March 14, 1944. J. CAMPBELL ET AL 2,344,232

APPARATUS FOR COATING

Original Filed Dec. 12, 1940

Fig. 1.

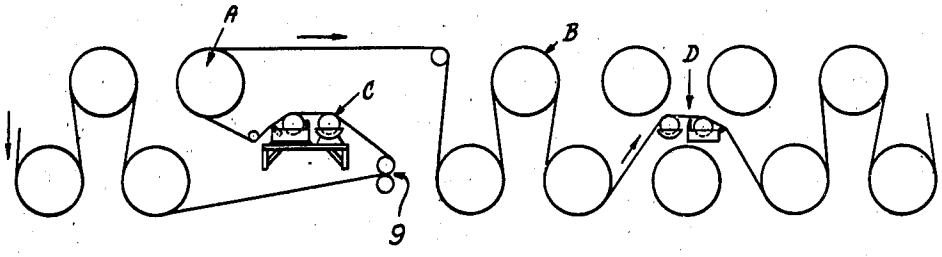


Fig. 2.

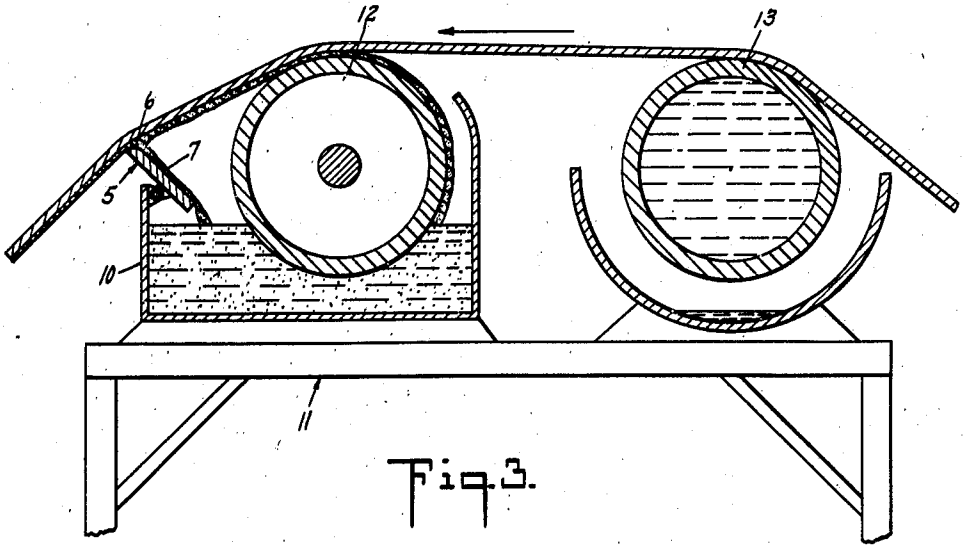
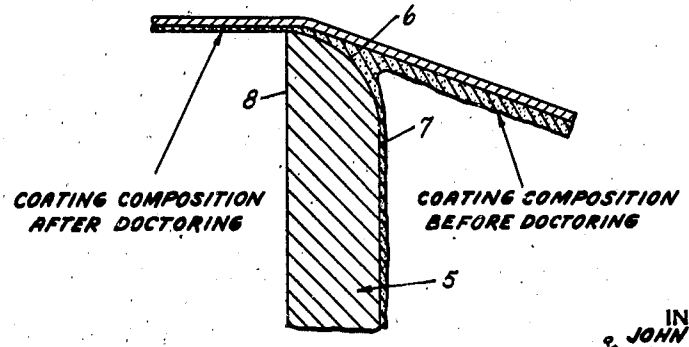


Fig. 3.



INVENTOR
JOHN CAMPBELL
KENNETH A. TAYLOR
BY
James D. Bock
Attorney

Patented Mar. 14, 1944 2,344,232

UNITED STATES PATENT OFFICE

2,344,232

APPARATUS FOR COATING

John Campbell and Kenneth Austin Taylor, Glens Falls, N. Y., assignors to International Paper Company, a corporation of New York

Original application December 12, 1940, Serial No. 369,778. Divided and this application August 12, 1942, Serial No. 454,496

4 Claims. (Cl. 91—53)

This invention relates to new and useful improvements in coating and particularly seeks to provide a novel method and apparatus for applying a smooth uniform mineral coating to a continuously moving web of paper or the like.

