Sept. 30, 1941. J. R. FANSELOW 2,257,373

METHOD AND APPARATUS FOR COATING SHEET MATERIAL

Filed Feb. 2, 1938 2 Sheets-Sheet 1

Fig. 1

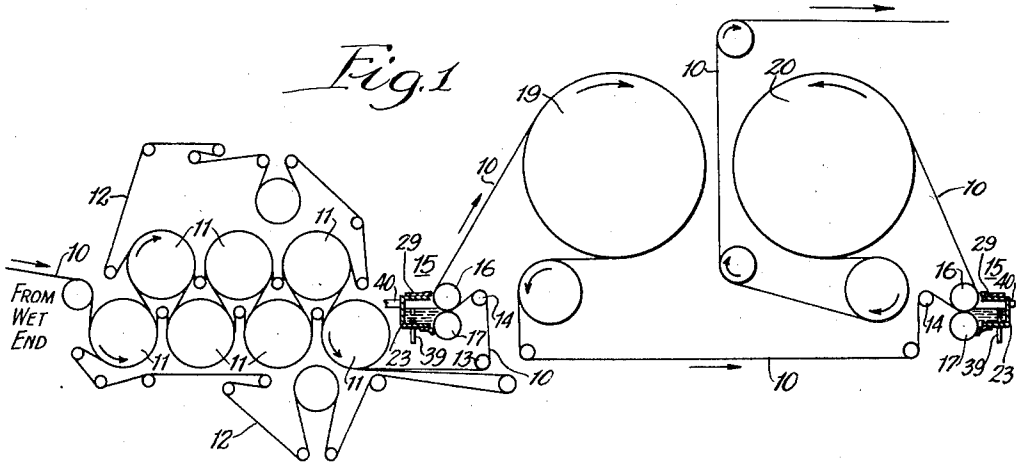


Fig. 2

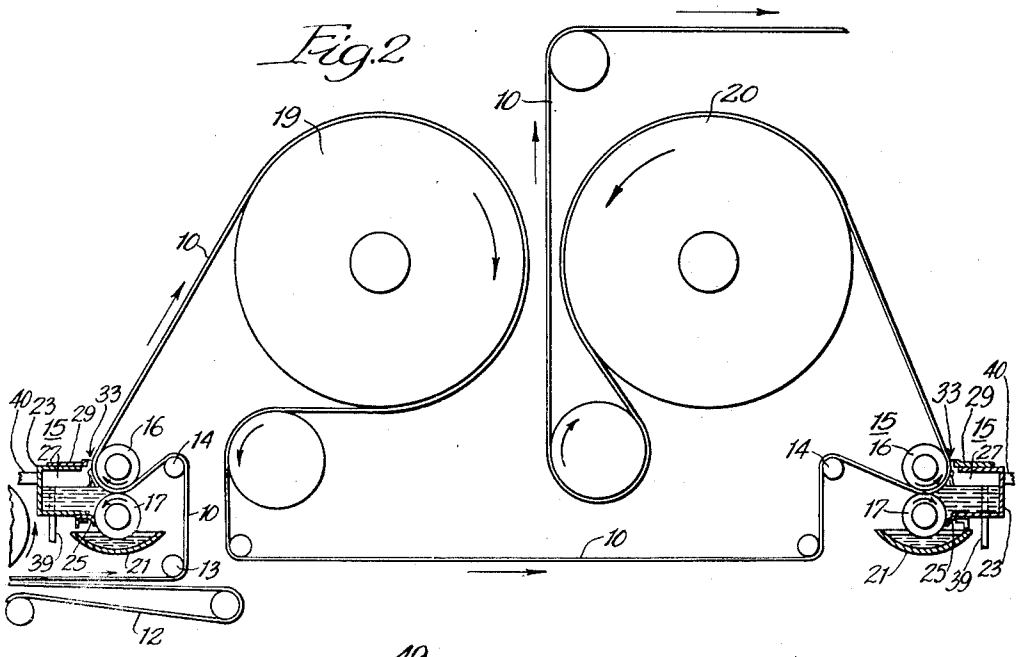
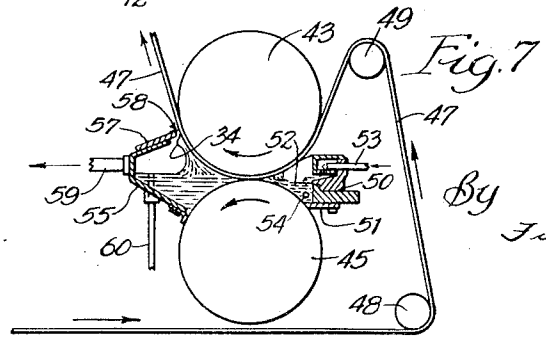


