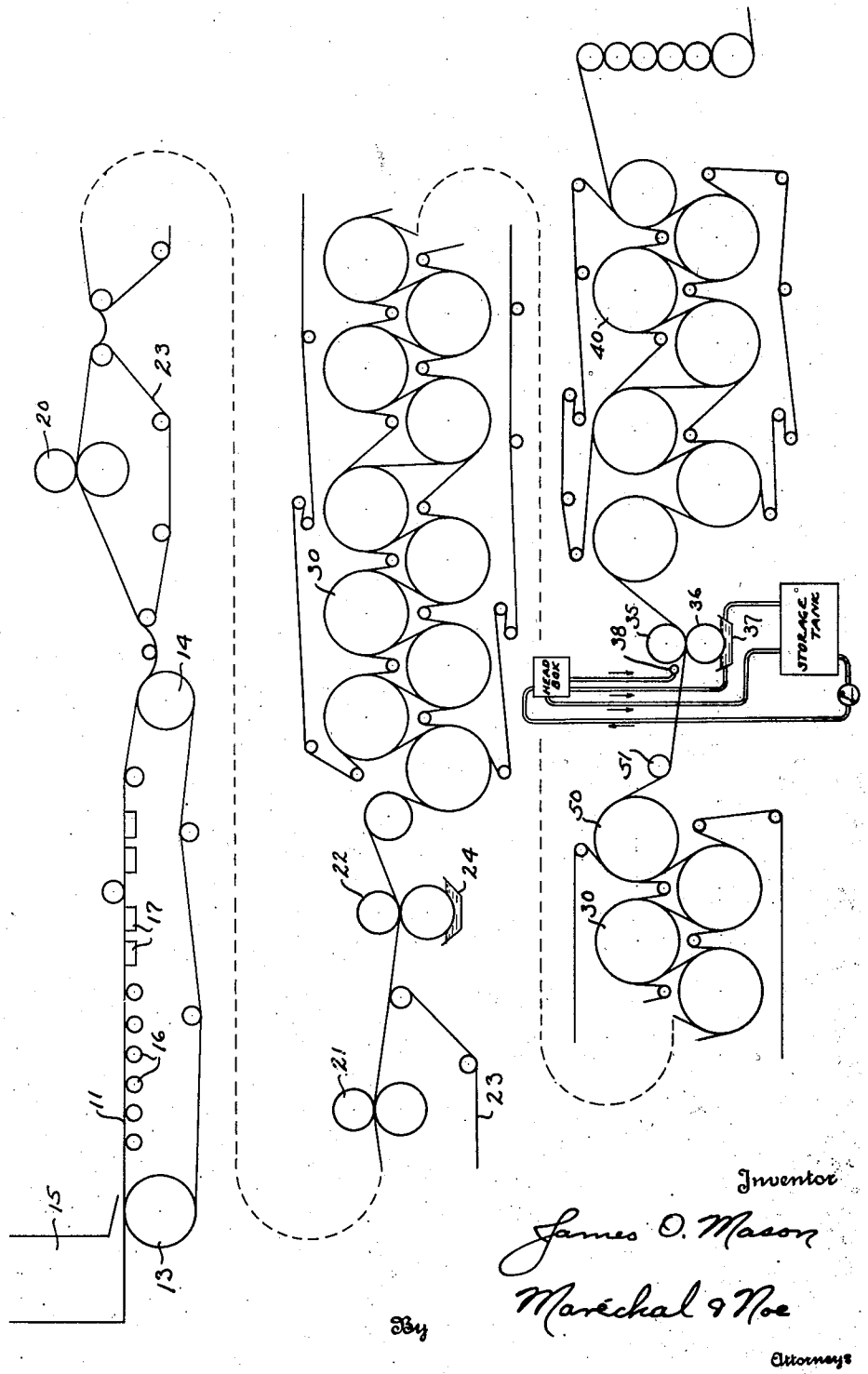
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PAPER MANUFACTURE

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## PAPER MANUFACTURE

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Continuation of application Serial No. 73,423, April 9, 1936. This application July 6, 1938, Serial No. 217,741

6 Claims. (Cl. 92—40)

This invention relates to the manufacture of paper.

