

Nov. 6, 1934.

H. G. RAPPOLT ET AL

1,979,346

METHOD AND APPARATUS FOR COATING AND DRYING MATERIALS

Filed Feb. 17, 1932

5 Sheets-Sheet 1

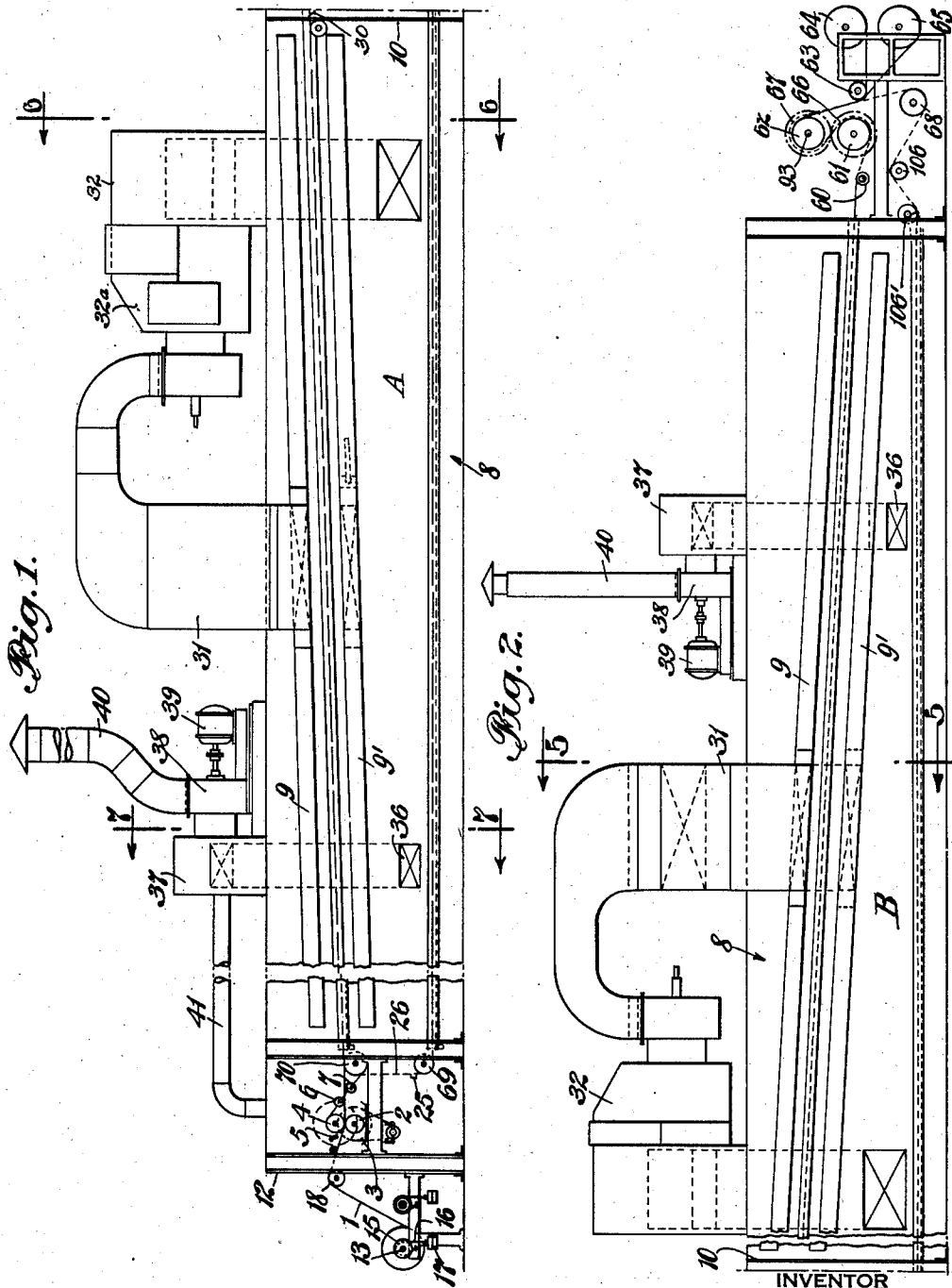


Fig. 1.

Fig. 2.