Fig. 7



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METHOD AND APPARATUS FOR COATING SHEET MATERIAL

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Fig. 3

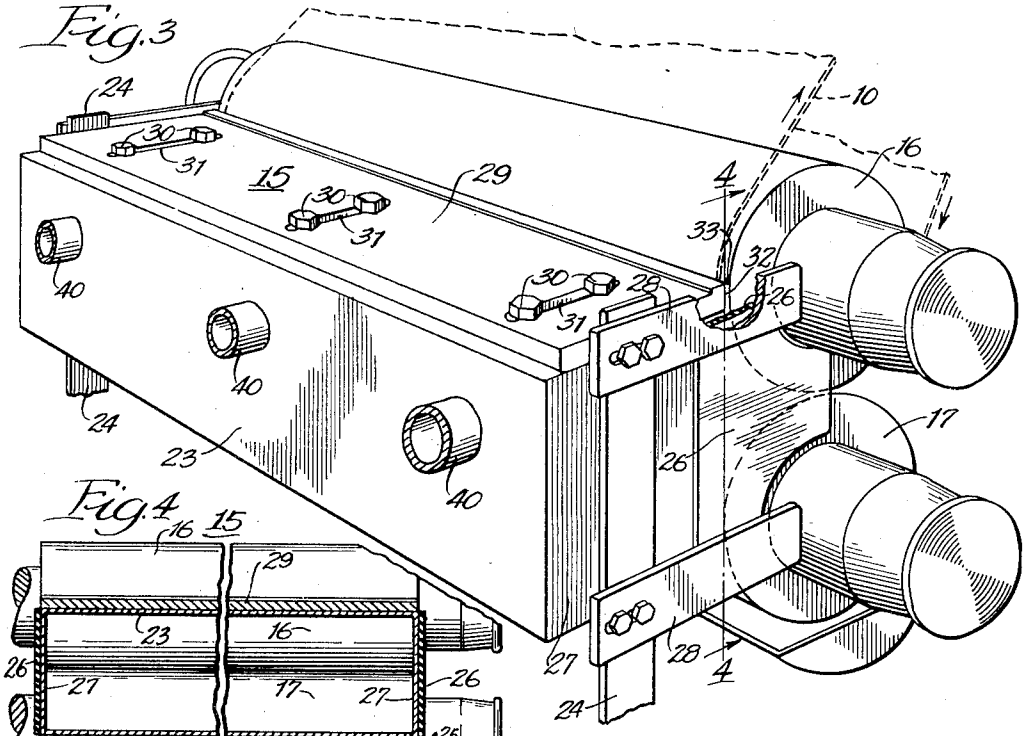


Fig. 4

Fig. 5

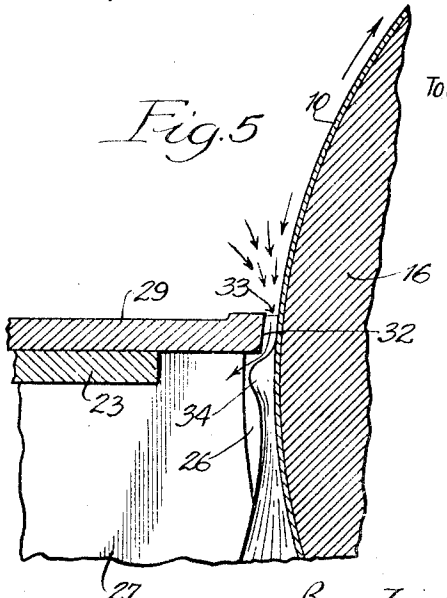
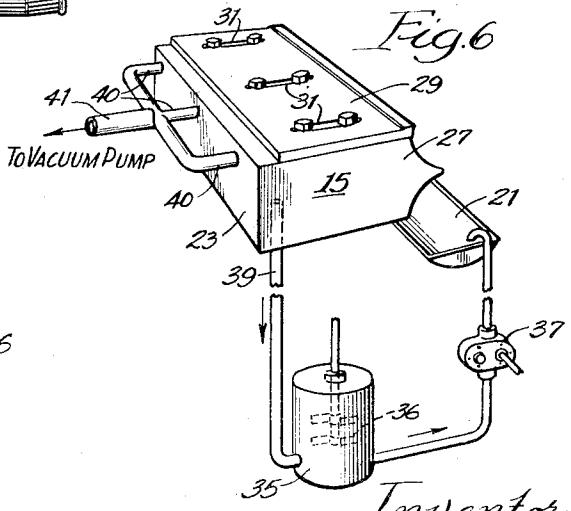


Fig. 6



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UNITED STATES PATENT OFFICE

2,257,373

METHOD AND APPARATUS FOR COATING SHEET MATERIAL

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Application February 2, 1938, Serial No. 188,369

24 Claims. (Cl. 91—48)

My invention relates generally to the art of coating sheet materials and has particular relation to the art of coating sheet materials such as paper, which have a relatively porous surface or body.

It is fairly well recognized in the printing art that clearer and better printing with minimum ink consumption can be accomplished on certain types of paper if the surface of that paper has a mineral surface, i. e. a surface coated with a mineral pigment or a mineral salt, than can be accomplished on paper with a natural fiber surface. Knowledge of this fact and the increasingly pressing demands of today for better, clearer printing has naturally resulted in a progressively increasing demand for surface coated papers of widely varying types.

Different kinds of paper require different types and weights of coating. Wall paper, for example, usually requires a relatively heavy coating applied to one side of the sheet. In contrast with this, the various commercial book papers require coatings of widely varying weight applied to both sides of the sheet. One principle is clear, however, if the coating is to provide a satisfactory printing surface and is to give a commercially satisfactory product, it must be evenly and uniformly applied to the sheet, and it must be free from streaks, bubbles, or other disfigurements; also, for certain types of paper the coating should be continuous over the sheet surface.

As might be expected, the economical provision of coated papers capable of meeting these diversified and stringent requirements has presented a most troublesome problem to the art. It appears to be impractical to apply the coating material to other than a formed sheet, and while various means have been suggested for applying coatings to formed sheets, none is completely free from difficulty.

