April 14, 1942. R. H. BRADT 2,279,553

METHOD AND APPARATUS FOR APPLYING COATINGS TO WEBS

Filed July 1, 1939 3 Sheets-Sheet 1

Fig. 2.

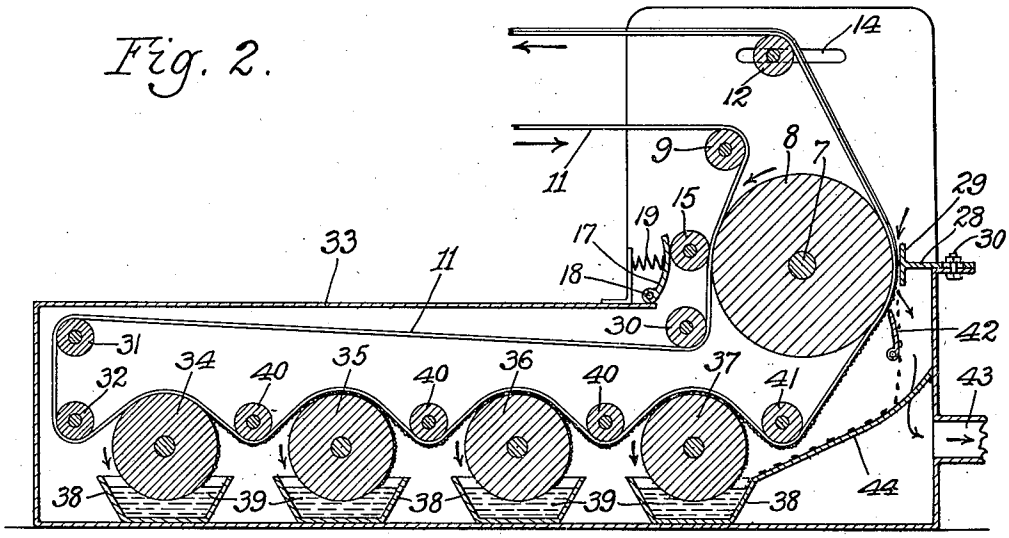
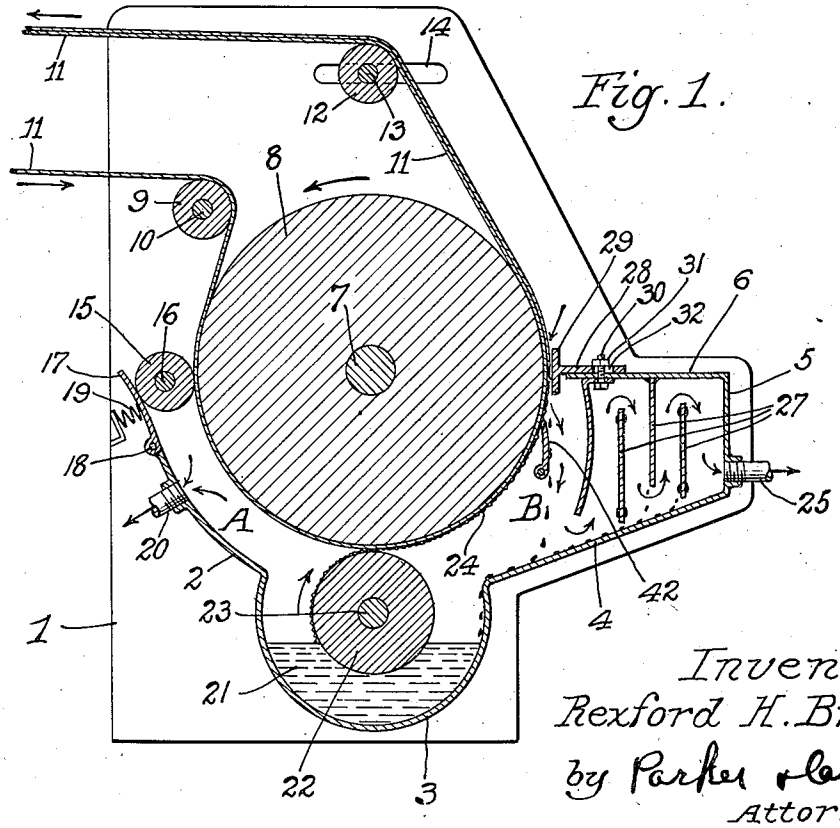


Fig. 1.