This application is a division of our co-pending application, Serial No. 369,778, filed December 12, 1940.

One procedure which may be employed in coating a web of paper is, broadly, to apply the coating composition to the web in greater quantities than required to produce the desired weight of coating and then remove the excess through the use of smoothing or wiping devices such as doctor blades.

Heretofore in following the normal procedure in applying mineral coating to a moving web of paper, considerable difficulty has been encountered as a result of the formation of a multiplicity of imperfections in the applied coating. These imperfections were generally caused as a result of the passage of a moving web of paper to which an excess of coating composition had been applied over some form of smoothing or wiping device such as a doctor blade, a smoothing roll, or other device, the web-contacting surfaces of which have been wettable by the coating composition. Once the web contacting surfaces have become wet, the affinity of the coating material for the wetted surface tends to cause a splitting of the coating film between the web and the smoothing device which results in marked irregularities in the finally coated surface.

Heretofore those doctor blades which have been employed with varying degrees of success to remove the excess coating from the web have been shaped to provide either a cylindrical surface disposed in contact with the web or have been provided with web-contacting surfaces of progressively decreasing radii of curvature. Each of these prior known types depends for its effectiveness upon the combination of a special shape of the web-contacting portion together with a generally dimensionally restricted maximum radius of curvature terminating in a minor radius of curvature at substantially the point at which the web leaves the doctor blade. In many instances where these prior known devices have been used, a small pool of coating composition has formed adjacent the doctor blade but on the trailing side thereof which frequently caused stippling or streaking of the applied coating.

A doctor blade constructed in accordance with the present invention avoids the difficulties heretofore encountered with prior known devices through the inclusion of several new factors which have heretofore been given little if any consideration.

A doctor blade constructed in accordance with this invention together with the method of use thereof facilitates the application of a smooth, uniform coating to a traveling web of paper with substantially no surface imperfections whatsoever. This desirable result has been achieved through providing a smoothing device such as a doctor blade which includes a web-contacting surface provided with a layer of non-wettable material whereby passage of the coated web thereover for smoothing purposes will not cause a splitting of the coating such as has been heretofore encountered with the prior known devices. One manner of providing a non-wetting surface on the doctor blade is to coat the outer surface of the doctor blade including the web-contacting portion thereof with a material such as a composite blend of waxes and resins which possesses non-wetting characteristics, or by electro-depositing on the surface of the blade a layer of metal such as chromium or the like. If the web-contacting surface of the blade is covered by the non-wetting waxes, it is merely necessary to finish this wax layer to a smoothness of a degree sufficient to minimize abrasion. If the web-contacting surface of the blade is provided with a plating of chromium or like metal, the plated surface should be highly polished with oil bearing polishing agents in order to provide both the requisite smoothness to prevent abrasion and to provide the desired non-wetting characteristics. In this connection it should be noted that by employing oil bearing agents to polish the plating, or by employing some form of oil such as mineral oil subsequent to the actual polishing of the plating, the pores of the plating will become oil impregnated to thereby produce a surface having a low affinity for and immiscible in those aqueous mineral coating compositions in conjunction with which the doctor blade is to be used.

Therefore it is an object of this invention to provide a doctor blade for removing an excess of coating composition from a continuously moving web and which includes a convex web-contacting portion on its leading side and terminating in an intersection with a plane surface disposed normal to the tangent at the intersection.

Another object of this invention is to provide a device of the character stated which includes a web-contacting portion having a constant radius of curvature, in section, on its leading side

and terminating in an intersection with a plane surface disposed normal to the tangent at the intersection.

Another object of this invention is to provide a device of the character stated in which the web-contacting portion thereof possesses non-wetting characteristics whereby flow of the coating composition over the intersection between the curved surface and the plane surface will be prevented.