Accordingly, the principal object of the present invention is to provide an improved apparatus and method for applying coatings to porous surface sheets, and especially to paper. As will hereinafter appear, the apparatus and method of the present invention constitute a simple, easily operated, inexpensive means for obtaining smooth continuous coatings of any desired thickness on any of the commercial types of paper, which coatings fully meet every requirement of the art. Moreover, by virtue of the novel apparatus and method of my invention, the coatings produced thereby are smoother and more uniformly distributed than is the case of the coatings of the prior art methods.

These and other objects of the invention and its numerous and important advantages over the methods and apparatus of the prior art will be made more apparent by reference to the accompanying drawings and the following description of certain preferred embodiments of the invention. Referring to the drawings—

Figure 1 is a diagrammatic side elevation of a paper making machine having embodied therein two coating mechanisms in accordance with my invention;

Figure 2 is an enlarged diagrammatic side elevation of the coating mechanisms comprising a part of the machine illustrated in Figure 1;

Figure 3 is a perspective view, partially in section, of one of the coating mechanisms illustrated in Figures 1 and 2;

Figure 4 is a fragmentary, sectional view on the general line 4—4 of Figure 3;

Figure 5 is an enlarged fragmentary, sectional view of a portion of the coating mechanism illustrated particularly in Figure 3;

Figure 6 is a schematic view illustrating the supply system for the coating material used in conjunction with the apparatus of my invention; and

Figure 7 is an enlarged diagrammatic side elevation of a modified form of the coating mechanism of my invention.

The coating apparatus and methods of my invention may be used to coat not only finished paper webs or sheets but also partially dried webs. The invention, therefore, may be embodied into a paper making machine so as to constitute one step in the manufacture of the paper. Such an arrangement is illustrated in Figure 1, wherein a formed web of paper as it comes from the wet end of the paper making machine is indicated at 10. This web, in accordance with the usual practice, will be carried over a plurality of heated drying cylinders 11, the web being held in place and pressed into contact with the cylinders by suitable felts 12. Any number of drying cylinders may, of course, be used.

The paper web after passing over the last drying cylinder 11 is led over a pair of suitable rolls 13 and 14 into the nip of a pair of coating rolls 16 and 17 which as shown preferably constitute a part of the coating mechanism proper 15. During the passage of the web or sheet through the coating mechanism 15 fluid coating material preferably an excess thereof is applied thereto; the web, with coating material thereon,

is carried through a vacuum chamber wherein the pressure is maintained below atmospheric, this step being one of the very important features of the invention; and finally as the web passes out of the coating mechanism 15, any excess coating material is doctored off to produce a finished coating of the desired weight by the use of a stream of air which flows substantially tangential to the surface of the coated sheet but in a direction counter to the direction of movement thereof, and the coating which remains on the web is leveled off.

To prevent vibration or movement during the doctoring operation, the web of paper is carried over the upper coating roll 16 for some distance above the doctoring means. After it leaves the coating mechanism 15 the web may be directed onto a large diameter, heated drying cylinder 19 or equivalent drying device. This drier serves to dry and set the coating.

If only one side of the sheet is to be coated, the web or sheet may be led directly from the roll 19 or other drier equipment to a suitable reel. If, however, it is desired to coat both sides, the sheet may be led from the drying cylinder 19 or other drier equipment into a second coating mechanism 15 which, as illustrated, is exactly similar in construction to the coating mechanism previously described. After passing through the second coater mechanism 15, the sheet is preferably led into a second drying means such as the large diameter drier indicated at 20, and into such additional driers or other processing mechanisms as may be neccesary.

It will be apparent that the particular type of apparatus used for drying the coating applied by the coating mechanism disclosed herein is not an important part of the invention, and that any apparatus capable of drying the coating without marring the surface thereof may be used. If both sides of the web or sheet are to be coated, it is desirable that the coating on the first surface to be coated shall be sufficiently dried and set that the sheet may be passed over supporting rolls or the like before the second coating is applied. It is not necessary that the sheet to be coated shall be absolutely dry during the applying of either coating.

The details of one form of the coating mechanism of my invention are illustrated particularly in Figures 3, 4, and 5. This mechanism, as previously stated, includes means such as the rolls 16 and 17 for applying an excess of fluid coating material to the surface of the sheet to be coated, a vacuum chamber, and means for doctoring off the excess coating material before the coating is dried. The coating rolls 16 and 17 are of the conventional type, and to permit the application of an excess of coating material, they may conveniently be provided with adjustable supports and should be so crowned that zero nip pressure can be obtained for the thicknesses of sheets which it may be desired to coat. The coating rolls 16 and 17 are preferably supported one above the other, although this arrangement is not essential, and a shallow pan 21 for receiving the fluid coating material is supported beneath the lower roll 17.

The vacuum chamber may take any convenient shape. The device illustrated in Figures 1 to 6 of the drawings comprises a generally rectangularly box-like structure 23 of sheet metal which is adapted to be supported adjacent the coating rolls by suitable support members 24. The length of the box structure 23 is exactly equal to the length of the rolls, as is illustrated in Figure 4, and one side of the structure 23 is adapted to be closed by the coating rolls 16 and 17. Since these rolls move, seals are necessary to prevent loss of vacuum; the seal at the bottom of the box structure comprises a suitable sheet rubber doctor 25 or the like which contacts the surface of the lower roll 17, as is illustrated in Figures 2 and 4. The ends of the box structure 23 are provided with flexible sealing plates 26 of rubber or the like which are adapted to rub against the end surfaces of the rolls 16 and 17. To provide support for the end sealing members 26, the end portions 27 of the box structure 23 are preferably cut to a configuration approximating that of the engaging rolls, as is illustrated in Figure 6.

