

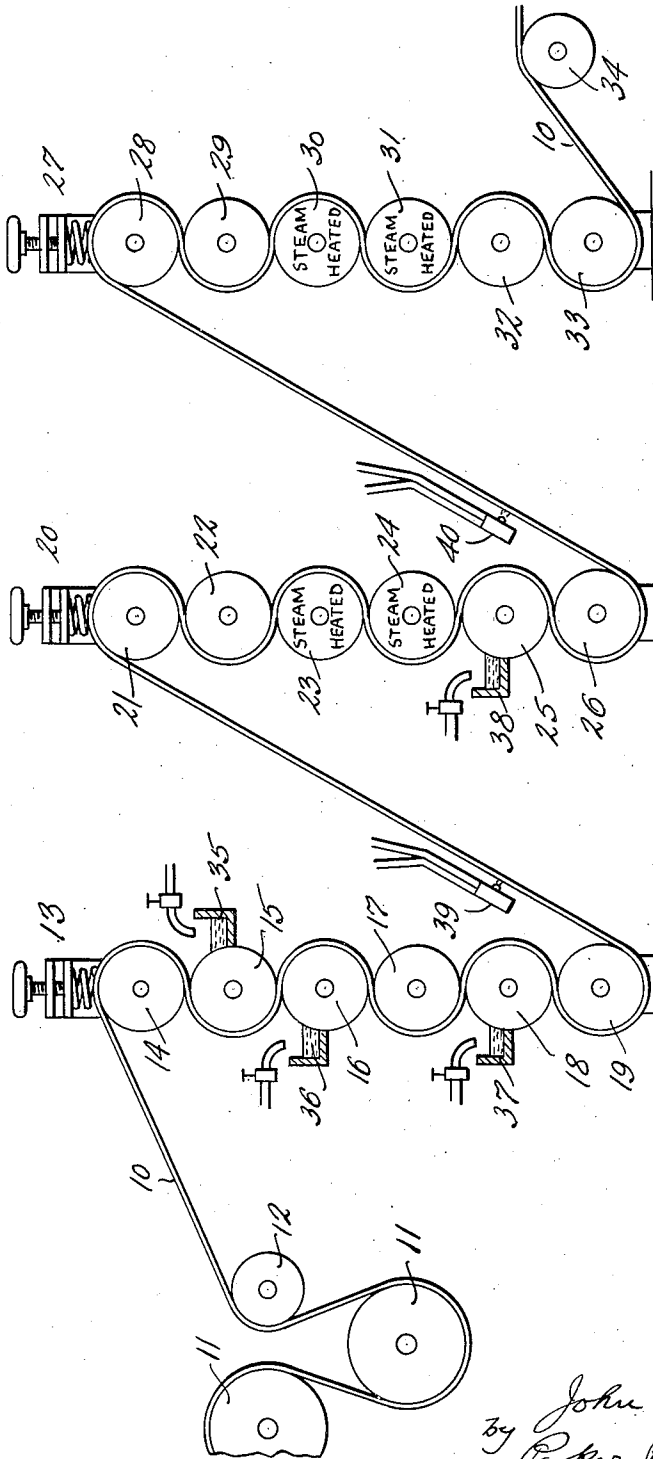
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METHOD OF COATING WEBS

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METHOD OF COATING WEBS

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This invention relates to the coating of fibrous webs, and surfaces or paper sheets, and particularly of a fibrous web such as the paper web leaving a paper forming machine. This application is a continuation-in-part of my prior application Serial No. 44,221, filed October 9, 1935, and which was copending with my prior Patent No. 2,130,530.

An object of the invention is to provide an improved method of applying a coating to a fibrous surface or sheet, with which the penetration of the coating material into said surface or sheet will be relatively slight, with which a fibrous surface may be coated in a simple, rapid and inexpensive manner, with a minimum of handling of the object to be coated, and with a minimum of manual labor.

Another object of the invention is to provide an improved method of coating a fibrous sheet, such as paper, with which the coating material will remain largely on the surface of the sheet, with which the finish as to gloss or flatness may be varied within limits, and which may be easily and inexpensively performed.

