the amount of the color applied and retained in and upon the paper may be varied, generally, as the solids content.

In this part of the mechanism, as with respect to the color applying mechanism at the third press, both rolls are driven, at substantially paper speed, as by a motor 64 and a chain of gears 65.

The paper with applied coated material is then passed through the final drier rolls 70, which have the upper and lower drier felts 71 and 72 and is dried to the desired low moisture content, usually about 4-5%; after which it may be passed through a calender or stack of rolls illustrated diagrammatically as a usual machine calender having a number of rolls and designated generally by the numeral 80. It is then reeled and may be thereafter passed through another calender.

Generally speaking a web so formed as to be "soft" so that it will more readily respond to the smoothing and the consolidating of the breaking down action is preferable to one which is "harder" or more resistant to such action, and the pressures required will vary accordingly. Also a web will require less drastic pressure if the moisture content is higher; but the moisture content may not be too high for the web must be in its complete formation and must not be destroyed by the pressures, that is, the paper web structure being formed of interwoven pulp fibers possesses an inherent resiliency, and the pressure used for the presmoothing and consolidating of the web structure must be not sufficient to exceed the inherent resiliency of the web structure. Very satisfactory results have been secured with the moisture removed from the web to give moisture contents of approximately 35%, and even substantially lower moisture contents down to air dry conditions have been found responsive to satisfactory operation although somewhat greater calendering or breaking down pressures are required for a paper web of given characteristics. Also the character and amount of color or coating mineral to be applied is important. I discovered, after the long period of great operating difficulties referred to, that if the color is applied without such properly coordinated smoothing and breaking down of the web the coated sheet in most instances could not be satisfactorily finished in uniform manner or without great expense and wastage. Apparently the color with its adhesive when dried sets or rigidifies the web formation so that it is difficult or even impossible to finish the surface thereafter to the smoothness and finish required. In efforts to accomplish this the coated paper coming from the machine was passed immediately through one, and also through two, calender stacks, of usual character, at roll pressures up to 235 pounds per lineal inch, and then passed once and even twice through regular and super calender stacks

at roll pressures up to 2300 pounds per lineal inch, in an effort to secure the desired and necessary finish and smoothness. But these great pressure operations in great part failed or the excessively drastic treatment broke down the sheet in an irregular and indeterminate way and destroyed the effectiveness of the coating as to color or continuity. This was found true with small amounts of applied mineral such as used in surface impregnated or very light weight coats of several pounds per side per ream of 500 sheets 24 inches by 36 inches. It is true also with the heavier coats of the order of $7\frac{1}{2}$ to 12 or 15 pounds per side. These drastic pressures in calendering would seemingly irregularly break up the coating and in heavier coats sometimes the layer of mineral would separate from the web of paper so that it would flake or peel off even in large sections. But by subjecting the sheet to predetermined and controlled comparatively moderate pressures at the proper stage as a preliminary conditioning to smooth and break down irregularities of formation and to effect retained consolidation of formation of chosen amount—i. e., to effect a predetermined non-reversible consolidation and breaking down of the body of the web itself in addition to smoothing down surface irregularities thereof—and before the coating is applied a smooth coating of desired weight may be easily and uniformly applied and may be readily calendered at comparatively moderate pressures within the resistance range resulting from the preliminary consolidating to give a superior product and without injuring the previously consolidated web structure and the layer of coating thereon. It is important that the action of the rolls 40, 41 be properly coordinated with the existing paper conditions and the subsequent coating operations so as to provide the required surface smoothing and breaking down and consolidation of the web structure to meet the necessities. And this is important with heavier coats as well as with lighter coats or surface impregnations.

By way of illustration, very satisfactory results in commercial operations, have been secured in commercial operations using a good grade of book paper, the furnish for web containing approximately 35% sulphite pulp, 33% soda pulp, 16% old paper stock and 16% broke (in which, of course, the same general proportions of sulphite and soda pulp exist) and 30% calcium carbonate filler on the fiber basis (i. e., so that the finished web will have retained therein such filler in the amount of approximately 30% of the web) with the rolls 40, 41 located in the drier section so that the web has a moisture content of the order of 35% and with chilled iron rolls 30 inches in diameter and having a pressure of approximately 700 pounds per square inch of nip area, the web having a dry weight of about 45 pounds per ream (as defined above) and having three to four and one-half pounds of coating material per side subsequently applied and with the subsequent calender pressures at the end of the paper machine 218 pounds; and the super calender pressures 1230 to 1430 pounds, per lineal inch of calender roll length when passed twice through the calenders. If a single pass is desired the pressure should be adjusted accordingly. Also where the conditions in the earlier operations are properly controlled as to character of web and the actions thereon, satisfactory results may be obtained without any machine calendering.