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METHOD AND APPARATUS FOR APPLYING COATINGS TO WEBS

Filed July 1, 1939 3 Sheets-Sheet 2

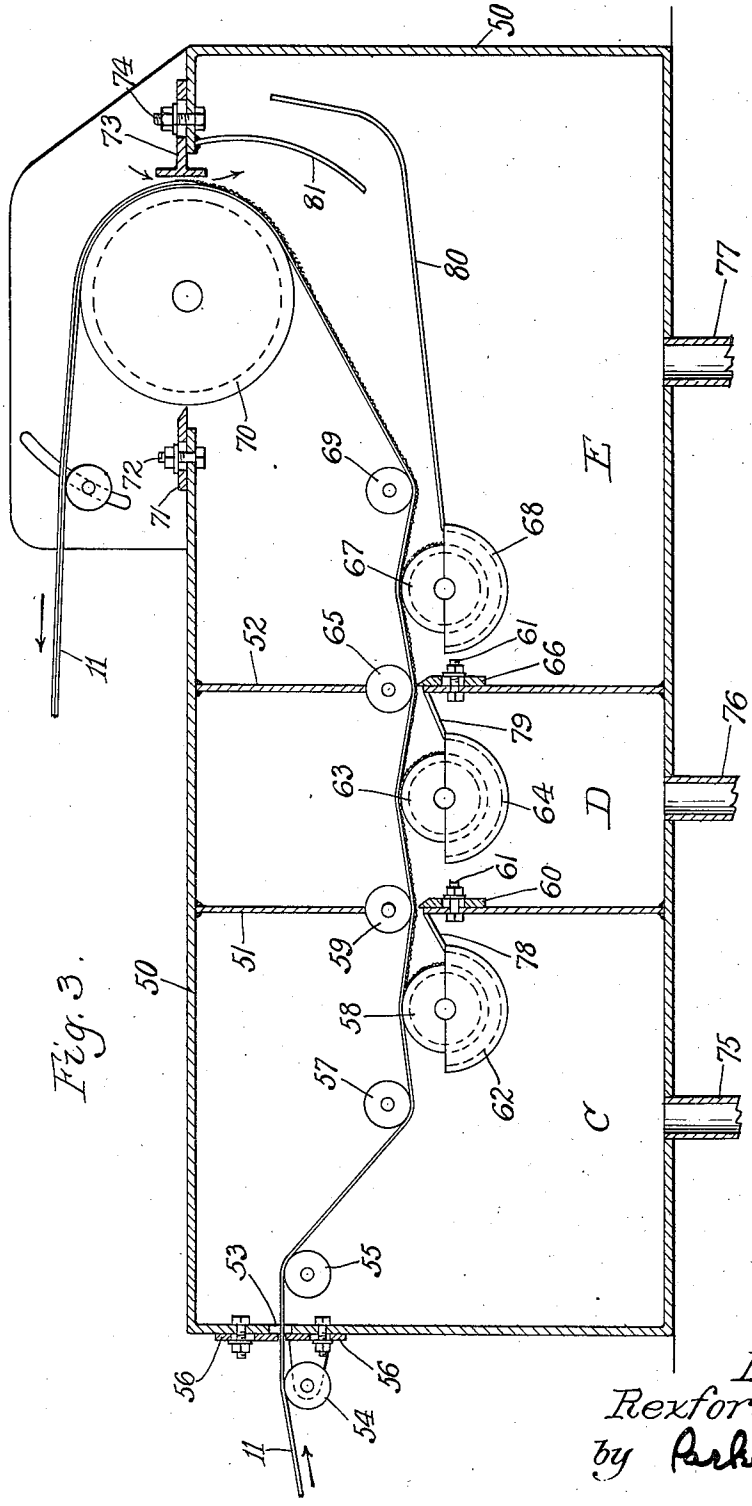


Fig. 3.