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5 Sheets-Sheet 2

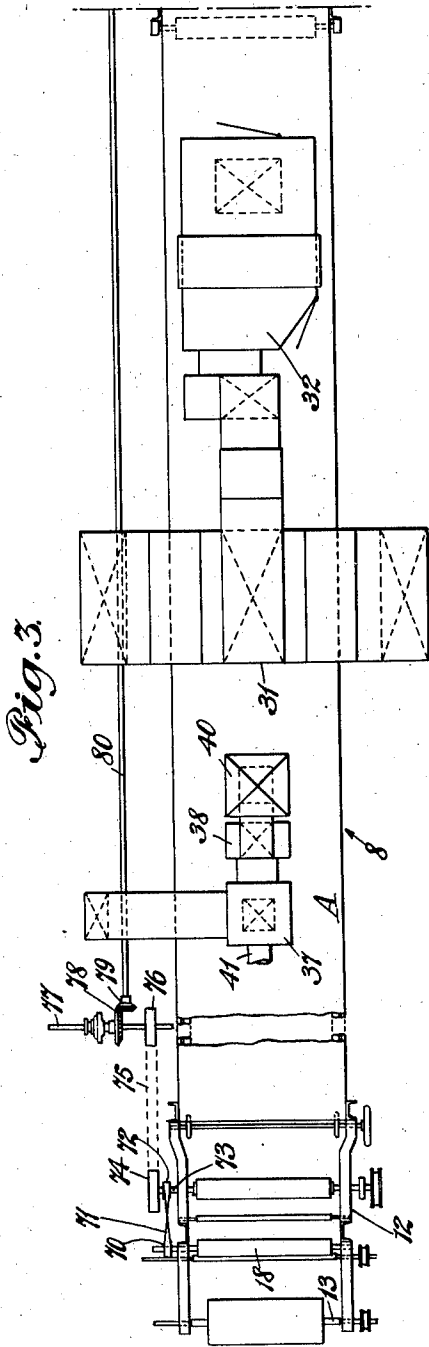


Fig. 3.

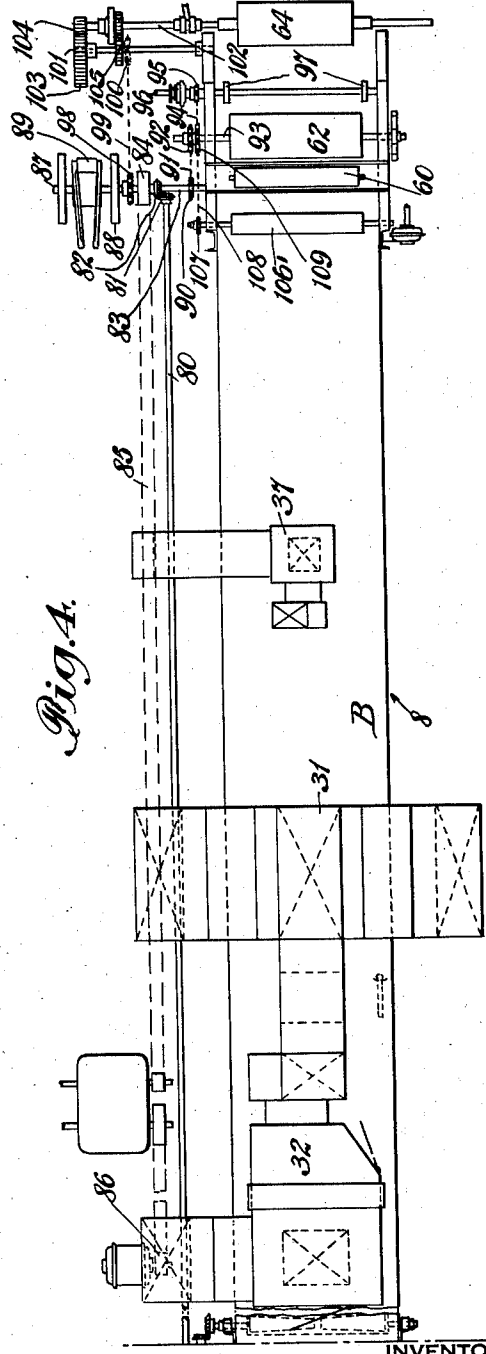


Fig. 4.