To prevent the box structure 23 from vibrating during use of the coating mechanism and to facilitate the positioning and adjusting of that structure, horizontal arms 28 adjustably attached to the box support members 24 are provided. The inner ends of the horizontal arms 28 are adapted to rub against the adjacent supporting shaft for the coating rolls, as is illustrated in Figure 3, and if desired suitable antifriction bearing surfaces may be provided at the area of contact.

The upper section of the box structure 23 which defines the walls of the vacuum chamber is provided with a doctor or shoe member 29 which is adjustably supported thereon by means of bolts 30 and cooperating slots 31. The inner surface 32 of the upstanding portion of this doctor 29 is preferably arcuate with a radius of curvature of such length that when the doctor is arranged in juxtaposition with the upper roll 16, as is illustrated in Figures 3 and 5, the opposed surfaces of the doctor and the roll are substantially concentric. The inner surface 32 of the doctor 29 is spaced from the adjacent surface of the roll 16 so as to provide a narrow gap or slot 33 of uniform width. The reduced pressure maintained within the vacuum chamber serves to draw a stream of air through this narrow slot 33, which stream flows in its zone of action substantially tangential to the surface of the paper, but in a direction opposite to the movement thereof, this stream serves to doctor off the excess coating material as the sheet leaves the coating mechanism 15. The doctoring action of the tangential stream causes the excess fluid coating material to collect into a wave or ripple immediately beneath the slot or gap 33, this being illustrated at 34 in Figure 5. The fact that this stream of air is produced by a pressure differential on the two sides of the slot defined by the opposed surfaces of the doctor 29 and the roll 16 is an important feature of the invention, because it makes possible a stream of air which in its zone of action flows substantially tangential to the coated surface of the sheet in a direction opposite to the direction of movement of the sheet. Neither the height nor the configuration of the surface 32 appears to be critical, but tests indicate that no advantage is gained by making this height greater than several times the width of the gap, and satisfactory results can be obtained by any arrangement which will produce a stream of air which in its zone of action flows tangential to the surface of the coated sheet.

The supply of coating material is preferably contained in a mixing vessel 35 which is provided with an agitator 36 for keeping the solids

in suspension, and is pumped into the shallow pan 21 by a rotary pump 37 or the like, as is indicated in Figure 6. Since an excess of coating material is applied to the surface of the paper as it passes through the nip of the coating rolls 16 and 17, and since this excess is carried into the vacuum chamber, an overflow pipe 39 leading to the mixing vessel is provided for preventing the vacuum chamber from filling up. The mixing vessel 35 is located a sufficient distance below the coating apparatus to assure maintenance of the vacuum within the vacuum chamber. The desired degree of sub-atmospheric or reduced pressure is maintained within the vacuum chamber by a suitable pumping means (not shown). Since the slot 33 opens into the vacuum chamber and the differential of pressure at opposite ends of the slot is relied upon to produce the stream of air which removes excess coating, the vacuum pump means must be capable of handling substantial amounts of air. The vacuum pump is connected to the vacuum chamber through a plurality of suitable outlet pipes 40 which may connect with a single main outlet 41. The stream of air flowing through the slot 33 which doctors off the excess coating is prevented from vibrating the coated sheet by virtue of the fact that that sheet is carried over the upper coating cylinder 16 under substantial tension to a point well beyond the zone of action of that stream.

The exact structural arrangement of the vacuum chamber and the particular manner in which the excess coating material is applied to the sheet during the coating operation are not basically important parts of the present invention, and in Figure 7 I have illustrated diagrammatically a modified form of my invention which while somewhat different from the previously described apparatus will operate very satisfactorily. In this modified structure a pair of rolls generally similar to the coating rolls 16 and 17 of the previously described embodiment of the invention are illustrated at 43 and 45. The sheet of paper or other material to be coated, which is illustrated at 47, is led from a supply roll or directly from the paper making machine over suitable guide rolls 48 and 49 into the nip of the rolls 43 and 45. Fluid coating material is applied to the lower roll 48 adjacent the nip by means of an inverted doctor applying apparatus generally similar to that disclosed in Wilkinson and Fanselow Patent No. 2,064,776, which was issued on December 15, 1936. This apparatus includes a suitable frame 50 arranged to extend along, and in juxtaposition to, the lower roll 45, a flexible doctor 51 which cooperates with the frame 50 and the adjacent roll surface to form a shallow trough 52, and suitable end members (not shown) for closing the ends of the trough. The coating material is pumped into the trough 52 through an inlet pipe 53, excess material flowing out through a suitable outlet 54. The vacuum chamber 55 in this form of the invention is generally V-shaped in cross section but is otherwise similar to the vacuum chamber 23 of the previously described embodiment of the invention. The chamber 55 is, of course, the same length as the coating rolls, and the ends are sealed by rubber sealing members (not shown) similar to the members 26. The level of the coating liquid within the vacuum chamber 55 is preferably maintained above the nip of the rolls 43 and 45.

The upper portion of the vacuum chamber 55 is provided with an adjustable plate or shoe member 57 arranged to extend along the upper roll 43 and to define with the surface of that roll a narrow slot 58 through which the sheet to be coated is moved and through which air is drawn into the vacuum chamber in a tangential stream to doctor off the excess coating material. The chamber 55 is provided with air outlet pipes 59 which lead to the vacuum pump and with an overflow pipe 60 for the excess coating material which is carried into the chamber. The sheet to be coated is carried on the upper roll 43 for a substantial distance beyond the slot 58 through which the air is drawn into the vacuum chamber in order to prevent vibration or movement of the sheet during the doctoring operation. The operation of this modified form of the invention is, of course, practically identical with the operation of the apparatus of Figures 1 to 6.

