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APPARATUS FOR COATING FIBROUS SHEETS

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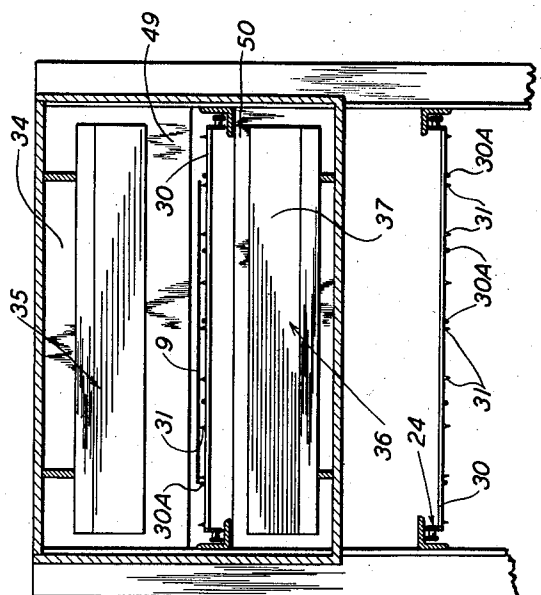
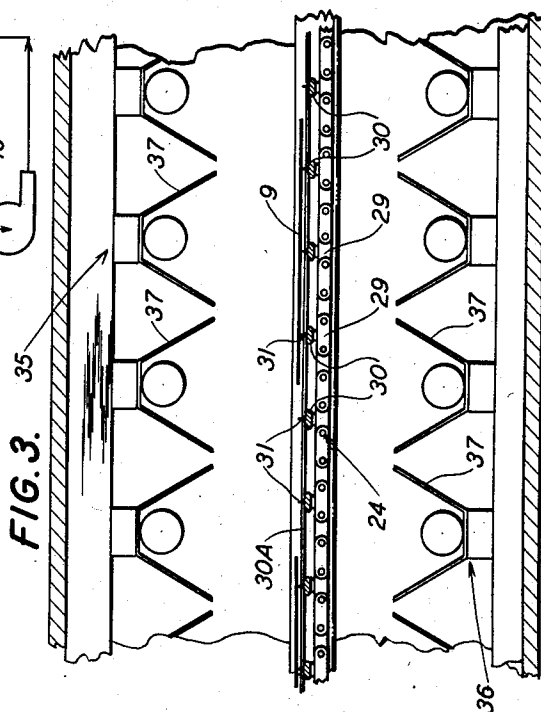
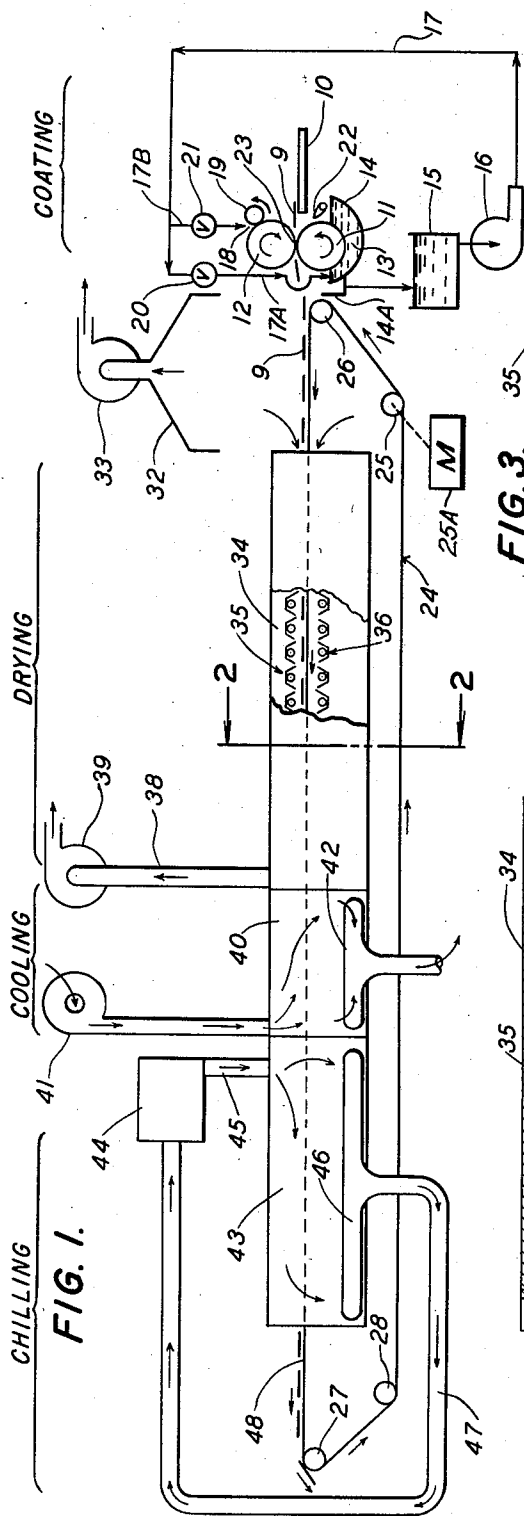


FIG. 2.