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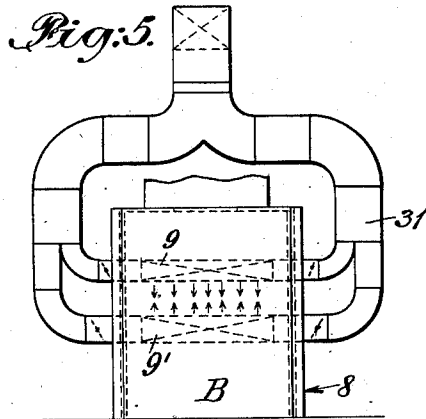


Fig. 6.

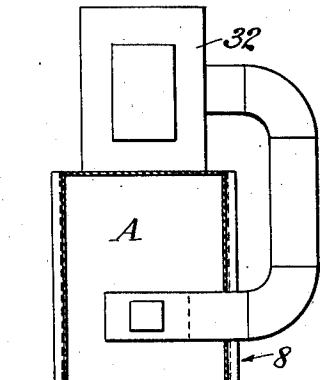


Fig. 7.

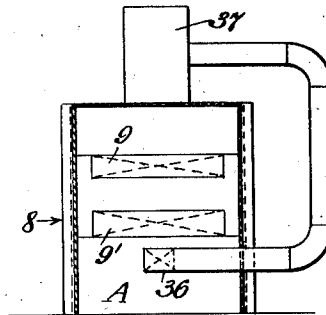


Fig. 8.

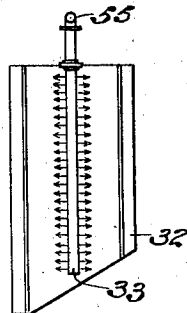


Fig. 11.

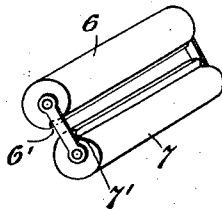


Fig. 9.

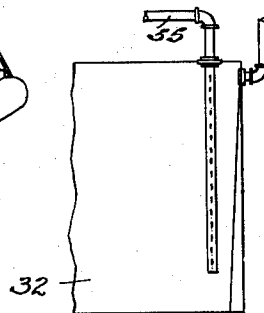
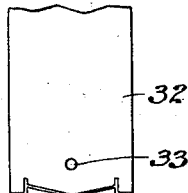


Fig. 10.



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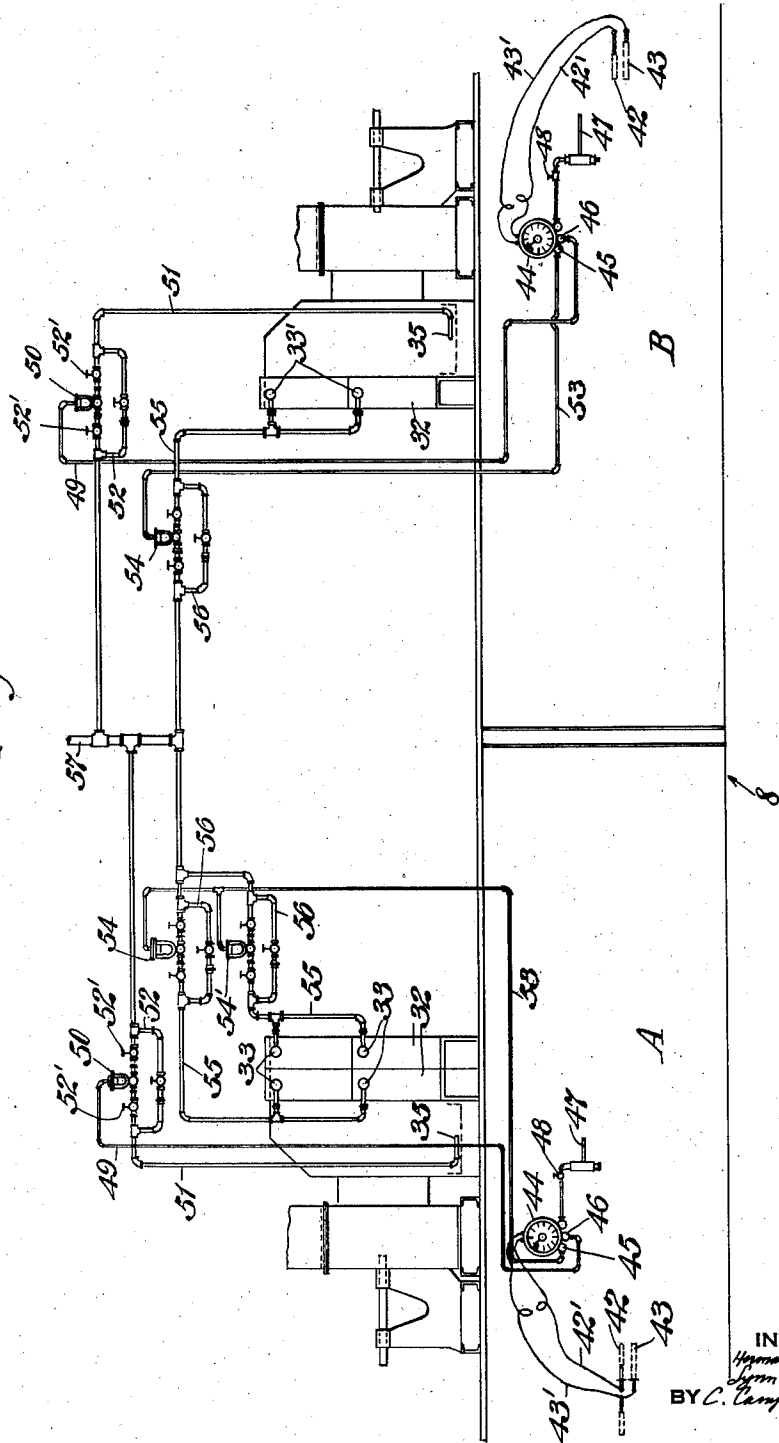
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Fig. 12.