In both of the vacuum coater structures which have been described in the foregoing the sheet to be coated is supported upon a roll which rotates during the coating operation. It will be understood that the support for the sheet can readily be made stationary, the sheet in such instance being drawn over a smooth surface of suitable contour.

Likewise, in connection with the description of the operation of these coater structures, it has been stated that the stream of air utilized for doctoring off excess coating is a tangential stream in its zone of action, i. e. in, and adjacent to, the slot by which the stream is formed. It will be understood that if the sheet to be coated is drawn over a flat surface in the zone of action of this air stream the stream will probably flow parallel to the surface of the sheet for at least a short distance. It is intended, therefore, that the term "tangential" as applied to the air stream produced in apparatus embodying the principles of the present invention shall include not only all streams which are actually or approximately tangential to the sheet support but also all parallel or approximately parallel streams of the character just described.

Tests show that the coatings applied to porous surfaced sheet materials such as paper by the apparatus and methods of my invention are particularly smooth and even, and at the same time produce a much more complete filling of the interstices of the sheet than is accomplished by the prior art methods. It is believed that this novel result is due in a very considerable degree to the fact that the sheet is passed through a region of sub-atmospheric or reduced pressure while excess coating material is on the sheet. In the vacuum chamber the coating material on the sheet is subjected to a number of forces, including the force of gravity, a slight centrifugal action due to the rotation of the cylinder, and fluid friction resulting from the translatory motion of the sheet through the coating material entrapped in the vacuum chamber and the wave formation 34; these forces tend to produce considerable turbulence in the fluid coating material on the sheet, and it appears that this turbulence combined with the reduced pressure within the vacuum chamber removes or at least partially removes a substantial portion of the air entrapped within the interstices of the sheet. When the sheet moves into the atmosphere, the atmospheric pressure against the continuous coating on the surface of the web serves to press that coating into the interstices, it being impossible at this time for air to enter the web from

the bottom due to the presence of the upper roll over which the sheet is carried. The net result appears to be in the nature of a pumping action.

The amount of penetration of the coating, which is a most important consideration in certain types of coating operations, may be readily controlled by varying the sub-atmospheric pressure maintained in the vacuum chamber. Lower pressures, of course, produce greater penetration. It will be evident, therefore, that the invention will accomplish maximum or controlled penetration of the coating into the web and thereby cause the anchoring of that coating in place with minimum danger of subsequent picking off or loosening of the coating during calendering or printing. It is not positively known whether the foregoing theory accurately explains the operation of the invention, but it is certain that the invention produces a very superior coating, and the theory set forth is believed to be the only reasonable explanation.

It is to be understood that the use of a stream of air for doctoring off excess coating material which flows tangential to the surface of the coated sheet but in a direction opposite to the movement of that sheet will of itself produce a smooth coating superior to the coating produced by many of the prior art methods. However, the invention is realized in its fullest sense by the combination of such a stream or its equivalent in connection with the vacuum chamber into which the sheet is passed with an excess of coating material thereon.

The apparatus and coating method of the invention, especially the use of the vacuum chamber for aiding in applying the coating and for producing a blast of air which moves and spreads the coating, will be applicable to the coating not only of paper sheets but various other types of porous sheets, such as woven fabrics, felts, and the like. Accordingly, when the terms "sheet" or "web" are used herein they will be understood to include all types of felted or woven sheets having a porous surface.

Various types of coating materials may be applied by the apparatus and methods of my invention, and there appears to be no definite limitation, within reasonable limits, upon the speed at which the coating may be applied. In fact, the increased turbulence produced at high speeds within the vacuum chamber apparently aids to some extent the even spreading and formation of the coating. Organic solvent coatings, especially those embodying moderately low volatile solvents, may be used, and substantially all of the water solvent coatings as ordinarily used for paper sheets are satisfactory. Such latter coatings, as is well known in the art, usually include a pigment or mineral coating material such as that sold under the trade name "Satinwhite"; coating clay, which is a highly refined, very fine, bright, white clay; calcium carbonate; titanium pigments; or, in general, any mineral salt, pigment, or filler in a suitable carrier medium. Coloring material may, of course, be added to the coating in the manner well known to the art.

One coating solution which I have used successfully consists of about 38% coating clay, 4.5% casein, and 57.5% of water. This yields a fairly high consistency (41.4%), moderately viscous coating, and is especially suitable for such papers as wall paper. For clay coatings it is desirable for the percentage of casein to be in the neighborhood of 10% to 15% by weight of the clay. Other fillers require different percentages of casein. "Satinwhite," for example, requires about 40 to 45% casein on the weight of the dry pigment. Coatings of lower viscosity and low percentage consistency will be used for applying thin coatings to book papers and the like and will, of course, contain less pigment and a greater percentage of water.

The width of the narrow slot 33 formed between the doctor and the adjacent surface of the upper coating roll 16 may be varied between fairly wide limits, providing, of course, that the vacuum pump is capable of maintaining a sufficient vacuum within the box. Tests indicate, however, that the slot opening when coating paper with clay or similar coating material should be within the range of 0.025 to 0.090 inch, these dimensions being the actual width of the slot when the paper is moving therethrough. Decreased slot width tends to decrease the amount of coating applied, a slot width of .025 inch, for example, producing under certain conditions a 12½ pound coating (500 sheets 24 x 36 inches) and a slot width of 0.085 inch producing an 18 pound coating under the same conditions, these figures being for a casein-clay coating of fairly high viscosity and consistency and at a coating speed of about 90 ft. per minute. It appears that for most ordinary paper coating the best results can be obtained with a slot width from about .025 to .060 inch, these widths being in the range where only slight variation in the weight of coating will result in variation in the slot width, i. e. it being the range where most uniform coating is produced.