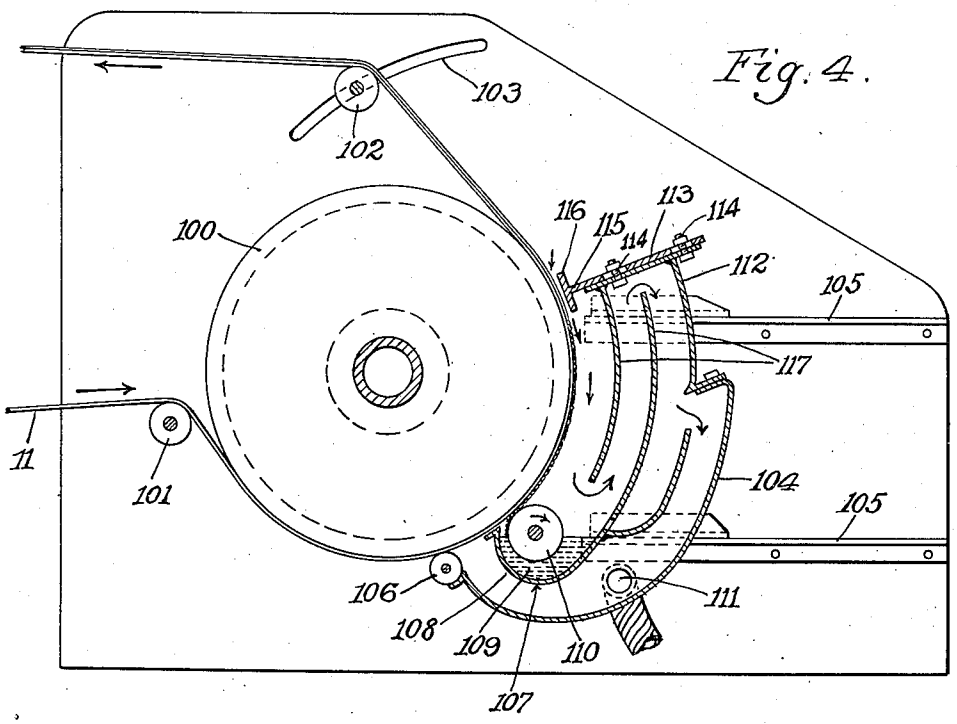
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METHOD AND APPARATUS FOR APPLYING COATINGS TO WEBS

Filed July 1, 1939 3 Sheets-Sheet 3

Fig. 4.



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UNITED STATES PATENT OFFICE

2,279,553

METHOD AND APPARATUS FOR APPLYING COATINGS TO WEBS

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Application July 1, 1939, Serial No. 282,329

10 Claims. (Cl. 91—33)

My invention relates to an improved process and apparatus for the production of coated web material.

One purpose is the provision of means for deaerating the web material prior to its coating and for thereby preparing it to receive and absorb the coating.

Another purpose is the provision of means for coating the web.

Another purpose is the provision of means for controlling the thickness of the coating and for removing the excess coating material, preferably without scraping contact.

Another purpose is the provision of means for preventing air at higher pressures from reaching the back of the deaerated coated web until after such air has first acted to press the surface coating into the evacuated voids of the web, thus giving a firmer coating bond or impregnation.

Another purpose is the provision of means for deaerating the web or paper and for thereby rendering it susceptible to a uniform stain.

Another purpose is the provision of an improved method and mechanism for continuously carrying out some or all of the above mentioned steps, in various orders, and for thereby producing, by continuous operation, a uniformly coated web having a firm coating bond or impregnation.

Another purpose is the provision of an improved means and method for doctoring a coated web, and, in particular, for doctoring it by the employment of a tangential or lateral flow of air through an orifice formed by the web itself and by a lip member or members spaced from the coated face or faces of the web.

Other purposes will appear from time to time in the course of the specification and claims.

I illustrate my invention more or less diagrammatically in the accompanying drawings wherein:

Fig. 1 is a longitudinal section through my device;

Fig. 2 is a longitudinal section through a variant form;

Fig. 3 is a longitudinal view of a further variant form of the device showing the housing in section; and

Fig. 4 is a vertical transverse section of a variant form of my invention.

Like parts are indicated by like symbols throughout the specification and drawings.