While the method herein described, and the

form of apparatus for carrying this method into effect, constitute preferred embodiments of the invention, it is to be understood that the invention is not limited to this precise method and form of apparatus, and that changes may be made in either without departing from the scope of the invention which is defined in the appended claims.

What is claimed is:

1. A method of manufacturing a mineral surfaced paper web, of the character described, suitable to receive printed impressions; which consists in forming the web structure on a paper making machine to have desired predetermined characteristics of responsiveness to consolidation when subjected to rolling pressure, partially drying the traveling formed web to bring the moisture content thereof down to and within the range of approximately 38%-4%, subjecting the traveling partially dried web to predetermined consolidating pressure effective through the whole of the web and sufficient to break down looseness of formation of the web and to effect predetermined retained consolidation thereof extending through the whole of the web structure but not sufficient to exceed the inherent resiliency of said web structure, said consolidating pressure being effective also to effect predetermined smoothing of the surface of the web, then applying mineral surfacing material to said consolidated web and maintaining said consolidated web structure under controlled pressure during the applying of the mineral surfacing material thereto to provide a smooth applied coat, then drying the coated web, and subjecting the mineral surfaced web to a supercalendering operation and thereby supercalendering the mineral surfaced paper web, to give a smooth printing surface.

2. A method of manufacturing a mineral surfaced paper web, of the character described, suitable to receive printed impressions; which consists in forming the web structure on a paper making machine to have desired predetermined characteristics of responsiveness to consolidation when subjected to rolling pressure, partially drying the traveling formed web to bring the moisture content thereof down to and within the range of approximately 5%-10%, subjecting the traveling partially dried web to predetermined consolidating pressure effective through the whole of the web and sufficient to break down looseness of formation of the web and to effect predetermined retained consolidation thereof extending through the whole of the web structure but not sufficient to exceed the inherent resiliency of said web structure, said consolidating pressure being effective also to effect predetermined smoothing of the surface of the web, then applying mineral surfacing material to said consolidated web and maintaining said consolidated web structure under controlled pressure during the applying of the mineral surfacing material thereto to effect a smooth applied coat, then

drying the coated web, and subjecting the mineral surfaced web to a supercalendering operation and thereby supercalendering the mineral surfaced paper web, to give a smooth printing surface.

3. A method of manufacturing a mineral surfaced paper web, of the character described, suitable to receive printed impressions; which consists in forming the wet paper web structure on a paper making machine to have desired character of formation, partially drying the traveling formed web to bring the moisture content thereof down to and within the range of approximately 38%-4%, subjecting the traveling web to predetermined consolidating pressure sufficient to break down looseness of formation of the web and to effect predetermined retained pre-smoothing of the web surface and non-reversible consolidation of the web body extending through the whole of the web structure but said consolidating pressure being within the range of consolidation resistance and not sufficient to exceed the inherent resiliency of said web structure nor to destroy said web structure and coordinated with the subsequent coating and calendering operations, then applying mineral surfacing material to said consolidated web while the consolidated web structure is maintained under controlled pressure to provide a smooth applied surface, and then subjecting said mineral surfaced web to a supercalendering operation and thereby supercalendering the mineral surfaced paper web, to give a smooth printing surface.

4. A method of manufacturing a mineral surfaced paper web, of the character described, suitable to receive printed impressions; which consists in forming the wet paper web structure on a paper making machine to have desired character of formation, partially drying the traveling formed web to bring the moisture content thereof down to and within the range of approximately 38%-4%, subjecting the traveling web to predetermined consolidating pressure coordinated with the character of the formed web and the moisture content thereof and effective throughout the body of the web and sufficient to break down looseness of formation of the body of the web and to effect predetermined retained pre-smoothing of the web surface and predetermined retained consolidation of the web extending through the whole of the web structure but not sufficient to exceed the inherent resiliency of said web body structure, then applying mineral surfacing material to said consolidated web while said consolidated web structure is maintained under controlled pressure whereby to provide a smooth applied coat, and subjecting the mineral surfaced web to a supercalendering operation and thereby supercalendering the mineral surfaced paper web, to give a smooth printing surface.

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