Increasing the rate of translatory movement of the sheet increases the weight of the coating applied, all other factors remaining constant. When using a moderately high consistency (about 40%) clay-casein coating under conditions similar to those in the tests of the effect of slot width, it was noted that at 70 ft. per minute an 8 pound coating would be applied, whereas with a sheet speed of 205 ft. per minute a 12 pound coating would be applied. With a lower viscosity coating having a consistency of about 29.1% it was noted that 5½ pounds of coating would be applied at a sheet speed of 50 ft. per minute, whereas 6½ pounds of coating would be applied at 205 ft. per minute.

The degree of vacuum which is maintained within the vacuum tank will be determined chiefly by the type of coating material and the thickness or weight of the coat which is to be applied. It will be understood that coats of the same weight can be produced by different combinations of coating material consistency and vacuum. Best results, however, will be obtained by using intermediate combinations, that is, a median consistency coating material with a median vacuum.

Higher vacuums, of course, effect better elimination of the entrapped air and tend to produce coatings which are somewhat better anchored or bonded and which fill the interstices of the surface somewhat better than is the case when low vacuums are used. For ordinary thicknesses of paper, such as the papers used for wall paper, book paper, and the other most frequently coated paper sheets, there appears to be sufficient turbulence in the vacuum chamber to produce reasonably good results with a vacuum of about 1 inch of mercury, although I prefer to use a vacuum between 1½ and 3 inches or more of mercury for such coatings, especially for the more viscous and the higher consistency coatings.

As will be evident from the foregoing, there are four ways of varying the weight or thickness of the coating which is to be applied to the sheet: First, the sub-atmospheric or reduced pressure within the vacuum chamber may be varied; second, the consistency of the coating material may be varied; third, the width of the stream of air, i. e. the width of the slot 33 or 58, may be varied; and fourth, the rate of movement of the sheet may be varied. In practical operation it is probable that only the first two would be used to any great extent. These inherent characteristics of the apparatus naturally produce an extremely flexible apparatus which is capable of use in connection with a wide variety of coating materials and sheets.

It will be understood that a sheet which is to be coated by the apparatus of the present invention may be subjected to various types of pressure or smoothing treatment either before or after the surface coating is applied. For example, the sheet may be smoothed by being passed between pressure rolls before or after it is coated in accordance with the methods disclosed in Bright Patent 1,964,312 issued June 26, 1934, or it may be coated or impregnated in accordance with the method of Germanson and Kranhold Patent 1,918,095, issued July 11, 1933, before it passes into the vacuum coater of my invention. In fact, it has been found that certain particularly beneficial and quite unpredictable results are achieved when the treating methods of one or both of these two patents are combined with the vacuum coating means of the present invention; these results and advantages are, however, outside the province of this application and will be disclosed in an application or applications to be subsequently filed.

When it is desired to process a sheet in accordance with the Bright or the Germanson and Kranhold patents either before or after applying a surface coating by the methods of the present invention, it is usually desirable to apply the fluid coating material solely within the vacuum chamber itself. This can be conveniently done by the apparatus disclosed herein through the provision of suitable piping for introducing the coating material directly into the vacuum chamber without loss of vacuum. A suitable arrangement for accomplishing this is within the skill of a mechanic.

From the foregoing it will be seen that I have disclosed the features of a novel method and apparatus for accomplishing the coating of sheet materials, especially sheet materials having a porous or rough surface. My invention includes the important concept that coatings may be more efficiently applied to materials of this type by the use of a vacuum chamber into which the coated sheet is carried with an excess of fluid coating material thereon, which excess is subsequently doctored off. It is believed that this concept is novel, and it appears to be in a large degree responsible for the established efficiency of the coating apparatus of my invention.

I have also disclosed a new and improved means for doctoring off excess coating material from a coated sheet during the coating operation. This aspect of my invention embodies the discovery that this doctoring operation can best be accomplished by the use of a stream of air which flows tangential to the surface of the coated sheet from which the excess material is to be removed, but in a direction opposite to the direction of movement of that sheet. This doctoring means is especially suited for use in conjunction with the coating apparatus embodying the vacuum chamber feature of the present invention, but it will be understood that in certain applications it may be used alone. Best results are believed to be attained when the stream of air is vacuum produced.

It is evident that various apparatus may be made embodying the principles and methods of my invention. Accordingly, it is my desire that the accompanying claims shall be accorded the broadest reasonable construction consistent with the language appearing therein and with the prior art.

I claim the following as my invention:

1. In apparatus particularly intended for coating paper or fabric sheets having a porous surface, means for applying an excess of fluid coating material to a surface of the moving sheet, means for passing the coated sheet with the excess coating material thereon through a region of decreased pressure, and means for subsequently doctoring off the excess coating material.

2. In apparatus particularly intended for coating paper or fabric sheets having a porous surface, means for imparting translatory motion to the sheet to be coated, means for applying an excess of fluid coating material to a surface of the moving sheet, means for passing the coated sheet with the excess coating material thereon through a region of decreased pressure, means for subjecting the coated surface of the sheet to a stream of air flowing into said region of decreased pressure substantially tangential to the surface of said sheet in a direction opposite to the direction of movement of said sheet so as to remove excess coating material, and means for removing air from said region so as to maintain said decreased pressure.