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APPARATUS FOR COATING FIBROUS SHEETS

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4 Claims. (Cl. 118—643)

This invention is concerned with coating fibrous sheet material, such as cardboard and paper, and provides improvements in methods and apparatus therefor.

In recent years printed paper products which are subject to much handling, such as menus, envelopes for phonograph records and book jackets, have been covered with plastic coatings to improve their wearing qualities and to resist soiling. The coating composition employed should form a glossy, hard, adherent yet flexible coat and should enhance rather than destroy the quality of any color printed on the paper. A number of such coating compositions comprising a plastic base and a volatile thinner or solvent are on the market and form no part of this invention. But any of them may be employed advantageously in the practice of the invention.

Although a number of satisfactory coating compositions have been available, the methods and apparatus for applying the compositions have left much to be desired. Thus it has not been practical to coat both sides of the sheet simultaneously, and in a two stage operation in which the sheet is run through the coating apparatus a second time in order to coat the second side, there is a tendency for the side that is first coated to become blistered. A second problem has resided in the fact that it has not been possible to coat completely pre-trimmed individual sheets, for example prefabricated record envelopes. Available coating machines have not produced a coating over the entire sheet, the forward portion or gripping edge being left uncoated, so that it has to be trimmed off afterward. Thirdly, sheets with apertures cannot be coated on machines available heretofore, so that any apertures must be cut after the coating operation. Fourthly, the edges of sheets coated heretofore, other than by dipping, have not been water-proof. Fifthly, prior coating procedures have required that the coated sheets be "edge stacked" for at least 24 hours to eliminate tackiness prior to packaging and shipping. This procedure involves not only loss of time, but excessive storage space and labor.

I have developed apparatus and methods for coating fibrous sheets, such as cardboard and paper, which solve all of the foregoing difficulties. Thus, my invention permits both sides of a sheet to be coated simultaneously. In accordance with my invention pre-trimmed sheets (such as menus) or prefabricated sheets (such as envelopes) may be coated completely, so that there is no need to leave a "gripper edge" on the sheet prior to coating, and no need of a subsequent trimming operation. The invention is applicable to sheets with apertures cut in them, so that the apertures may be cut prior to coating, rather than afterward. The practice of the invention assures that the edges of pre-trimmed sheets that are coated simultaneously on both sides will be coated completely and become as water-proof as the coating composition employed. Sheets treated in accordance with my invention become non-tacky in a matter of seconds, and may be packed and shipped as they come off the coating machine, edge stacking with its attendant loss of time and

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consumption of labor and space being avoided. Moreover, the coated sheets have a harder and more uniform finish.

In accordance with my invention, the wet sheets from the coating operation are dried while they are supported on a traveling loop conveyor having sharp pins on which the sheets rest while the coating dries and hardens. The wet coating composition flows around the pins and coats the paper even under the pins, so that the points of contact are not visible, at least to the naked eye, on the finished product.

Preferably the pins project from spaced bars extending across the conveyor and mounted on chains or the like on either side. The space between the bars is open and relatively wide in comparison with the bars, so that heating means (say infrared tubes) may be mounted below the conveyor and heat the under-side of the sheets undergoing treatment without substantial interference from the bars. Such interference as exists is minimized by rounding the sides of the bars so that they have a circular or oval cross section with no sharp corners. The bars should be joined by a series of elastic strips extending longitudinally of the conveyor. These strips prevent the sheets from falling off the conveyor between the bars and stretch to adapt themselves to the curvature of the conveyor as it bends to pass over sprockets or other supporting or driving means.

In the preferred form of my apparatus, the sheets are coated by being passed between rollers mounted substantially tangentially and one above the other, both rollers being positively driven. The lower roller runs in a bath of the liquid coating composition, say varnish or lacquer. When both sides of a series of thin sheets are to be coated, they are fed in spaced relationship serially into the rollers. In the interval between sheets, liquid is transferred from the lower roller to the upper roller so that both are wet. Both rollers in turn transfer the coating to top and bottom faces of the sheets.