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Fig. 14.

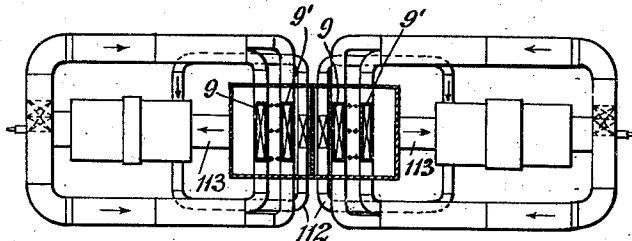
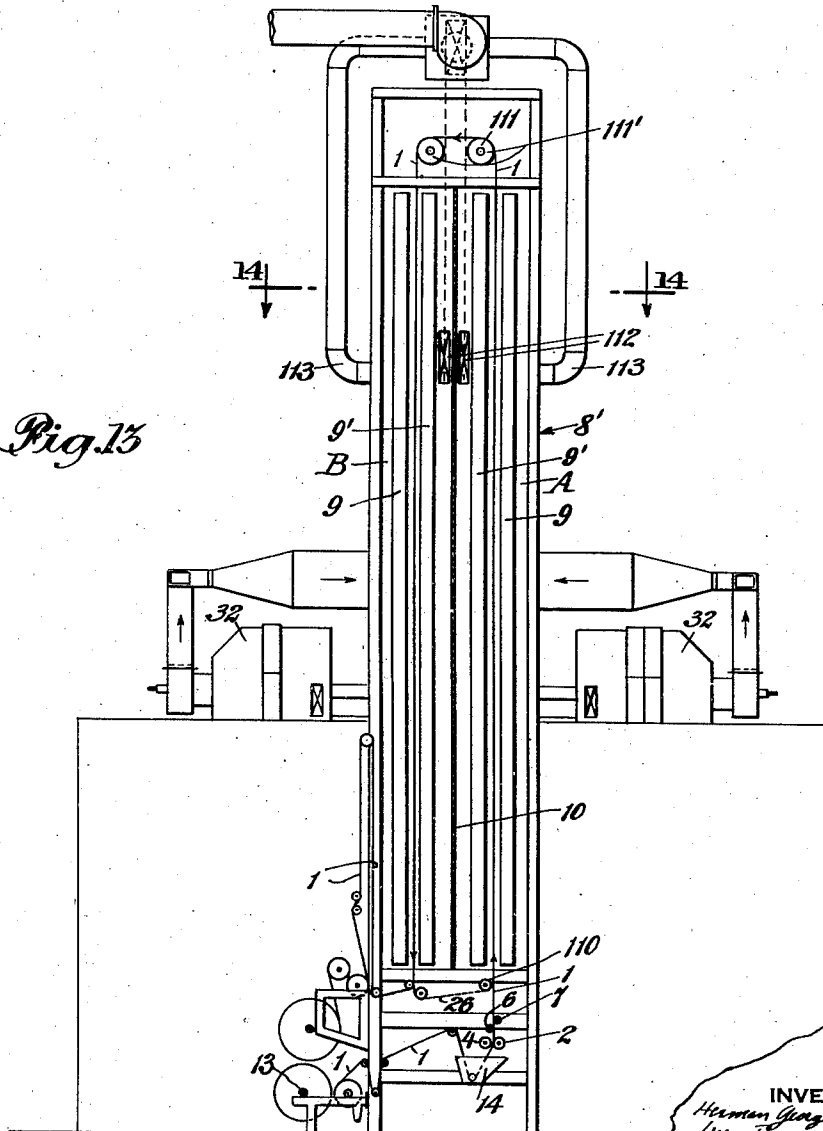