Referring to the drawings, and for example to Fig. 1, 1 is any suitable exterior housing or base, which includes or supports transversely extending wall members 2, 3, 4, 5 and 6. It will be realized that the specific details and form of the housing and walls may be varied without departing from the spirit of my invention.

Mounted in any suitable fashion, for example upon any suitable shaft or support 7, I illustrate a supporting roll 8. 9 indicates a fly roll mounted, for example, on a shaft 10, over which the web 11 passes toward the supporting roll 8. 12 is a tensioning or control roll mounted, for example, on a shaft 13, which may be adjusted in any suitable manner along the slot 14 in the side walls of the housing or base 1. It will be understood that it may be adjusted to vary the bearing or arc of contact of the web 11 upon the supporting roll 8.

15 is any suitable vacuum seal roll mounted, for example, on a shaft 16 and yieldingly thrust against the supporting roll 8 and the web passing thereover. It serves as a seal for preventing any substantial penetration of air into the space below it and between the wall member 2 and the opposed face or arc of the supporting roll 8.

As indicating means for maintaining a sealing contact, I illustrate a hinged member 17, pivoted as at 18 to the upper edge of the wall portion 2 and urged as by the coil spring 19. The above described specific means is given as illustrated, and it will be realized that a variety of means for maintaining a sealing contact between the wall 2 and the web 11 may be employed.

20 illustrates any suitable suction outlet to any suitable pump or evacuating means not herein shown and the details of which do not of themselves form part of the present invention. It will be understood, however, that I may employ any suitable means for maintaining a partial vacuum within the space indicated as A. The more or less porous web, as it passes about the supporting roller 8 and beyond the sealing roller 15, is thereby subjected to a vacuum, and the entrapped air is substantially exhausted from the voids and spaces within the web.

The wall portion 3 is shown as forming a species of pocket in which a volume of any suitable coating material is maintained. The coating roll 22, mounted in any suitable shaft 23, extends at its upper arc to close proximity to the web 11 as it passes about the supporting roller 8. The lower part of the roller 22 is immersed in the coating fluid 21. As it rotates in the direction of the arrow of Fig. 1, it carries an excess of the coating material 21 and applies it to the outer surface of the web 11. As the web 11 has just been deaerated by the vacuum

through which it passes, it is in condition to receive and absorb the coating. This excess coating adhering to the web is indicated as at 24. As the web passes with the supporting roller 8 in a counter-clockwise direction, as indicated in Fig. 1, it is still subjected to a partial vacuum maintained by any suitable air outlet 25 in communication with the space defined by the wall portions 4, 5 and 6. If desired, a series of baffles 27 may be employed, forming a baffle chamber adapted to prevent the entrainment of any substantial amount of the coating material.

Further closing the space defined by the walls 4, 5 and 6, is an adjustable lip member illustrated as including a relatively flat blade 28 and a member 29 generally vertical thereto and generally tangential to the surface of the supporting roll 8, but slightly spaced therefrom. This spacing may be controlled by any suitable adjusting means, which may include, for example, the bolt 30 and the nut 31, the bolt passing through a slot 32 in the member 28. Outside air enters between the member 29 and the opposed surface of the web 11, and passes laterally or tangentially across the coating. The parts are preferably so spaced that there is no direct wiping or scraping contact, but the current of air flowing across the coated surface of the web 11 and downwardly into the chamber or space indicated at B in Fig. 1 is effective to doctor or level the excess coating material on the web 11. A baffle 42 may be used to receive the excess coating.

The web, with this excess material removed, and with the coating in place on its exterior surface, is still pressed against the outer surface of the supporting roll 8, and the outside air cannot reach the rear of the web until after the web has travelled through a predetermined and adjustable arc of movement. The exterior air pressure has a compacting effect. Finally the web passes over the adjustable roller 12 and, in the direction of the top arrow of Fig. 1, outwardly away from the mechanism or zone of treatment.

It will be understood that any suitable means may be employed for moving the web and for rotating the various rollers. I may, for example, employ means for driving the rollers 8 and 22 in unison. The rollers 9 and 12 may, if desired, be idlers.