3. In apparatus of the class described, means for imparting translatory motion to a sheet of paper or fabric, means for applying an excess of fluid coating material to one surface of the moving sheet, a vacuum chamber, means for passing the coated sheet with the excess coating material thereon through said vacuum chamber, and means for subjecting the coated surface of said moving sheet as it leaves said vacuum chamber to a stream of air flowing substantially tangential to the surface of said sheet in a direction opposite to the direction of movement of said sheet.

4. In apparatus of the class described, a pair of coating rolls, means for applying fluid coating material to at least one of said coating rolls, means for defining a vacuum chamber one of the sides of which is closed by said coating rolls and another of the sides of which includes a doctor arranged in juxtaposition to the other of said coating rolls so as to define a narrow slot-like opening, means for moving a sheet of paper or fabric between the nip of said coating rolls through said vacuum chamber and out said opening, means for maintaining a reduced pressure within said vacuum chamber whereby the surface of the sheet being moved through said vacuum chamber is subjected first to a region of decreased pressure and later to a stream of air flowing substantially tangential to the coated surface of said sheet in a direction opposite to the direction of movement of said sheet.

5. In apparatus of the class described, a pair of coating rolls, means for defining the walls of a vacuum chamber one of the sides of which is closed by said rolls, said wall defining means including a doctor or shoe member arranged in

juxtaposition with one of said coating rolls so as to define with that roll a narrow passageway of substantially uniform width, means for maintaining a reduced pressure within said vacuum chamber, and means for removing excess coating material which is carried therein without loss of vacuum.

6. In apparatus of the class described, means for imparting translatory motion to the sheet to be coated, said means including a rigid support for the sheet which contacts one side only of the sheet, a doctor arranged in juxtaposition to said support, means for applying an excess of fluid coating material to the other side of the moving sheet, and means for creating a differential in air pressure on opposite sides of said doctor to develop a stream of air between said doctor and said support in a direction counter to the direction of movement of the sheet.

7. In apparatus of the class described, means for imparting translatory motion to the sheet to be coated including a roll upon which the sheet is carried, a doctor arranged in juxtaposition to, but spaced from, said roll, means for applying an excess of fluid coating material to the exposed side of the moving sheet carried on said roll, means for creating a region of reduced pressure through which the coated sheet carried on said roll moves before reaching said doctor, and means for developing a differential in air pressure on opposite sides of said doctor to develop a stream of air between said doctor and said support in a direction counter to the direction of movement of the paper.

8. In apparatus of the class described, means for imparting translatory motion to the sheet to be coated including a roll upon which the paper is carried, means for defining the walls of a vacuum chamber enclosing at least a portion of the length of the paper carried upon said roll, said wall defining means including a doctor arranged in juxtaposition to, but spaced from, said roll, means for applying an excess of fluid coating material to the exposed surface of the sheet carried on said roll at such point that the coated sheet will subsequently pass into said vacuum chamber, and means for producing a partial vacuum within said vacuum chamber whereby a stream of air is caused to flow between said doctor and said support in a direction counter to the direction of movement of the paper.

9. In apparatus of the class described, a supply of fluid coating material, means including a pair of coating rolls adjustable to provide substantially zero nip pressure for applying an excess of said fluid coating material to sheets passed between the nip of said rolls, means for passing a sheet of paper or fabric through the nip of said coating rolls and over a substantial portion of the peripheral surface of one of said rolls, and means for subjecting the surface of such sheet to a stream of air flowing substantially tangential to the surface thereof but in a direction opposite to the direction of movement thereof, said last mentioned means including an arcuate shaped, elongated doctor member supported adjacent the coating roll over which the sheet is carried, said doctor member being so shaped and so positioned that it defines with the adjacent roll an arcuate shaped air gap of substantially uniform width, and means for creating a differential of pressure on opposite sides of said doctor member.

10. The method of coating a felted or woven sheet which comprises moving the sheet with translatory motion, applying an excess of fluid coating material to the side of the sheet to be coated, subjecting the coated surface of the moving sheet to a vacuum and then to a stream of air flowing counter to the direction of movement of the sheet into said vacuum.

11. The method of coating a porous surfaced felted or woven sheet which comprises moving the sheet with translatory motion, applying an excess of fluid coating material to the side of the sheet to be coated, passing the moving coated sheet through a region of reduced pressure, and then doctoring off the excess coating material.

12. The method of coating a felted or woven sheet which comprises moving the sheet with translatory motion, applying an excess of fluid coating material to the side of the sheet to be coated, passing the moving coated sheet through a region of reduced pressure, and then subjecting the coated surface of the moving sheet to a vacuum-produced stream of air flowing counter to the direction of movement of the sheet.

13. The method of coating a felted or woven sheet which comprises moving the sheet with translatory motion, applying an excess of fluid coating material to the surface of the sheet which it is desired to coat, passing the coated sheet with the excess coating material thereon through a region of decreased pressure, and then subjecting the coated surface of said sheet to a stream of air which flows substantially tangential to the coated surface of said sheet in a direction counter to the direction of movement thereof.

14. The method of coating a felted or woven sheet which comprises moving the sheet with translatory motion, applying an excess of fluid coating material to the surface of the sheet which it is desired to coat, passing the coated sheet with the excess coating material thereon through a region of decreased pressure, rigidly supporting the sheet against vibratory motion, and while the sheet is so supported subjecting the coated surface thereof to a stream of air which flows substantially tangential to the coated surface of said sheet in a direction counter to the direction of movement thereof.