Fig. 15



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UNITED STATES PATENT OFFICE

1,979,346

METHOD AND APPARATUS FOR COATING AND DRYING MATERIALS

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Application February 17, 1932, Serial No. 593,464

2 Claims. (Cl. 34-48)

This invention relates to the method and apparatus for coating and drying coated papers, films, fabrics, compositions and the like.

In the application of coatings to various materials provision must be made for the drying of the coatings in some manner. Various forms of apparatus have been constructed for the purpose of coating and drying. Where the use of a heated drying medium is utilized it has been found in practice that the coated material may have the surface coating made too brittle by the complete drying out of the moisture content. Also changes in color may be occasioned by the complete drying. In certain forms of material not only does the coating become brittle but the base also is affected. This is particularly true in the case of films. The problem of drying is not simple in practice. In the first place, there is the element of time, that is, the quicker the product may be dried the greater is the production. The speeding up of the drying generally is accomplished by increasing the temperature of the drying medium. Such increase of the temperature is limited by the character of the product to be dried and its moisture content. If too high a temperature is used throughout the drying the product is injured either by charring or by the removal of all the moisture.

One of the objects of this invention is to provide a method and apparatus for the coating and drying of coated paper, films, fabrics and the like whereby the coating and drying are done without injury to the base and coating. A further object of the invention is to provide a method and apparatus for the drying of coated materials whereby the proper amount of moisture is retained within the base and coating. Still another object of the invention is to provide a method and apparatus for the drying of materials whereby the drying is accomplished by a medium having a controlled amount of moisture to provide a balanced condition so that a predetermined amount of the original moisture is retained throughout the material in order that the material after the drying shall be in such condition as to be "live".

Another object of the invention is to increase the normal speed of drying of coated materials and the like by controlling the temperatures in zones during the passage of the material through the drying medium whereby a maximum temperature is applied initially or at the desired point with varying temperatures at other points thereby preventing charring or affecting the quality of the product while at the same time, in view of

the application of greater heat, reducing the time of drying. A further object of the invention is to apply a predetermined amount of coating to materials and to smooth same without roping or streaking the material in the smoothing process.

Still another object of the invention is to control the moisture content of the drying medium in different zones so that the moisture content of the drying medium is such as to prevent the withdrawal of all the moisture from the material and to secure the balancing of the moistures. Other objects will appear more fully hereinafter.

Referring to the drawings:

Figure 1 is a view in elevation, parts in section, of approximately one-half of a device embodying the principles of our invention.

Figure 2 is a view in elevation, parts in section, of the other half of the device.

Figure 3 is a plan view of Figure 1.

Figure 4 is a plan view of Figure 2.

Figure 5 is a cross sectional view of Figure 2 along the line 5, 5, looking in the direction of the arrows.

Figure 6 is a cross sectional view of Figure 1 along the line 6, 6, looking in the direction of the arrows.

Figure 7 is a cross sectional view of Figure 1 along the line 7, 7, looking in the direction of the arrows.

Figure 8 is a detail plan view of the humidifying spray pipe in the air chamber.

Figure 9 is a detail end elevation of the spray pipe in air chamber.

Figure 10 is a detail view in elevation of water pan and spray pipe.

Figure 11 is a detail view of the smoothing stationary doctor rolls.

Figure 12 is a detail view of the steam humidifying arrangement showing controls.

Figure 13 is a view in elevation, partly in section, of a modified form of our device wherein the drying is done in a vertical manner.

Figure 14 is a cross sectional view of Figure 13 along the line 14, 14, looking in the direction of the arrows.