Another object of this invention is to provide a device of the character stated in which the non-wetting characteristics are obtained as a result of providing the web-contacting surfaces with a layer of smoothly finished non-wetting material.

Another object of this invention is to provide a device of the character stated in which the non-wetting characteristics are obtained as a result of electro-depositing a layer of metal such as chromium or the like on the surface of the doctor blade and then highly polishing the deposited layer with oil-bearing polishing agents.

A further object of this invention is to provide a doctor blade of the character described which is simple in design, rugged in construction and economical to manufacture.

With these and other objects in view, the nature of which will become more apparent, the invention will be more fully understood by reference to the drawing, the accompanying detailed description, and the appended claims.

In the drawing:

Fig. 1 is a diagrammatic side elevation of a portion of a papermaking machine to which devices constructed in accordance with this invention have been applied;

Fig. 2 is an enlarged detail sectional view showing the coating means; and

Fig. 3 is an enlarged transverse section of the doctor blade which is used in conjunction with the coating means.

Referring to the drawing in detail, this invention includes a doctor blade 5 which is preferably shaped from a bar or plate of a metal such as stainless steel. One edge of the blade 5 is machine finished or ground to present a generally quadricylindrical surface 6, one end of which merges into the face 7 of the blade and the other end of which terminates at an intersection with the opposite face 8 of the blade. At the point of intersection between the cylindrical surface 6 and the face 8 of the blade, the blade face is disposed normal to the tangent to the surface 6 at the point of intersection. After the quadricylindrical surface 6 has been formed on one edge of the blade the outer surfaces of the blade are then brought to a relatively high finish. The blade is then subjected to some form of treatment by which a layer of material is deposited thereon to thereby present a non-wettable surface. One manner of treating the blade to obtain this result is to electro-deposit a plating of metal, such as chromium or the like and then polishing the deposited layer with oil bearing polishing agents. The oil which serves as a vehicle for the polishing agents penetrates and fills the pores of the plating to produce thereby a surface having a low affinity for aqueous coating compositions. Of course, the high polish may be effected by other means and then the plating may be impregnated with an oil such as mineral oil which is immiscible in such compositions to produce thereby the desired non-wettable surface. It is, of course, entirely possible to employ various compositions such as suitable blends of waxes and resins to produce the desired non-wettable surface on the blade, so long as such compositions are relatively hard and possess the ability to stand temperatures of at least 100° F. without change.

One manner of installing the above described doctor blade in a paper-making machine for the application of a coating composition to the traveling web of paper is somewhat diagrammatically indicated in Figs. 1 and 2 of the drawing. In this particular installation the paper-making machine includes a first dryer section A and a second dryer section B separated therefrom. Coating apparatus generally indicated at C is located intermediate the dryer sections A and B and is effective to apply coating composition to one side of the moving web of paper. As the web of paper is carried around the drums of the first dryer section A the path of travel is directed from the last bottom drum of the first dryer section to the rolls of a size press indicated at 9 then back towards the wet end of the machine and over the coating devices whereby the underside of the web will be coated. After the coating has been applied by the coating devices, the web is passed around the last upper drum of the first dryer stage in order that the freshly applied coating may have an opportunity to set prior to the time at which the coated surface is disposed in contact with the dryer drums and the drums of the second dryer section. The web is then carried around several of the drums of the second dryer section and thence over another coating apparatus D, identical with the coating apparatus C, by which coating composition is applied to the opposite face of the moving web. The web, after leaving the second coating apparatus, is passed over the remaining dryer drums and thence to the calender stack and/or reel.