15. In apparatus of the class described, means for defining the walls of a vacuum chamber having an elongated, slot-like opening therein, means for conducting a sheet to be coated into said chamber and out through said opening, means for applying an excess of fluid coating material to a surface of the sheet which is conducted through said chamber, and means for developing a vacuum within said chamber, said vacuum serving to create a pressure differential on opposite sides of said opening whereby a stream of air flows into said chamber through said opening tangent to the coated surface of said sheet to doctor off excess coating fluid adjacent said opening.

16. In apparatus for coating a continuous web of paper or analogous material, the combination of a chamber having an inlet and an outlet for the continuous web, means for propelling the web through said chamber, means for applying coating material to the web before the web leaves the chamber, and means for withdrawing air from the chamber and thereby creating a flow of air into the chamber through said web-outlet so as to remove excess coating material from the web.

17. In apparatus for coating a continuous web of paper or analogous material, the combination of a chamber having an inlet and an outlet for

the continuous web, there being a pair of rolls associated with the wall of said chamber so that the nip of said pair of rolls serves as the web inlet, means for propelling the web through said chamber, means for applying an excess of coating material to the web before the web leaves the chamber, and means for withdrawing air from the chamber and thereby creating a flow of air into the chamber through said web-outlet so as to remove excess coating material from the web.

18. The method of coating a sheet which comprises maintaining a difference of pressure on opposite sides of a barrier having a slot therein, propelling a web, having less thickness than the width of the slot, through said slot from the zone of inferior pressure into the zone of superior pressure, maintaining one surface of said web in contact with said barrier at one side of said slot so as to prevent transverse vibratory movement of said web as it passes through said slot, and applying liquid coating material to the other surface of said web prior to its passage through said slot.

19. In apparatus particularly intended for coating continuous webs of paper or fabric having a porous surface, a pair of cooperating rolls, means for defining the walls of a chamber one of the sides of which is closed by said cooperating rolls and another of the sides of which includes a doctor member arranged in juxtaposition to one of said rolls so as to define a narrow slot like outlet opening, means for passing the web to be coated into said chamber through the nip of said cooperating rolls and out of said chamber through said slot like outlet opening, means for applying fluid coating material to said web before said web passes out of said chamber, and means for withdrawing air from said chamber whereby sub-atmospheric pressure is maintained therein and a stream of air is caused to flow into said chamber through said slot like opening.

20. In apparatus particularly intended for coating continuous webs of paper or fabric having a porous surface, a pair of cooperating rolls, means for defining the walls of a chamber one of the sides of which is closed by said cooperating rolls and another of the sides of which includes a doctor member disposed in juxtaposition to one of said rolls so as to define a narrow slot like outlet opening, means for passing the web to be coated into said chamber through the nip of said cooperating rolls, through said chamber in contact with the rolls which is adjacent said doctor member, and out of said chamber through said slot like opening, said web being held in contact with the said roll which is adjacent said doctor member a substantial distance beyond said outlet opening, means for applying fluid coating material to said web before said web passes out of said chamber, and means for withdrawing air from said chamber whereby sub-atmospheric pressure is maintained therein and a stream of air is caused to flow into said chamber through said slot like opening.

21. In apparatus particularly intended for coating continuous webs of paper or fabric having a porous surface, a pair of cooperating rolls, means for defining the walls of a chamber one of the sides of which is closed by said cooperating rolls and another of the sides of which includes a doctor member arranged in juxtaposition to one of said rolls so as to define a narrow, slot-like web outlet opening, a quantity of fluid coating material disposed in said chamber, means for passing the web to be coated into said chamber through the nip of said cooperating rolls, through said fluid coating material, and out of said chamber through said slot-like opening, said web being held in contact with said first mentioned roll at least during the passage of said web through said slot-like outlet opening in order to prevent transverse vibratory movement of said web during the coating operation, and means for withdrawing air from said chamber whereby sub-atmospheric pressure is maintained therein and a stream of air is caused to flow into said chamber through said slot-like opening.

22. In a machine for coating webs of paper or the like, a housing means for maintaining a partial vacuum in said housing, means for guiding a web through said housing, means for coating the web, and means for directing a flow of outside air inwardly into said housing and across the coated surface of said web as it passes out of the housing, said means including an aperture defining member spaced from the coated face of the web, the coated face of the web itself providing another side of the aperture through which the air passes.

23. The method of coating a web of material which includes applying an excess of coating material to the web while the web is passing through a vacuum, guiding the web out of said vacuum, and causing air to flow directly and tangentially across the coated surface of said web in the direction of the vacuum as the web escapes from the vacuum.

24. The method of coating a web of material which includes applying an excess of coating material to the web while the web is passing through a vacuum, guiding the web out of said vacuum, and causing air to flow directly and tangentially across the coated surface of said web in the direction of the vacuum as the web escapes from the vacuum, through an aperture one side of which is defined by the coated surface of the web, and supporting said web on an arcuate surface as it escapes from the vacuum.

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DISCLAIMER

2,257,373.—*John R. Fanselow*, Appleton, Wis. METHOD AND APPARATUS FOR COATING SHEET MATERIAL. Patent dated September 30, 1941. Disclaimer filed October 21, 1943, by the assignee, *K. C. M. Company*.

Hereby disclaims from the scope of claim 6 of said patent any apparatus which includes a chamber connected to a source of air under pressure and having an outlet slot for discharging a stream of air towards the coating, both walls of said slot being spaced from the coating.

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