In carrying out our invention, we propose first to coat the material 1 being treated with a predetermined thickness of coating. This coating is not applied in an excess quantity as is generally done in coating operations but the proper amount is applied. We preferably utilize in double coating a lower nip roll 2 rotating in a bath 3 of the coating and for the upper coating a controlled quantity of sprayed coating material ap-

plied adjacent the upper nip roll 4 by a spray or stream 5. The distance apart of the nip rolls 2, 4, control the depth of coating. Of course, the viscosity and percentage of solid matter must be considered in the coating being applied in determining the proper adjustments since in the drying, the volatile and/or moisture content is to a great extent driven off thereby reducing the final thickness of the coating. The simplified form of coating control with the elimination of the utilization of excess material and the removal of said excess by knives or knife doctors, we avoid by a novel form of smoothing rolls 6, 7, which rolls do not rotate and which have a cut-out portion 6', 7'. In general, the use of smoothing rolls has been unsatisfactory as the rolls tend to create a roping or streaking effect due to the picking up and redepositing of the coating on the paper in connection with the coating which prevents uniform redepositing, but this is overcome by the special design shown. The coated material after coating and smoothing process is then conveyed into a dryer 8 by means of a threading device which device is disengaged upon completion of the threading over the rewinder. Dryer 8 may be made in the form of a tower 8' or horizontal type. In the case of the horizontal type 8 it is necessary to provide means for supporting the coating material while it is being dried within the dryer. We utilize the drying medium as principal supporting means in the horizontal coater. We utilize ducts 9, 9', on both sides of the paper whereby the drying medium is blown to impinge against the surface of the coating material 1. This blowing gives a wiping effect to remove the surrounding air from the surface and to more quickly effect a transmission of heat from the drying medium to the coated material 1 and also diffuses and removes the vapors given off by the coating in the process of drying. The difference between the vertical and the horizontal lies in the fact that in the horizontal a greater proportion of heating medium is blown through the lower duct 9' to furnish support for the coating material as it passes through the dryer while in the vertical the pressure is equal. As a matter of fact the pressure in the horizontal is balanced, the weight of the paper plus the pressure from the upper duct 9 being equal to the pressure from the lower duct 9'. A very important element in connection with our method of drying is the division of the drying chamber into separate zones A, B. To more effectively accomplish this result we preferably have partitions 10 in the dryers. The proportion of humidity in the heating medium for the different zones A, B, is separately controlled likewise the temperature of the heating medium is also controlled for the different zones so that it is possible to apply in one zone a high temperature with low humidity or a low temperature with high humidity, in other words, varying the two independently of the other in each zone. The quantity of humidity is automatically controlled and can be adjusted so that with respect to the moisture content the desired amount of moisture in the base or in the coating may be retained and the solvents in the coating removed or the coating dried to the degree desired. It should be borne in mind that primarily in drying, the free moisture is driven off while a proper percentage of combined moisture is desirable to be retained in the product and the solvents driven off in the coating. The effect of moisture in the drying medium in the case of waterproof coatings does not prevent the proper removal of the solvents. In fact, even up to the saturation point the drying medium would still function to remove the solvents. The coated material after passing through the dryer is then wound up on a rewind mechanism as shown. The method of drying whereby the combined moisture is retained in the base and where desired in the coating is of great importance in connection with the production of a satisfactory product since the life of the product and many desirable characteristics are harmed by the complete removal of the moisture from the base. This was not appreciated in the art and many products have but a short life in spite of a protective coating. In some cases where the coating is not of the waterproof type, the product may again absorb some moisture either from the atmosphere or by some humidifying device but such attempt to return the moisture required is never as satisfactory as the retention of the proper amount of the original combined moisture. Possibly, this is occasioned by mechanical changes caused by the application of heat to the physical structure of the base.

Certain coatings upon drying give off volatiles which can be recovered with a saving of chemicals which in our application are recovered at the point of highest concentration making such recovery easier.