One of the principal objects of the invention is to provide a method of forming paper which includes effecting controlled formation as to the opposite sides to produce a formed sheet or web having superior characteristics for printing, as part of a continuous paper making operation.

Another object is to provide a method of producing such a paper having surface characteristics making it adaptable for color printing, and other high grade printing applications, but with a lower cost of production than the coated papers ordinarily used for the same printing applications.

Another object of the invention is to provide a method in the formation of a paper sheet having surfaces controlled as to physical characteristics and responsiveness to printing operations in which controlled operations are effected upon the sheet in the course of its production to give properly coordinated control of its resulting surface and printing characteristics.

Still another object of the invention is to provide as a superior product a paper sheet having such coordinated surface and printing characteristics.

Another object of the invention is to provide apparatus for carrying out this method and producing such a product which is simple in construction and effective in operation to produce the desired characteristics in the paper.

Other objects and advantages of the invention will be apparent from the description set out below and from the accompanying drawing and claims.

This application is a continuation of original application Serial No. 73,423, filed April 9, 1936.

Reference is made to patent William Edison Bair, Jr., No. 1,875,208, patented August 30, 1932, and issued to the assignee of the present application. As pointed out in the said Bair patent the normal manufacture of paper, particularly as carried on prior to the development of the said Bair patent, resulted in what was known as "two-sidedness". That is, as the so-called "furnish", consisting of fibrous materials suspended in water, the mineral filler, the size, etc., desired to be incorporated into the final product is flowed onto the forming wire, part of this material flows through the wire with the first rush of water therethrough, the remainder being trapped upon the wire by the forming web which acts as a filter mat. As a result the normal tendency in the manufacture of paper, especially under the high speed operations generally attempted in the industry in more recent years, is to produce a sheet having the coarser fibers more concentrated upon the wire side, and the finer fibers, filler, and other suspended materials more concentrated upon the upper or so-called felt side. In addition in the ordinary paper machine, such as a Fourdrinier machine generally used, the forming wire is supported by a large number of rather closely spaced rolls known as table rolls. These rolls rotate in contact with the wire and during operation the water flowing from the forming sheet is carried around by these rolls, and each of them acts, under centrifugal force, to flush water through the wire side of the forming web and thus to still further flush out of the sheet finer materials which might be in the wire side. This action, under the long used processes, further accentuates the two-sidedness.

Under the practicing of the Bair invention a new product has appeared in the paper industry, namely a product having a controlled amount of mineral material introduced into the wire side of the formed web so as to be incorporated into the surface zone of the wire side and in the interstices in that wire side surface and zone. The present invention in part utilized the teachings of the Bair development for producing a process which makes possible still a new product, having characteristics hitherto associated only with the very expensive coated papers which were made as a so-called "converting" step. That is to say, in the normal coating paper operation the formed sheet, having been completed as such, was passed through a machine having mechanisms for applying a comparatively large quantity of suspension of mineral to one or both sides of the paper, after which means, generally brushes, were utilized for brushing and spreading the suspension of mineral and adhesive in water so as to give a smooth layer of mineral and adhesive applied and affixed to the surface of the sheet and covering over that surface as a coating. Such papers would ordinarily have from 8 or 10 pounds per side of mineral and up to as much as 15 to 20 pounds, or whatever might be desired to give the particular thickness and weight of mineral film or coating upon the paper. These papers were used primarily for finer classes of color reproduction and printing jobs of that sort.

The present invention has for its principal object to provide a more economical way of manufacturing a sheet of paper having a suitable amount of mineral incorporated upon its oppo-

site sides to give surface characteristics adequate for color reproduction and the like, with the manufacture carried on as a continuous process, with much less mineral material utilized, and with a great saving in expense.

The drawing diagrammatically illustrates, in the one figure, a machine adaptable for carrying out this process.