When only one side of the sheets is to be coated, the lower roller is kept dry (for example, by wiping it as it comes out of the bath) and the liquid coating composition is fed continuously onto the upper roller, where it is spread, as with a doctor roller, and then transferred to the upper surface of the sheet.

When thick sheets of cardboard or the like are to be coated it may be necessary to raise the upper roller out of contact with the lower, so that during the interval between sheets, there is no or insufficient transfer of liquid from the lower roller to the upper. In such case, the liquid coating composition is fed directly to both rollers.

In any of the foregoing cases, the wet sheets from the coating operations are fed onto the pins of the moving conveyor which carries them through a series of zones on which the coatings are dried and cured. In my preferred practice, the sheets move first through a heating tunnel, where they are heated from both top and bottom by radiant heat, at the same time that a current of drying gas, say atmospheric air, is passed through the tunnel to pick up the solvent evaporated from the sheets.

In my preferred practice the sheets, from which the bulk of the solvent has been evaporated in the heating tunnel, are next passed through a cooling tunnel. Atmospheric air is drawn through this tunnel while any remaining solvent is evaporated and the sheets are cooled rapidly.

In the next stage of my preferred practice, the sheets pass from the cooling tunnel directly into a chilling tunnel through which a current of refrigerated air is circulated. In the chilling tunnel the coating on the sheets is, effectively, "case-hardened" so that the coating becomes non-tacky in a matter of seconds, and the sheets come off the end of the conveyor in a condition which permits

them to be stacked and shipped immediately, without the usual edge-stacking for twenty-four hours or so.

These and other aspects of my invention will be understood thoroughly in the light of the following detailed description, which is illustrated by the accompanying drawings, in which:

Fig. 1 is a diagrammatic flow-sheet of a presently preferred form of the apparatus of the invention;

Fig. 2 is an enlarged and somewhat detailed section through the apparatus of Fig. 1 along the line 2—2; and

Fig. 3 is an enlarged fragmentary elevation of a portion of the apparatus of Fig. 1, showing the construction and disposition of the conveyor and the heating means within the heating tunnel.

Sheets 9, say printed cards to be coated, are fed one by one at spaced intervals from a feeding platform 10 through coating rollers 11, 12. The lower roller 11 turns in a bath 13 of the liquid coating composition, say lacquer with a base of vinyl chloride resin, retained in a trough 14 having an overflow weir 14A. The weir discharges by gravity into a surge tank 15 from which the coating composition from the weir is moved by a pump 16 through a pipe 17 and either through a branch 17A to the bath, or through a branch 17B to a small reservoir space 18 formed between the upper roller 12 and an adjacent doctor roller 19.

The two coating rollers and the doctor roller are positively driven in the directions indicated on Fig. 1 by conventional means (not shown).

When thin sheets are to be coated simultaneously on both faces, both the upper and lower coating rollers have resilient sleeves of rubber or the like to which the liquid coating composition adheres smoothly and in adequate amount. A valve 20 on the return branch pipe to the bath is opened, and a valve 21 which controls the flow through the other branch (to the space between the doctor roller and the upper roller) is closed. A hinged wiper blade 22 disposed above the bath at the rear of the lower roller is swung back out of engagement with the lower roller. Then the sheets 9 to be coated are fed at spaced intervals from the feeding platform, which is disposed at the rear of the coating rollers on the level of their line of tangency 23. The liquid coating composition is carried up on the lower roller out of the bath, which is replenished continuously. In the intervals between sheets some of the liquid accumulates at the rear of the line of tangency of the two coating rollers and is transferred to the upper roller, so that both are wetted. The wet rollers coat both faces of the sheets as they feed through.

When sheets are to be coated on only one face, the lower rubber-covered roller is replaced with a roller of the same size but with a smooth metallic surface, say polished aluminum, to which the liquid coating composition adheres but slightly and from which the liquid can be wiped thoroughly. The valve 20 which controls the flow of the coating composition to the bath is closed and the other valve 21 which controls the flow of the coating composition to the space between the upper coating roller and the doctor roller is opened. The wiper blade is swung forward into contact with the lower coating roller. Then the sheets are fed between the coating rollers as before. Under these conditions, the lower coating roller is wiped dry as it turns up out of the bath and the liquid wiped off drops back into the bath. The upper coating roller, however, is kept continuously and uniformly wet by the stream fed to the space between it and the doctor roller. Any excess drips off the end of this space and back into the bath. The upper coating roller thus applies the liquid coating composition to the upper faces of the sheets as they are fed through and the lower faces of the sheets stay clean and dry.