The efficiency is increased by the utilization of the heated air from the low concentration areas. The coating mechanism is supported by frame work 12 and consists of the usual axle 13, drums 15 carried by axle 13 may have a tension device such as a band 16 about drums 15 carrying weights 17; the material passes over guide roll 18 and between nip rolls 2 and 4, the upper surface being coated by a spray 5 permitting the coating to flow thereon and the excess to run off into pan 3 in the horizontal type or being coated by passing through a bath 14 in the vertical type; the lower surface of the coating is applied by the lower nip roll 2 rotating in trough 3 containing the coating material. The nip rolls 2, 4, are adjustable in the usual manner. The material 1 after the coating has been applied on either one side or both sides and has passed through the nip rolls, then passes between the smoothing or doctoring rolls 6 and 7. These rolls are adjustable with respect to their relative position and are of special construction, that is, a portion of their surface 6', 7', is removed adjacent the point of tangency of the material against them. Rolls 6 and 7 serve to smooth the coating and to prevent streaking and ribbing. After passing through the smoothing rolls 6 and 7, the material can then be secured to sticks 25 carried by chain 26 to thread same through the machine.

The coated paper having been fastened to a stick 25 carried by chain 26 is drawn through chamber A and chamber B where it is threaded about the rewinding mechanism and the process then proceeds. In the case of the horizontal dryer after the paper is threaded it is no longer supported by sticks 25 and chains 26 but is supported by the heating medium emitted from ducts 9, 9'. The humidifying and drying chambers A, B, have ducts 9, 9', extending substantially throughout their length. There is a partition 10 dividing chambers 27, 28, with an opening 30 therein to permit passage of the material being dried, chains 26 and sticks 25. The two chambers are substantially similar in construction. Ducts 9, 9', are supplied by heating and drying medium through con-

duit 31 leading to mixing chamber 32. Chamber 32 procures part of its drying medium from the point of least concentration of the volatiles in chamber A, that is, adjacent partition 10.

5 Within chamber 32^a we provide steam nozzle 33 to furnish the proper drying medium when steam is used. These nozzles are controlled by means of controls which are subsequently described. Hot air or other form of drying medium may be

10 used instead of steam. Humidifying steam is utilized and admitted as shown in Figure 12 at 35. The volatiles are withdrawn from the point of maximum concentration through duct 36 to chamber 37 by exhaust fan 38 operated by motor

15 39 and are either exhausted to the atmosphere through stack 40 or conserved and delivered to the recovery system. In chamber B as the concentration of volatiles is relatively low the conservation thereof may be dispensed with.

20 The control of the heating medium and of the humidity in chambers A, B, are practically identical and therefore it is sufficient to describe such control for one chamber. The heating medium may be hot air, steam or the like.

25 Figure 12 shows the system utilizing dry steam for the heating medium and steam for the humidifying medium. The wet bulbs 43 and dry bulbs 42 are located as desired in chambers A, B. Flexible tubing 42' and 43' lead from the bulbs to the recording indicator 44 and control mechanism. 45, 46 are gauges. The air supply to operate the controls comes through the air supply pipe 47 up through reducing valve 48. The humidifying control through pipe 49 passes to control valve

35 50 whereby the amount of steam through pipe 51 to outlet 35 in the mixing chamber is controlled. The automatic control may be by-passed by closing valves 52' if desired through by-pass 52. The heating medium is controlled through

40 pipe 53 from dry bulb control gauge 45 to control valves 54, 54' in pipe lines 55 of outlets 33 in the heaters. By-passes 56 are also provided. Pipe lines 51, 55, connect with the main steam supply 57. Chamber B only having two sets of outlets 33 in the mixing chamber does not have the duplication of the control valves and extra outlets but otherwise is the same.

45 The feeding chain and material passing from chamber B passes over guide roller 60 and the material then passes around roll 61, over roll 62 and under roll 63 to the windup rolls 64, 65. Windup roll 65 may be in duplicate or triplicate whereby the machine need not be shut down during the operation when a windup roll has received

50 the proper amount of material wound up on it. The feeding chains after passing over roll 60 pass under sprocket 66 and thence over sprockets 67 and under sprockets 68 over sprocket 106 and under sprocket 106' and back through chambers B, A, to sprockets 69 and roll 70.