In the practicing of the process, utilizing a machine such as diagrammatically illustrated, the furnish or fibrous, etc., material is flowed from a headbox 15 onto a traveling Fourdrinier wire 11, which wire is carried upon the usual breast roll 13 and couch roll 14. A comparatively small number of table rolls are illustrated diagrammatically and designated by the numeral 16. As the forming sheet travels over these table rolls the flushing operation referred to occurs as the water rushes down from the sheet through the wire and the flushing out of the mineral and finer material occurs. Beyond the table rolls 16 several conventional suction boxes each designated by the numeral 17 are shown, the purpose of these being to extract additional water from the sheet in the usual manner. The formed sheet, as it passes the suction boxes and goes up to the couch roll has in it some 80 to 86% of water. Preferably the couch roll 14 is of the suction type, more water thus being removed from the sheet as it passes over the suction couch, and leaving the suction couch the sheet then normally has, under such circumstances, approximately 75 to 80% moisture, the amount of moisture of course depending upon the operating conditions such as the length of time available for the gravity separation of water, the amount of suction at the suction boxes and the number of the suction boxes, and the amount of suction at the couch roll. In actual commercial operations, utilizing the present invention, these various factors are so controlled that the sheet when leaving the couch roll has generally from 75 to 80% moisture and, correspondingly, 25 to 20% of fiber and other solids.

At this step in operation the sheet is capable of sustaining its own weight, and removed from the wire and passed to a series of press rolls. As shown in the drawing three sets of press rolls are diagrammatically illustrated, and designated by the numerals 20, 21 and 22 respectively. Preferably a felt 23 is provided for carrying the wet sheet through the first two press rolls, as in the usual practice, and from the second press roll 21 it is passed, without the felt, to the third pair of press rolls 22.

It has been discovered that, not only has the wire side differing characteristics, as referred to above; but in addition its texture is such that the receptivity of the wire side to the reception of coating material is less than the receptivity of the felt side. That is, the felt side having a larger proportion of fine filler and fiber at its surface zone will more readily retain coating material such as heretofore used, than will the bottom or wire side. And in order to secure paper of final characteristics desired, under this process, the paper sheet is subjected to a controlled processing, preferably at this third press, in order to impart a coordination or balance to this wire side with respect to the receptivity and retention of coating, to thus provide a paper which under the subsequent processing will receive and retain controlled and coordinated quantities of mineral material. As shown the lower roll of the pair of press rolls designated by the numeral 22 dips into a pan or trough which contains a suspension of mineral material and adhesive, of proper characteristics, the roll as it rotates carrying this suspension up into the nip where it is brought into incorporating contact with the wire side of the sheet. By properly controlling the character of material applied to the wire side of the paper at this point, and also the incorporating pressure, the wire side may be thus built up in a controlled manner to have a coordinated receptivity for further processing which may be in proper balance with the receptivity inherent in the top or felt side at that point.

The amount of incorporated material, the consistency of the suspension, the amount of adhesive, etc., will necessarily vary according to the original furnish of the sheet and the amount and character of mineral, etc., to be subsequently added upon the paper to give a surface finish sufficiently approximating the surface finish which is found in the high grade coated papers heretofore referred to. In successful commercial operations this invention and apparatus has been utilized in connection with a sheet made from a furnish in which the mineral or filler material in the furnish is a finely divided calcium carbonate. Such a material is ordinarily considerably whiter than the clays which are often used for filler, and are also generally finer. As a result the tendency toward two-sidedness is increased where such a material is used. In operations utilizing this material, with approximately 50% of mineral in the furnish it is found that the sheet formed on the wire and leaving the couch roll will have lost approximately so much of its mineral through the wire that in the further processes it would ultimately contain approximately 25% mineral and 75% fiber. With such a sheet, having a moisture content at the third press of approximately 60%, very satisfactory results in processing according to this invention have been secured utilizing as the mineral suspension within the pan 23 a suspension containing approximately 15 to 20% of solids by weight and 85 to 80% of water, with the solids consisting of calcium carbonate in the proportion of 80 to 90% of the total amount of solids and tapioca starch in the amount of 20 to 10%. And most satisfactory results have been secured where the carbonate and tapioca starch were cooked together with enough water to produce a suspension containing from 15 to 20% of solids by weight as stated. Ordinarily a small amount of alkali is added during the cooking of the starch and carbonate together, to prevent mutual flocculation; and if desired dyes may be added to increase or decrease the whiteness or otherwise vary the color as desired. Preferably the resulting suspension or mixture is treated in a pebble mill or the like to thin it, get rid of lumps and make it more homogeneous.