Referring to the form of Fig. 2, I illustrate a modification of my device in which the web 11, instead of being coated as it passes over or about the supporting roller 8, receives a coating applied from a plurality of separate coating rollers. After the web passes the sealing roller 15, it passes about idlers 30, 31 and 32, within a laterally extended closed housing 33. I provide therein a plurality of coating rolls 34, 35, 36 and 37, each penetrating an associated container 38, having therein a body 39 of coating material. Intermediate idlers or rollers 40 are employed to maintain the web 11 in contact with the upper surfaces of the rolls 34 to 37. Any suitable means are employed to drive said four rolls in a counter-clockwise direction, whereby the coating is supplied to the lower surface of the web. After the four coating increment has been received by the web, it passes under the final idler 41, and thence about a supporting roller 8. Any suitable means, for example the baffle 42, may be employed for receiving excess coating blown off by the air passing about the member 29. The entire interior of the housing 33 may be exhausted through the outlet 43 by means of any suitable pump or exhausting means not herein shown. 44 indicates a return member for returning excess coating to the container 38 below the coating roll 37.

Fig. 3 illustrates a variant form of my device, in which a closed housing 50 is divided by baffles or walls 51 and 52 into three separately exhausted chambers, indicated as C, D and E. The web 11 enters the compartment C through an aperture 53, its path being controlled by idlers or rollers 54 and 55, one being outside of and the other inside of the housing 50. Any suitable adjusting sealing means 56 may be employed to cut the entry of air down to a necessary minimum. The web then passes beneath a carrier roll 57, over a coating roll 58, and beneath another carrier roll 59 located in any suitable aperture in the baffle 51. 60 indicates any suitable adjustable doctor, which may be raised or lowered to vary the distance between it and the opposed arc of the roller 59. I illustrate for example adjusting bolt 61.

62 indicates any suitable container for the coating, which partially surrounds the roller 58. From the carrier roll 59, the web 11 passes over the second coating roll 63, having its associated coating container 64, and thence beneath the carrier roll 65 located in an aperture in the baffle 52. This aperture is provided with an adjustable doctor 66. Thereafter the web passes over the final coating roll 67 and thereby receives a coating of the material from the container 68. It then passes beneath a carrier roll 69 and thence to the supporting or stripping roll 70, which is located in an aperture in the top of the housing 50.

71 is any suitable adjustable seal with its adjusting securing means 72. 73 is an adjustable doctor, with its adjusting securing means 74. 75, 76 and 77 indicate vacuum lines or exhaust passages whereby air may be exhausted individually from the compartments C, D, and E of the housing 50.

It will be understood that any suitable pumps or exhaust means may be associated with these various passages, the details of which do not form part of the present invention. It will be understood that the degrees of vacuum in the chambers C, D and E may be regulated in different amounts, or, if desired, the adjustable doctors 60 and 66 may be dropped, and the pressure may be made uniform throughout. Under some circumstances it may be desirable to heat the coating rolls 58, 63 and 67 and the supporting or stripping roll 70.

The air which passes inwardly past the adjustable doctor 73 is effective to strip the excess coating from the web, as described in connection with the form of Fig. 1. If additional stripping action is desired for the individual coating rolls or individual coatings delivered by the coating rolls, I may adjust the doctors 60 and 66 to close proximity to the opposed surface of the web, and then provide a vacuum drop from chamber to chamber, whereby air flows across the space between each of the adjustable doctors and the opposed portion of the web, thus leveling and reducing the coating.

I may provide any suitable means for returning the excess to the containers. I illustrate, for example, plates 78, 79 and 80, and the deflector 81. Whereas I have illustrated in Fig. 3, three separate compartments, it will be understood that I may, if desired, reduce the number of compartments and employ two compartments, or even a single compartment. The choice of such

matter depends upon whether or not a multiplicity of coats or coatings is desired.

Referring to the form of Fig. 4, I illustrate a further application of my invention, in which a large roll 100 is employed, for which preferably any suitable heating means, not herein shown in detail, may be provided. The web indicated at 11 passes over a guiding roll 101 and thence about the periphery of the roll 100 to an adjustable roll 102, which may be moved along any suitable adjusting slot 103 in order to control the degree of arc through which the web contacts the surface of the roll 100. This is effective to vary or control the arc of contact of the web with the roll 100, after it passes through the doctoring orifice below described.