Another object of the invention is to provide an improved method of coating a travelling paper sheet or web, such as the web leaving the drying rolls or cylinders of a paper making machine, and with which the coating may be applied to the web and hardened in a rapid, simple and inexpensive manner while the web is travelling and then be immediately wound or otherwise disposed of.

A further object of the invention is to provide an improved method of coating and coloring a fibrous sheet, such as a paper sheet, with which uniformity in the coating and coloring may be obtained, with which the coating and coloring may be performed while the sheet is travelling, and which requires no complicated or elaborate apparatus.

Another object of the invention is to provide an improved method of coating paper and similar sheets with a water dispersion of coating substances, such as nitrocellulose lacquers, synthetic resins, natural fossil resins and rosin.

Another object of the invention is to provide improved apparatus for applying water dispersions of lacquers, resins, rosins and other coating materials which harden by evaporation of solvents, to fibrous objects, such as paper webs and sheets, and which will be relatively simple, inexpensive, and easily incorporated in the usual paper making machines.

Another object of the invention is to provide an improved method of applying one or more

successive coats of coating compositions, with which the coating may proceed continuously and rapidly; which may be advantageously applied in conjunction with the manufacture of the web, such as in the manufacture of a web of paper, and which will be relatively simple and inexpensive.

Another object of the invention is to provide an improved method of treating a fibrous web to increase its flame resistance; and with which the treatment may proceed continuously and rapidly.

Another object of the invention is to provide an improved apparatus for coating a fibrous object, such as a travelling web, with a plurality of layers of coating materials, which will be compact, simple and dependable; which will operate continuously on a travelling web; which may be applied to the calendering mechanism of a paper-making machine when a web of paper is to be treated, and which will be relatively inexpensive.

Further objects and advantages will be apparent from the following description of an example of the invention, and the novel features will be particularly pointed out hereinafter in connection with the appended claims.

In the accompanying drawing I have illustrated diagrammatically an apparatus for applying one or more coatings of a water dispersion of a coating material to a travelling, freshly formed paper web as the web leaves the drying cylinders or rolls of a paper making machine, and also for applying one or more layers of other coating materials, in accordance with this invention.

Emulsions or water dispersions of various coating substances which are normally insoluble in or immiscible with water, and which are of the type that harden normally upon the evaporation of a solvent, are now available for industrial use. Examples of coating materials which may be employed for the coating of paper webs in accordance with this invention are the water dispersions or emulsions of the following materials.

Cellulose and nitrocellulose compounds including:

Nitrocellulose lacquer,
Ethyl cellulose,
Cellulose esters, and
Cellulose acetate.

Alkyd resins including:

Polybasic acid-polyhydric alcohol resins, or esters of polybasic acids and alcohols.

Example: Phthalic anhydride — glycerol resin.

Esters from rosin including:

Rosin-glycerol.

Rosin-maleic anhydride-glycerol.

Phenolic type resins including the following resins:

Phenol-formaldehyde,

Cresylic acid-paraformaldehyde.

Para cresol-rosin-formaldehyde.

Catalysts for these resins may be either alkali such as ammonia, hexamethylenetetramine, NaOH, or acids such as HCl, and H₂SO₄.

Urea-formaldehyde resins (soluble in butyl alcohol).

"Vinylite" resins—obtained by polymerization of vinyl compounds such as vinyl acetate and vinyl chloride described in an article on pages 645-652 of "Industrial and Engineering Chemistry" for June 1, 1933, on page 252 of October 1932 issue of "Canadian Chemistry and Metallurgy," and in U. S. Patent No. 1,935,577, of November 14, 1933.

Methyl methacrylate resins.

Natural resins including:

Rosin, Kauri, Congo, Manila, East India resins, and esters of same.

Coal tar resins including:

Coumarone and indene made by polymerization of coal tar oils with H₂SO₄.

Paper resins including:

Abietic acid, pitch, and fatty acids obtained from refining black liquor, a by-product of sulphate pulp manufacture.

Protein resins including those from:

Soya bean proteins,

Casein proteins, and

Corn proteins.

Chlorinated products, such as—

Chlorinated naphthalene,

Chlorinated diphenyl, and

Chlorinated rubber (available in the commercial market under the trade-mark "Tornesit" and under the trade-mark "Pliolite").