Operating at paper speeds of approximately 450 feet per minute, and under the conditions described, this processing will cause from $\frac{5}{10}$ to 1 pound of material to be incorporated into the surface zone of the wire side of the paper, and within the interstices of that surface zone; but, of course, these amounts may be varied by varying the consistency of the suspension in the pan, the materials therein, the percentage of water in the paper at the point of application, etc. The desired condition is to control these factors so as to impart to the wire side such characteristics for subsequent reception of the mineral to be later added, as to produce a paper having its two sides substantially balanced as to appear-

ance, surface characteristics, receptivity to printing, etc. By increasing the amount of solids in the suspension the wire side may be modified to a condition even superior to that of the felt side; but a generally balanced condition is that normally desired.

For operating economies the upper roll of the pair of press rolls 22 should be driven so as to avoid drag of the roll against the paper which tends to adversely affect its formation, and also tends to greatly increase broke. This is especially true where high pressures are utilized. For satisfactory operations the upper roll is of non-ferrous metal such as brass or a special composition covering, and the bottom roll of rubber, and the amount of moisture which will pass through the nip as incorporated within the sheet, for a given roll pressure will vary with the consistency.

The paper which as thus modified would have suitable balancing of the two sides with respect to each other is then passed through driers, which may be of ordinary character, and which are arranged diagrammatically and designated by the numeral 39. For operating economies the amount of drying to which the paper is subjected before further processing may be varied; but very satisfactory operations have been secured where the sheet is dried in the drier section down to a low moisture content of from 5 to 6%. This low moisture content is not essential as satisfactory operations may be carried on with paper having higher moisture content, satisfactory paper having been made commercially where the moisture content was as high as 20%, and even a substantially higher moisture content may be used if desired. With the paper dried to a moisture content of around 5 to 6% the paper as thus dried is then passed between the nip of a pair of press rolls the upper of which is designated by the numeral 35 and the lower by the numeral 36. The lower roll is immersed in a suspension of solid material in a pan 37, somewhat as heretofore described for the rolls 22 and the pan 24. And where it is desired to apply additional material to both sides of the sheet suitable suspension of material may be applied to the upper roll 35 by means of pipes, sprays, or the like 38 which flow the material onto the roll so as to cause it to spread uniformly down into the nip and onto the sheet of paper. In actual operation the material is fed to the upper roll in excess and a pool is thus formed which provided an excess to insure an adequate amount and thus secure uniformity of incorporation into the sheet. Also the lower roll carries an excess up into the nip so as to maintain a pool against the lower side of the sheet for the same purpose.

As a satisfactory paper adaptable for color reproduction and for high grade printing work of that character, it has been found that the addition of from 8 to 8½ pounds of total solids to the sheet, half of that amount being added to each side, will give a very satisfactory and commercially very desirable paper. With the paper of 5 to 6% moisture content at the time of treatment the total moisture in the paper as it leaves the nip of the rolls 35 and 36 will be approximately 30 to 35%, and the necessary driers designated generally by the numeral 40 are provided to dry the paper sufficiently, in commercial operations to a moisture content of about 5 to 6%.

While the composition of the suspension which is applied at this point will be varied according to the characteristics desired, very satisfactory results have been secured in commercial operations, with paper having carbonate material incorporated therein as above described, where the suspension applied at the rolls 35 and 36 comprises approximately 30% solids. And satisfactory results have been secured where the solids consist approximately of 73% of a so-called Satin H. T. clay, 5% of finely divided white calcium carbonate and 22% of starch such as commercially known as "Stayco". To these solids are added suitable dyes to give properly controlled color characteristics and varying amounts of glycerine, for example 50% based on the weight of the starch.

The carbonate, when used in conjunction with the other materials has a tendency to limit the "dusting" and therefore maintains a more satisfactory surface in use of the paper.

Utilizing the procedure described will result in the addition of 8 to 8½ pounds of added material, incorporated in and upon the opposite surfaces of the paper with about the same quantity on each side; and this operation will add, using an ordinary 45 pound sheet of book paper as the basis of comparison, approximately 15% of materials by weight, about 10% of which is finely divided mineral material and the other 5% starch and glycerine, the weight being calculated on a basis of a ream of 500 sheets 25 by 38 inches.