When thick sheets are to be coated on both upper and lower faces the coating rollers may not be in sufficient contact with each other between sheets to assure trans-

fer of enough coating composition to the upper roller. In such case, the valves on both branch pipes are left open, and the liquid is fed to both rollers directly.

The coated sheets leaving the rollers drop onto a "continuous" or loop double chain conveyor 24 mounted on four pairs of sprockets 25, 26, 27, 28. One of the sprockets, such as sprocket 25, is driven from a variable speed drive, indicated generally at 25A.

Each pair of chain links 29 carries a cross bar 30 which extends from one link to the other. The bars are about $\frac{1}{4}$ inch thick and about $\frac{3}{4}$ inch wide. Both their front and rear faces are rounded so that the bars are oval in section, this configuration having proved to be valuable in bringing about uniform heating and drying of the lower faces of the sheets. The bars are spaced about $3\frac{1}{2}$ inches apart and each carries a series of small sharp pins 31 on their outer surface. These pins project about $\frac{1}{4}$ inch from the bars, and the coated sheets rest on them as they travel along the conveyor. The pins have sharp points and make no detectable marks on the finished coated sheets. Continuous resilient bands 30A of rubber or the like and about $\frac{1}{8}$ inch in diameter extend around the conveyor longitudinally at the level of the cross bars and prevent the sheets from falling down between the bars. The bands are disposed on 6 inch centers.

As the sheets drop onto the conveyor they are carried under a hood 32 equipped with a suction fan 33. Solvent evaporated into the atmosphere from the wet sheets is carried through the hood and fan and discharged into a stack or sent to solvent recovery, as economics may dictate.

The conveyor then carries the sheets into a drying tunnel 34 which is placed as close to the coater as safety will permit, say six feet. The space from coater to drying tunnel should be kept short, to prevent the coating composition from soaking deeply into the fibrous sheet, with attendant difficulties in subsequent drying and curing of the coating.

The drying tunnel is about 18 feet long and is provided with an upper bank 35 and a lower bank 36 of infrared heating tubes, each of which is provided with a reflector 37 to assure uniform distribution of heat on both faces of the sheets. The conveyor carries the sheets between the two banks of heating tubes, which are about 6 inches from the sheets. Because of their spacing and configuration, the cross bars do not interfere with uniform heating of the lower faces of the sheets. Atmospheric air is drawn into the open rear end of the heating tunnel or oven and removed through a duct 38 attached to the front end of the heating tunnel at the top. A suction fan 39 pulls out this air, together with solvent evaporated in the tunnel, and discharges it to atmosphere or to solvent recovery.

Leaving the heating tunnel the sheets move on the conveyor directly into an adjacent drying and cooling tunnel 40 about six feet long. Atmospheric air is forced into the top of this tunnel near the front by a blower 41 and is discharged to atmosphere from the sides of the tunnel through side manifolds 42.

The conveyor carries the sheets from the drying and cooling tunnel directly into an adjacent chilling tunnel 43 about twelve feet long. Here the sheets meet a current of chilled air provided by a standard fan-equipped refrigerating unit 44 which discharges chilled air into the rear of the chilling tunnel at the top through a duct 45. Air from the chilling tunnel is returned to the refrigerating unit through side manifolds 46 and a return duct 47.

Following the chilling tunnel is a short section 48 of the conveyor on which the coated sheets may be inspected before they drop off for packaging and shipment.

To inhibit gas leakage from one tunnel to the next, flaps 49, 50 are mounted respectively above and below the conveyor between tunnels.

In the preferred example just described, the conveyor

is wide enough to handle sheets as wide as 24 inches and is equipped with a variable speed control so that its speed may be adjusted from a minimum of 60 feet per minute to a maximum of 150 feet per minute, with capacity in terms of sheet area (one side) ranging from 2,000 to 5,000 square feet per hour.

When employing a lacquer comprising a vinyl chloride resin and plasticizer in a solvent mixture of amyl acetate and xylene, the sheets enter the heating tunnel at room temperature and leave it at a temperature ranging from 150 to 170° F., the operation being adjusted to heat the sheets as high as possible without blistering the coating. The interior of the heating tunnel has a temperature of about 250° F., and the volume of air through the tunnel is about 650 cu. ft. per minute.

In the cooling and drying tunnel the temperature of the sheets drops about 25 to 30° F., under the influence of 2,000 cu. ft. of atmospheric air per minute.

The circulation of air through the chilling tunnel is about 800 cu. ft. per minute, and under the influence of this air at 30° F. the sheet temperature drops to about 70° F.