104 generally indicates a housing structure, which may be mounted for ready movement toward and away from the surface of the roll 100. I may, for example, mount the entire structure on slides 105, which are diagrammatically indicated in Fig. 4. The general housing structure 104 may be provided with any suitable contacting roll or the like 106, adapted to engage the face of the web and to maintain a relatively tight seal. An inner wall 107 defines a pocket 108, in which the coating fluid 109 is held. 110 is any suitable coating roll for applying the coating, for which any suitable driving means may be provided.

111 is any suitable outlet to a pump or the like, whereby a partial vacuum may be obtained within the housing 104. The housing 104 has an upward continuation generally indicated as 112, terminating in a transverse wall 113, preferably adjustable, as by any suitable set screw 114 or the like. It terminates in an edge 115, which may be adjusted toward and away from the opposed face of the web 11, thus defining or controlling the width of the aperture. The edge 115 may, if desired, be provided with a terminal member 116, generally tangential to the roll. Within the housing 112 are any suitable baffles 117, which are effective to trap and return any liquid which may be drawn inwardly by the air flowing through the gap between the web 11 and the opposed member 116.

The ready applicability and removability of the housing structure above described is advantageous as permitting very easy threading of the paper through the roll and easy cleaning of the apparatus as a whole. It will be understood that the details of the supporting, guiding means may be widely varied.

It will be realized that whereas I have described and illustrated a practical and operative device, nevertheless many changes may be made in the size, shape, number and disposition of parts without departing from the spirit of my invention. I therefore wish my description and drawings to be taken as in a broad sense illustrative or diagrammatic, rather than as limiting me to my precise showing.

It will be realized particularly that, although I have illustrated various forms of my device, including means for deaerating the web and for subsequently doctoring it by a flow of air, the deaerating step may be omitted and the doctoring may be done without the preliminary deaeration.

It will also be understood that where in my description or claims I use the term "vacuum," I wish it to be understood that a partial vacuum is employed, and I wish the term "vacuum" to be interpreted to indicate a partial vacuum.

The use and operation of my invention are as follows:

I illustrate a method and an apparatus for the production of coated web material by continuous operation, in which the web is passed into a vacuum chamber, deaerated, suitably coated with an excess of coated material, and thereafter conducted from the vacuum chamber through an adjustable orifice or vacuum lip or passage, which is effective to suck or draw the excess coating material uniformly from the surface of the web and back into the chamber. At the same time the coating is leveled without being scraped. Thereafter the web carrying the smoothed surface coating is conducted beyond the vacuum lip and about the supporting or stripping roll 8 or 10, in such manner as to prevent air at higher pressure from reaching the back of the web. The air has first acted to press the surface coating into the evacuated voids of the web, thereby giving a firmer coating bond or impregnation. Deaeration may also be employed in connection with my process and apparatus for preparing the web or paper to take a uniform stain.

In web coating there are three fundamental operations, as follows:

(1) Application of the coating;

(2) The doctoring or removal of the excess coating; and

(3) The leveling of the coating.

By my process and apparatus the results obtained in each such step are superior to those obtained by any previous mechanism or method known to me. A coated web material having definitely superior qualities is produced. In the application of the coating, the thoroughness with which the web is wet or coated determines the intimacy of the union of the finished coating and web. It is advantageous, in web coating, to apply an excess of coating material and subsequently to remove the excess. By my process and apparatus I obtain the evacuation and deaeration of the web 11 prior to the application of the excess of coating material. This deaeration or evacuation results in a more uniform wetting of the web by the coating composition. The evacuation of the web prior to the application of the coating material also results in a superior anchorage of the coating material to the web. Deaeration of the web prior to coating also permits a higher speed of wetting or coating, and thus a higher speed of operation of the machine and a greater output per unit of time.