The control of pressure as between the rolls 35 and 36 and the character of those rolls is important. The upper roll is preferably of non-ferous metal such as brass or a special composition covering, and the lower roll of a reasonably soft rubber, having a plastometer reading preferably of about P. J. 25 to 40. With a roll pressure of approximately 160 pounds per square inch such rolls will cause compression of the lower rubber roll to give a nip about an inch wide. This pressure is sufficiently high to so limit the quantity of material incorporated into the sheet that the receptive capacity of the sheet as it leaves the nip of the rolls is sufficient to accommodate the moisture and other materials present so that as the paper leaves the nip of the rolls, and the pressure is relieved, the material is smoothly and uniformly distributed and incorporated in and upon the surface. The consistency of the suspension (that is the amount of material contained in the water) should be controlled with respect to the receptivity of the paper sheet at the point of entrance into the nip of the rolls, so that a pressure controlled sufficiently high will thus limit the amount of material passing between the rolls and incorporating contact with the paper, to come within this referred to absorptive capacity and to thus produce the desired smooth and uniform distribution. The pressure of 160 pounds per square inch referred to above, has given satisfactory commercial results under the conditions as to moisture content, solids, consistency, etc., set out. Where the pressure is too low the absorptive capacity of the sheet beyond the rolls may be inadequate and worming or ridging of the mineral suspension may result. And by properly coordinating the suspension consistency and character, the moisture content of the paper, the weight and character of the paper, with the controlling pressure desired limitation of the amount pressed into incorporating contact with the sheet may be readily secured.

Preferably the paper as it comes from the first

drying operation is led around a cooling roll designated by the numeral 50, thence to supporting roll 51 which is placed close to the press rolls 35 and 36 and so located that the sheet is fed into the nip nearly horizontally but connects with the top roll slightly in advance of the nip.

The excess of color supplied onto the top side of the paper at the nip runs over the side and back into the source of supply. Preferably the suspension for application to both sides is fed from a common source, which facilitates the maintenance of uniform pressure, of uniform feed and of composition so as to thus give readier control of the balancing conditions.

While the method, product and form of apparatus herein described constitute preferred embodiments of the invention, it is to be understood that the invention is not limited to these precise methods, products and forms of apparatus, and that changes may be made therein without departing from the scope of the invention which is defined in the appended claims.

What is claimed is:

1. Process in the manufacture of paper having controlled balanced quantities of mineral material incorporated in and upon the opposite sides thereof to produce a paper of superior finish characteristics adaptable for color reproduction and the like; which comprises flowing a fibrous stock containing mineral filler material onto a forming wire to form a web of paper, extracting moisture therefrom, passing the paper through press rolls to effect a moisture expressing pressure thereon, bringing a suspension of mineral filler material and adhesive into incorporating contact with the wire side thereof to incorporate a controlled amount of such mineral into the wire side of the sheet effective to produce a balancing of receptivity conditions of the opposite sides of the sheet with the wire side rendered comparable in receptivity characteristics with the top side, drying the paper to a condition of high moisture receptivity, and then bringing a suspension of paper coating mineral into incorporating contact with the opposite sides of said sheet under predetermined conditions of pressure to effect a balanced incorporation of the coating material into and upon the opposite sides of the sheet.

2. Process in the manufacture of paper having controlled balanced quantities of mineral material incorporated in and upon the opposite sides thereof to produce a paper of superior finish characteristics adaptable for color reproduction and the like; which comprises flowing a fibrous stock containing mineral filler material onto a forming wire to form a web of paper, extracting moisture therefrom, passing the paper through press rolls to effect a moisture expressing pressure thereon, bringing a suspension of mineral filler material and adhesive into incorporating contact with the wire side thereof to incorporate an amount of such mineral of approximately .5 to 1 pound into the wire side of the sheet effective to produce a balancing of receptivity conditions of the opposite sides of the sheet with the wire side rendered comparable in receptivity characteristics wtih the top side, drying the paper to a condition of high moisture receptivity, and then bringing a suspension of paper coating mineral into incorporating contact with the opposite sides of said sheet under predetermined conditions of pressure to effect a balanced incorporation of the coating material into and upon the opposite sides of the sheet.