The respective residence times of the sheets in the several stages are as follows:

	Seconds	
	From—	To—
Heating Tunnel.....	7.2	18
Drying Tunnel.....	2.4	6
Chilling Tunnel.....	4.8	12
Total.....	14.4	36

If desired, the cooling tunnel employing the atmospheric air may be eliminated and the sheets sent directly from the heating tunnel to the chilling tunnel. This, however, is not desirable from an economic standpoint, because the cooling accomplished with the air at atmospheric temperature is cheaper than the cooling with refrigerated air.

Substantially all of the volatile solvent in the coating composition is evaporated in the heating tunnel, but the sheets emerging from it are tacky, so tacky in fact that the sheets would stick together if opportunity arose, and if the dry sheets are permitted to cool slowly to atmospheric temperature they will remain tacky for hours. If, however, the dry sheets are chilled with relative suddenness, as in the case described, they lose their tackiness in a matter of seconds and will not stick together. The reason for this is not clearly understood, but it may be due to the formation of a thin but hard outside layer on the coating which protects the balance of the coating until it has a chance to set. Whatever be the explanation, the fact remains that with a great variety of lacquers and varnishes which employ volatile solvents as carriers for their film-forming ingredients, the chilled coating is not only non-tacky but also acquires uniform hardness and gloss which are not attained when the same coating composition is applied, dried and cured by conventional methods.

As mentioned previously, the heating tunnel should be placed as close to the coater as possible without running any fire hazard from the vaporized solvent. In this way, evaporation of the solvent is accelerated so that penetration of the coating composition into the pores of the sheet is minimized. This not only reduces consumption of coating composition without adversely affecting adherence of the coat to the sheet, but also reduces the time

required in the heating tunnel and improves the hardness and gloss of the finished sheet.

The temperatures given in the foregoing example are illustrative only. Generally speaking, the coated sheets should be heated as high as possible without causing the coating to blister, and then cooled as rapidly as possible to room temperature or below.

I claim:

1. In apparatus for coating fibrous sheets with an adherent layer of plastic, the combination which comprises means for coating simultaneously both sides of each of a series of the sheets with the plastic dissolved in a volatile thinner and in liquid form, means for moving the series of sheets one after the other through the coating means, a loop conveyor of skeletal construction having a horizontally disposed upper portion with one end adjacent said means for moving the series of sheets so that the wet coated sheets pass directly onto the upper portion of the conveyor from said means for moving the series of sheets, a series of cross bars of rounded cross-section extending across the conveyor with open spaces between them, each bar having a plurality of outwardly projecting sharp pins upon which the coated sheets ride, means for driving the loop conveyor at variable speed, longitudinally extending narrow bands spaced from each other on said loop conveyor and extending between cross bars with the pins on the cross bars extending outwardly beyond the bands so that ordinarily the coated sheets are out of contact with the bands, a drying tunnel disposed near the coating means with the upper portion of said loop conveyor passing through the tunnel so that the plastic does not soak deeply into the fibrous sheets, radiant heating means disposed in the drying tunnel above and below the upper portion of the loop conveyor so as to heat both sides of the respective sheets, means for forcing a current of drying gas through the drying tunnel, a chilling tunnel disposed beyond the drying tunnel in the direction of passage of the coated sheets and around the upper portion of the loop conveyor, and means for circulating a current of chilling gas through the chilling tunnel including means for cooling said current of chilling gas.

2. Apparatus according to claim 1 in which the bands are resilient.

3. Apparatus according to claim 1 provided with a cooling tunnel disposed between the drying tunnel and the chilling tunnel, with the upper portion of the loop conveyor passing through the cooling tunnel, and means for forcing a current of cooling gas through the cooling tunnel.

4. Apparatus according to claim 1 provided with a hood disposed above the conveyor between the coating means and the drying tunnel, and means for sucking the thinner volatilized from the coated sheets into the hood.

References Cited in the file of this patent

UNITED STATES PATENTS

163,598	Marsh	May 25, 1875
936,472	Pfanhauser	Oct. 12, 1909
1,849,938	Lewis	Mar. 15, 1932
1,872,629	Fahrenwald	Aug. 16, 1932
1,979,758	Merritt	Nov. 6, 1934
2,169,772	Schweitzer	Aug. 15, 1939
2,321,938	Quinn	June 15, 1943
2,465,161	Little	Mar. 22, 1949
2,537,279	Quick	Jan. 9, 1951
2,689,196	Daniels	Sept. 14, 1954