The coating apparatus at each of the coating stations C and D generally comprises a tank 10 in which a supply of coating composition is maintained at a uniform level. The tank 10 is preferably rigidly secured to supporting framework generally indicated at 11 and which may well be a portion of the main supporting framework of the paper-making machine with which the apparatus is associated. A dip roll 12 is associated with the tank 10 and is partially immersed in the coating composition contained therein. The dip roll 12 is adapted to be constantly rotated through power means, not shown, to thereby pick up a supply of coating material from the tank and present it to the web of paper which is disposed in surface contact with the top of the roll. Thus, an excess of coating composition is applied to the underside of the web. After the web leaves contact with the dip roll 12 it is passed over the cylindrical surface of the doctor blade 5 where the excess coating is removed by a progressively increasing but abruptly terminating wiping action and the coated surface is given the desired finish. It should be noted that when the coated web of paper passes over the web-contacting portion of the doctor blade, the excess of coating will immediately flow back over the face 7 of the blade and will not be carried beyond the intersection of the cylindrical surface 6 with the plane surface 8. Thus, there is no formation of a pool of coating composition on the trailing side of the doctor blade beyond the line of intersection between the curved and plane surfaces and the consequent stippling of the coating.

It should be noted that the best results in the finished applied coating are obtained when

the angle between the web on the trailing side of the doctor blade and the plane surface 8 thereof is maintained at approximately 90°. An effective operating range has been found to lie within an angularity of roughly 80° to 100°. It has been found that if this angle between the web and the plane surface 8 is reduced much below 80° the applied coating will present a surface which is stippled or mottled in appearance, or if the angularity between the web and the plane surface is increased to much greater than 100° the applied coating is likely to present a streaked appearance. Of course it should be realized that the above mentioned effective operating angles are those which may be normally encountered when the paper-making machine is being operated under reasonably uniform conditions as to the basis weight of the web, the amount of moisture remaining in the web at the time of coating, the tension of the web, the speed at which the web is traveling and the weight and composition of the coating to be applied. It is quite likely that other variables may enter into the picture from time to time and will have to be given consideration in order to determine the most efficient angular disposition of the web relative to the trailing side of the doctor blade. Thus, if the furnish is greatly changed over that which had been employed, an initially satisfactory setup for the coating operation, or if the tension of the web is varied or if the speed of travel of the web is varied, the setup of the coating apparatus will have to be varied in accordance with the new general web characteristics. For the above reasons, the angular values mentioned above should not be considered as limiting, but are merely indicative of a range of angular values which are effective under certain operating conditions.

It has been found that the radius of curvature of the quadricylindrical surface 6 of a doctor blade constructed in accordance with this invention may be varied within a relatively wide range and still smooth the applied coating in an effective and satisfactory manner. However, if the radius of curvature of the generally cylindrical surface is carried much below $^3/_{16}$ of an inch. the applied coating is likely to present a streaked appearance and if the radius of curvature is carried to too great an extreme, the applied coating will likely present a stippled or mottled appearance. It is generally believed, however, that under the normal operating conditions encountered through the use of a paper-making machine in which this apparatus is employed, doctor blades having radii of curvature varying from $^3/_{16}$ of an inch to approximately one inch can be satisfactorily employed.

The above-mentioned values for the angularity between the surface 8 of the doctor blade and the web, and the values for the range of effective radii of curvature have been predicated upon the use of a mineral coating composition carried by an aqueous vehicle. It is not believed to be necessary to herein describe any specific formula of coating composition since such are well known. It should be noted that should coating compositions be employed in which vehicles other than water are employed to carry the mineral content, it is quite likely that the above-mentioned ranges of values would become greatly modified according to the particular vehicle used and its effect relative to the non-wetting surface of the doctor blade, the radius of curvature of the doctor blade and the angularity between the web and the normal face of the doctor blade.

In some instances when certain particular formulae of coating compositions are to be applied to the web of paper, it may be found desirable to pre-moisten that surface of the paper web to which the coating is to be applied. In such instances the pre-moistening may be effected through the use of a sweating or dampening roll 13 adapted to transfer moisture from its outer surface to the adjacent surface of the web of paper passing thereover. The sweating roll 13 is preferably power driven at a uniform rate of speed by means not shown and is journaled adjacent the dip roll of the coating apparatus and is disposed in parallel alignment therewith. When the sweating roll is employed, the moving web of paper is first passed over the upper portion of the surface thereof to thereby receive a certain amount of moisture and then the web is passed over the dip roll in the manner above described. The moistening of the web prior to the actual application of the coating composition thereto appears to facilitate uniform distribution of the coating over the web.