3. Process in the manufacture of paper having controlled balanced quantities of mineral material incorporated in and upon the opposite sides thereof to produce a paper of superior finish characteristics adaptable for color reproduction and the like; which comprises flowing a fibrous stock containing mineral filler material onto a forming wire to form a web of paper, extracting moisture therefrom, passing the paper through press rolls to effect a moisture expressing pressure thereon, bringing a suspension of mineral filler material and adhesive into incorporating contact with the wire side thereof to incorporate a controlled amount of such mineral into the wire side of the sheet effective to produce a balancing of receptivity conditions of the opposite sides of the sheet with the wire side rendered comparable in receptivity characteristics with the top side, drying the paper to a condition of high moisture receptivity, and then bringing a suspension of paper coating mineral into incorporating contact with the opposite sides of said sheet under predetermined conditions of pressure to incorporate an amount of such coating mineral into and upon said sheet of approximately 8 to 8½ pounds to effect a balanced incorporation of the coating material into and upon the opposite sides of the sheet.

4. Process in the manufacture of paper having controlled balanced quantities of mineral material incorporated in and upon the opposite sides thereof to produce a paper of superior finish characteristics adaptable for color reproduction and the like; which comprises flowing a fibrous stock containing mineral filler material onto a forming wire to form a web of paper, extracting moisture therefrom, passing the paper through press rolls to effect a moisture expressing pressure thereon, bringing a suspension of mineral filler material and adhesive into incorporating contact with the wire side thereof to incorporate an amount of such mineral of approximately .5 to 1 pound into the wire side of the sheet effective to produce a balancing of receptivity conditions of the opposite sides of the sheet with the wire side rendered comparable in receptivity characteristics with the top side, drying the paper to a condition of high moisture receptivity, and then bringing a suspension of paper coating mineral into incorporating contact with the opposite sides of said sheet under predetermined conditions of pressure to incorporate an amount of such coating mineral into and upon said sheet of approximately 8 to 8½ pounds to effect a balanced incorporation of the coating material into and upon the opposite sides of the sheet.

5. Process in the manufacture of paper having controlled balanced quantities of mineral material incorporated in and upon the opposite sides thereof to produce a paper of superior finish characteristics adaptable for color reproduction and the like which comprises flowing a fibrous stock containing mineral filler material onto a forming wire to form a web of paper, extracting moisture therefrom, passing the paper through press rolls to effect a moisture expressing pressure thereon, bringing a suspension of finely divided papermaking mineral and adhesive into incorporating contact with the wire side thereof to incorporate a controlled amount of such mineral into the wire side of the sheet effective to produce a balancing of receptivity conditions of the opposite sides of the sheet, drying the paper to a condition of high moisture recep-

tivity, then bringing a suspension of paper coating mineral into incorporating contact with the opposite sides of said sheet, and controlling the pressure of application of said coating mineral and the consistency thereof to control the amount of mineral materials so deposited upon and incorporated in said sheet to approximately four pounds per side per ream of paper to produce predetermined balanced mineral finished surfaces.

6. Process in the manufacture of paper having controlled balanced quantities of mineral material incorporated in and upon the opposite sides thereof to produce a paper of superior finish characteristics adaptable for color reproduction and the like which comprises flowing a fibrous stock containing carbonate mineral material onto a forming wire to form a web of paper, extracting moisture therefrom, passing the paper through press rolls to effect a moisture expressing pressure thereon, said sheet at this stage in the processing containing substantial quantities of said mineral matter, up to as much as 25% thereof, bringing a suspension of said mineral and adhesive into incorporating contact with the wire side thereof to effect the added incorporation of .5 to 1 pound per ream of the mineral matter into said wire side to produce a balancing of receptivity conditions of the opposite sides of the sheet, drying the paper to a condition of high moisture receptivity, and then bringing a suspension of paper coating mineral into incorporating contact with the opposite sides of said sheet to effect an added incorporation of coating mineral into and upon said sheet controlled to approximately four pounds per side per ream to effect a balanced incorporation of material into and upon the opposite sides of the sheet in predetermined balanced mineral finished surface.

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