My method and apparatus, broadly stated, cover means for causing a doctoring action by providing a flow of air across the treated surface through an aperture one side of which is defined by the paper or fabric treated and the other side of which is defined by a lip, wall or the like. It will be understood, of course, that any suitable means may be employed for coating the web with a coating mixture of any desired composition, for example, clay compounds, enamels, lacquers or photosensitive mixtures. I prefer to provide an enclosure or housing the purpose of which is to maintain a pressure of air which is different from the atmospheric pressure. I prefer a partial vacuum, but it will be understood, of course, that any pressure differential may be employed. In any event, air is caused to flow through an orifice or slot, or a plurality of orifices or slots, preferably adjustable in any suitable enclosure or housing or container, through which the sheet passes. The air may be caused to flow through one or more ori-

fices or slots simultaneously with the sheet and in such a manner that the air is confined by the sheet as part of the slot or orifice, and a solid member, wall, lip or the like, as the other part or side of the slot or orifice. The flow of air serves to remove the excess of coating and to level the remaining coating. This is, of course, a differentiation from any possible method or apparatus in which a flow of air is directed through a slot which is defined on both sides by walls, solid members, or the like.

My method and apparatus will permit the uniform doctoring of plastic coatings having a high solids content. The controlled flow of air between the adjustable lip **29** or **73** and the web strikes the web substantially tangentially. The air has the greatest stripping action on the coating material when it passes tangentially across the coating. Consequently a higher solids content coating may be handled with my vacuum lip technique than with any directed jet or air blast. The inherent tangential flow of air along or across the web, combined with the high velocity of air flow in the lip area, where the web forms one side of the orifice, develops a highly efficient and complete stripping or doctoring action and with a minimum of turbulence. The air moves against the movement of the web and has a consequently greater stripping action.

The use of high consistency coating material results in a direct economy in the drying of the coated web **11** and thereby permits high web speeds and lower drying costs.

In my mechanism the moving parts are reduced to a minimum. The only moving parts are rolls which carry the webs or excess amounts of coating material. I avoid the employment of any contacting bars or blades, or any other elements which actually contact the coating material and which could be fouled by deposits of coating material. The inflowing air, not a contacting mechanical member, effects the doctoring, and I provide means, such as the baffle **42** of Fig. 2 and the members **80** and **81** of Fig. 3, for returning the excess coating to the coating containers. This also reduces the necessity of cleaning the material. By varying lip clearance, my lips **29** and **73** being adjustable, I may obtain a wide range of coating thickness. The thickness may also be controlled by varying the air pressure in the vacuum chamber, or the air pressure and the lip clearance may be employed together in order to vary the air movement, and thus the thickness of the final coating. These adjustments also permit variations in viscosity of the coating mixtures to be compensated for.

The leveling of the coating, in my method and apparatus, is obtained simultaneously with the removal of the excess coating by the action of the vacuum lip. This leveling action is particularly efficient because the web itself, as it passes over the supporting or stripping roll **8** or **70**, forms one side of the aperture through which the inflowing air passes. The high velocity and turbulence free flow of air gives my coatings freedom from the wavy or windblow effect which would be obtained were a thick film applied or controlled by a directed jet of compressed air.

With my process the forming of pin holes is reduced to a minimum. Such pin holes may be formed from air displaced from the voids in the web, which air forms bubbles which may not burst until after the coating film has set sufficiently to prevent it from flowing and covering holes thus formed. With my process, the web is deaerated, and no air is left in it to form bubbles and consequent pin holes. Another possible cause of pin holes is by actual brushing or contacting doctoring action, with the consequent formation of bubbles or foam. Since I obtain my doctoring by a direct flow of air through the web lip, there is no formation of bubbles and foam, and this further cause of pin holes is thereby eliminated.

With my apparatus and method the operator is able to control the penetration of the coating in the web to a considerable extent. Controlled absorption and penetration is obtained by causing the deaerated coated web to cling to the roll **8** or **70**, after the web **11** emerges from the vacuum chamber. The exterior air pressure is higher than in the vacuum chamber but is able merely to press against the coated or outer side of the web **11** and is thus effective to force the coating material into the pores of the web **11**.

An important feature of my invention and of my mechanism, which may be employed independently of the deaerating step or means, is the employment of the characteristic doctoring lip structure and the use of a rapid lateral or tangential flow of air to obtain the doctoring effect. In effect I provide an orifice for the passage of air at high speed, which orifice is defined on one side by a lip, such as **29**, and on the other by the web. In other words, the web itself defines or provides one side of the orifice, in contrast to less efficient structures in which a separate and independently defined orifice having no connection with the web might be employed, and the fact that the air follows a tangential path across the face of the coating gives it a particularly efficient doctoring effect.