60 Various elements are driven as follows: Roll 18 is driven through pulley belting from nip roll shaft 73. Shaft 73 in turn is driven by belt 75 through pulley 76 on shaft 77. Shaft 77 is a

65 driven shaft carrying mitre gear 78 driven by mitre gear 79 on shaft 80 running lengthwise of the machine and driven through mitre gears 81, 82, by drive shaft 83. Shaft 83 is driven through pulley 84 and belt 85 by motor pulley 86. Directly above shaft 83 is shaft 87 driven through pulley 88 and belting 89. Shaft 83 carried sprocket wheel 90 and chain 91 driving sprocket 92 on shaft 93 which latter carries sprocket 94 driving

70 through chain 95, shaft 96. The latter shaft 96

is the feeding chain drive and carries sprockets 97 for the chain drive. Shaft 83 also carries sprocket 98 with chain 99 to drive sprocket 100 on shaft 101 to drive the windup roll shafts 102 through gears 103, 104, 105. Sprocket 106 is driven through chain 108 by sprocket 109 carried by shaft 93. The circulation fans or blowers in the drying system have individual motor drives. Modifications of the drive system may be made and still fall within the scope of our invention.

80 In the modified form the principles utilized are the same and the structure is almost the same. The coating is accomplished by a similar structure except that the material is run through a bath, then passes through nip rolls 2 and 4 and doctor rolls 6 and 7 of our special construction. The travelling chain 26 is continuously passing around through chambers A, B, but only utilized as a threading means and the material is maintained in its proper position in the two drying chambers A, B, by the balanced dry medium pressures emitted from ducts 9, 9'. The drying medium is admitted slightly below the central portion of the vertical height to the ducts. Withdrawal of the volatiles is had in the upper portion where the concentration is the strongest. Withdrawal is made through ducts 112, conduits 113 to the recovery room. The material 1 to be coated and dried passes up between ducts 9, 9', in chamber A where it receives proper drying treatment, the humidifying control being the same as in the horizontal structure as well as the control of the heating medium. The material then passes over rolls 111' and down through chamber B in a similar manner where it passes to a similar rewind mechanism as in the case of the horizontal dryer. Either steam may be utilized as a drying medium in the vertical or horizontal type or hot air or hot gases.

110 It will thus be seen that we have provided a form of coating and drying coated materials in an enclosed dryer whereby recovery of the volatiles may be had with means for prevention of escape of volatiles into the room thereby providing greater safety for the operators and the factory with increased economies. We have further provided a process and apparatus that is easily threaded and compact in structure wherein by our method and apparatus in a continuing process a base may be coated on either or both sides and the coating dried relatively quickly without injury to the qualities inherent in the base and delivered in merchandisable condition at the completion of the operation.

115 It should be further noted that for specific materials having desired thicknesses of coating that the method and apparatus is practically automatic in its operation although it is subject to control to adapt it to varying requirements. Therefore it can be utilized in connection with the manufacture of various forms of coated material.

120 It will also be seen that it operates under unique principles in that the drying medium is utilized to wipe the moisture and solvents by the balanced impingement action thereof from the material and thereby to increase the heat transfer. Furthermore, the zone principle in conjunction therewith permits higher initial temperatures permitting more rapid drying and in consequence increased speed of travel of the material with increased output. The specific type of doctor smoothing rolls satisfactorily prevents ribbing and streaking with high speed of travel of the material in high speed coating. Various modifi-

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cations in detail might be made and still fall within the scope of our invention.

What we claim is:

1. The process of drying a coated web comprising moving the web through a drier at a relatively high speed, subjecting the material while traveling at a relatively high speed to a drying medium in one chamber of a dryer, controlling the temperature, independently controlling the amount of humidity in the chamber, exhausting the gases given off from the material to the atmosphere adjacent the entrance of the material into the chamber, withdrawing the gases mixed with the drying medium from the balance of the chamber, adding fresh drying medium and recirculating the mixture in the chamber, then subjecting the material to a drying medium in a second chamber, controlling the temperature, independently controlling the amount of humidity in the second chamber, recirculating the gases mixed with the drying medium in the chamber, directing the drying medium to impinge on both sides of the material in each chamber whereby high velocities and greater quantities of drying medium may be

used by balancing the pressure of the heating medium on the top of the material and the weight of the material by a pressure of the heating medium upon the bottom of the material equal thereto.

2. An oven comprising a housing, sources of heating medium of high temperature exteriorly of said oven, a plurality of zones in said housing, a plurality of means for withdrawing used heating medium from said oven, means for independently mixing the recirculated heating medium with predetermined amounts of fresh high temperature heating medium and delivering said mixture independently to each zone of said oven, means for independently controlling the temperature and humidity of each zone of said oven, and means for exhausting to atmosphere used heating medium from that portion of the oven adjacent the admission of the material having a content of gaseous products given off from the material being dried too high for use in recirculation.

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