It is believed that the above-stated descriptive matter is set forth with sufficient clarity that the method of coating a moving web of paper in accordance with the principles of this invention is adequately defined. To summarize, however, the method of coating a continuously moving web of paper in accordance with this invention consists in applying an excess of coating composition to a moving web of paper, then passing the coated web over a doctor blade including an abruptly terminating wiping surface having a low affinity for the coating composition, whereby the excess of coating will be completely removed from the web while the web is in contact with the wiping surface and prior to passage of the web beyond the line of abrupt termination of the wiping surface to thereby produce a smoothly finished coating having substantially no surface imperfections.

Thus, it will be seen that the herein-described invention discloses a novel doctor blade for use in conjunction with the coating of a continuously moving web of paper, which includes a convex web-contacting portion on its leading side and terminating in an intersection with a plane surface disposed normal to the tangent at the intersection; in which the outer surface thereof possesses non-wetting characteristics whereby flow of a coating composition over the intersection between the curved surface and the plane surface will be prevented; and which provides a novel method of coating a continuously moving web of paper consisting in applying an excess of coating composition to a moving web of paper, passing the thus coated web over an abruptly terminating wiping surface having a low affinity for the coating composition, whereby the excess of coating will be completely removed from the web while the web is in contact with the wiping surface and prior to passage of the web beyond the line of abrupt termination of said surface to thereby produce a smoothly finished coating having substantially no surface imperfections.

It is of course to be understood that certain details of arrangement and proportions of parts may be variously modified without exceeding the scope of the appended claims.

We claim:

1. A doctor blade for use in conjunction with paper coating machines comprising a body hav-

ing a surface treated to present a low affinity for coating composition, said surface being formed on a convex web-contacting portion of said blade, the radius of curvature of said web-contacting portion being not less than $\frac{3}{16}$'' and not greater than 1'', said web-contacting portion terminating in an intersection with a plane disposed radially to said web-contacting portion.

2. A doctor blade for use in conjunction with paper coating machines comprising a body having a surface treated to present a low affinity for coating composition, said surface being formed on a web-contacting portion of said blade, said web-contacting portion having a constant radius of curvature of not less than $\frac{3}{16}$'' and not greater than 1'', said web contacting portion terminating in an intersection with a plane disposed radially to said web-contacting portion.

3. Paper coating apparatus comprising a doctor blade having formed thereon a convex surface terminating in the intersection of said surface with a plane surface substantially normal to the tangent to said convex surface at said intersection, said convex surface being substantially non-wettable by an aqueous coating composition, means to move a web of paper having an excess of said aqueous coating composition on a surface thereof progressively across said convex surface and across said intersection in a plane at an angle of not more than 10° to the plane tangent to said convex surface at said intersection, said doctor blade exerting a constantly increasing but abruptly terminating wiping pressure upon said coating composition without wetting of said convex surface by said coating composition whereby to remove a portion of said coating composition from said web and to form on the remaining coating composition a smooth surface free from stippling and streaking.

4. Paper coating apparatus comprising a metallic doctor blade having formed thereon an arcuate surface having a radius of curvature between $\frac{3}{16}$'' and 1'' and terminating in the intersection of said surface with a plane surface substantially radial of said arcuate surface, said arcuate surface being substantially non-wettable by an aqueous coating composition, means to move a web of paper having an excess of aqueous coating composition on a surface thereof progressively across said arcuate surface and across said intersection in a plane at an angle of not more than 10° to the plane tangent to said convex surface at said intersection, said doctor blade exerting a constantly increasing but abruptly terminating wiping pressure upon said coating composition without wetting of said arcuate surface by said coating composition whereby to remove a portion of said coating composition from said web and to form on the remaining coating composition a smooth surface free from stippling and streaking.

JOHN CAMPBELL.
KENNETH AUSTIN TAYLOR.