In referring to the form of Fig. 4, the web **11** may be very easily and quickly threaded through the roll structure. The web is not supported on or positioned by the housing structure **104**, **112**. This housing structure may be readily moved toward and away from the roll **100**. It is self-contained and supports the coating roll **110** and the coating material. It also serves to define the aperture, by means of the member **116**, through which the air flows into the spaces within the housing **104**, **112**, and doctors the coating on the web.

It will be understood, as to all forms of the device herein shown, that the rate of flow of air across the doctored surface can be controlled, not merely by varying the relative pressure conditions within and without the housing, but by varying the air gap between the members **29**, for example, and the opposed face of the web. In the use of my apparatus and method, the weight or thickness of the coating can be varied within reasonable limits by varying the size of the orifice through which the air passes. A further factor which may be employed to control the thickness of the coating is the speed of movement of the web itself.

To summarize, the factors which determine the efficiency of the stripping action include:

First, the degree of suction within the housing;

Second, the size of the doctoring gap, one of which carries the web and the other of which acts to control the slot through which the air passes;

Third, the amount of the coating applied to the sheet; and

Fourth, the speed of the web through the machine.

I claim:

1. The method oi coating a web of material which includes deaerating the web, thereafter applying an excess of a coating material to said deaerated web, and thereafter removing the excess portion of the material by causing a flow of air across the coated surface of said web.

2. The method of coating a web of material which includes deaerating the web, thereafter applying an excess of a coating material to said deaerated web, thereafter removing the excess portion of the material by causing a flow of air across the coated surface of said web, and consolidating the coating by subjecting the coated surface of the web to air pressure.

3. The method of coating a web of material which includes passing a web continuously through a partial vacuum and thereby deaerating it, applying an excess of coating material to said deaerated web, while maintaining it in said vacuum, thereafter removing the excess material by the passage of air across the coated surface of said web, and thereafter subjecting the coated surface to air pressure and thereby consolidating it.

4. The method of coating a web of material which includes deaerating the web, thereafter applying in succession a plurality of excess coats of coating material to said deaerated web, and removing the excess portion of each coat by causing a flow of air across the coated surface of the web.

5. 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, sealing means located adjacent the point of entry of the web into the housing and adapted to prevent any substantial inflow of air to said housing, means located within said housing for delivering an excess of a coating material in fluid form to a surface of said web, and means for causing a flow of air across the coated surface of said web as it passes from the housing, and for thereby removing the excess portion of the coating, 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, said sealing means being located above the level of said fluid.

6. 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 the web through said housing, means for applying a succession of coatings to said web as it passes through said housing, and means for thereafter directing a flow of air across a coated surface of the web and for thereby removing the excess coating.

7. The method of coating a web of material which includes conveying such web through a partial vacuum, coating said web after it has entered and been subjected to such vacuum with an excess of liquid coating material, 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.

8. The method of coating a web of material which includes conveying such web through a partial vacuum, coating said web after it has entered and been subjected to such vacuum with an excess of liquid coating material, 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.

9. In a machine for coating webs of paper or the like, a housing, a horizontally axised roller extending into said housing, means for maintaining a partial vacuum within the space defined by said housing and roller, means for guiding a web for passage about said roller, a liquid transporting means located within said housing and entirely within said vacuum, means for maintaining a body of liquid in said housing out of contact with said roller but in contact with said transporting means, and means for doctoring said coating as the web passes out of the housing.

10. In a machine for coating webs of paper or the like, a housing, a horizontally axised roller extending into said housing, means for maintaining a partial vacuum within the space defined by said housing and roller, means for guiding a web for passage about said roller, a liquid transporting means located within said housing and entirely within said vacuum, means for maintaining a body of liquid in said housing out of contact with said roller but in contact with said transporting means, and means for doctoring said coating as the web passes out of the housing, said means including a horizontally axised feed roller, the lower portion of which is immersed in said body of liquid, an upper portion of which is opposed to the web passing about said first mentioned roller.

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