It will be understood, however, that the invention is not limited, in its broadest aspects, to the particular examples of materials which are herein specifically set forth, because for the coating material I may utilize any emulsion or water dispersion of a solution of any coating material of the type that sets or hardens upon the evaporation of the solvent in which it is dissolved, and is normally insoluble in and immiscible with water.

By way of example, a description of lacquer emulsions or water dispersions and their preparation, composition and use has recently been published and made available to the trade in a booklet entitled Lacquer Emulsions, copyrighted in 1935 and published by The Hercules Powder Co., Inc., of Wilmington, Delaware. The same principle may be employed for preparing water dispersions or emulsions of other coating materials of the type that harden normally upon the evaporation of the solvent contained in the dispersion or emulsion.

Referring now particularly to the drawing, the invention is illustrated in its preferred embodiment, as applied to a paper making machine for the coating of the travelling paper web as rapidly as it is formed thereby. The travelling web 10 of freshly formed paper, after passing over or around a desired number of drying rolls or cylinders 11, as usual in paper making machines,

is conducted over an idler cylinder 12 to the upper end of a calendering device or unit 13. This calendering device includes a series of floating, superposed, abutting calender cylinders 14, 15, 16, 17, 18 and 19. These cylinders are arranged above one another in a vertical stack and are guided for vertical movement in floating contact with one another, the cylinders being urged yieldingly in contact with one another under heavy pressure in any suitable manner, such as is usual in the calendering devices of paper making machines. Such a calendering device is a common attachment to or a part of paper making machines for calendering the web leaving the drying cylinders.

The web 10 passes over and then downwardly around the upper roll 14, then successively and alternately around and between the other rolls, then after passing around the lowermost roll 19 of that unit, the web passes through quite a long stretch, in which it is largely exposed to air, to the top of a second calender unit 20, where it passes over and around the upper roll 21 of that unit. The unit 20 is similar to the unit 13, and in addition to the upper roll 21, it includes the rolls 22, 23, 24, 25 and 26. The web 10, after passing over the upper roll 21, passes between and around the other rolls below 21 in that unit. After passing around the lowermost roll 26 in that unit, the web passes through quite a long stretch, in which it is largely exposed to air, to the top of a third calender unit 27. The unit 27 is similar in construction to the units 13 and 20 and includes the rolls 28, 29, 30, 31, 32 and 33. The web, after passing over and around the upper roll 28 of the unit 27 passes between and around the lower rolls of that unit, then passes over an idler 34 to the usual winding or cutting mechanism where the web is either wound into rolls or cut into sheets of the desired size.

Some of the intermediate rolls in the units 20 and 27 are preferably heated in any suitable manner, such as by steam, the heating of such rolls being a common expedient in paper machines. For example, in the calendering unit 20, the rolls 23 and 24 are heated, and in the unit 27 the rolls 30 and 31 are heated. A water box 35 is provided along one side of one of the rolls of the calendering unit 13, such as roll 15, as usual in calendering devices for applying moisture to the paper web which is passing around or in contact with the roll 15. The roll 15 forms one side wall of the box 35 and thus, when water or other liquid is placed in the water box 35, it will engage with the roll 15 and a film of the liquid will be carried by the roll upwardly into contact with a face of the web which passes between the rolls 14 and 15.

Any excess liquid in the film will be squeezed out by the pressure on the web between the rolls 14 and 15, and run back into the box 35. Similar water or liquid boxes 36 and 37 are applied to the rolls 16 and 18 respectively, also of the unit 13. A similar water box 38 is applied to the roll 25 of the second unit 20. Any suitable means may be provided for supplying a coating liquid continuously to these boxes 35, 36, 37 and 38.

A suitable spray device 39 is arranged adjacent to the unit 13 just above the paper web 10 as it leaves the roll 19 of the unit 13, for discharging a continuous spray of liquid across the entire width of the web, and may comprise a row of individual spray units arranged in a row in such a spaced relation to one another across the width

of the web that together they spray a continuous film of liquid coating material across the face of the travelling sheet or web. While any suitable spraying units may be employed, I have found it advantageous to employ spraying devices of the atomizing type, many of which are now available in the open market for industrial spray uses. These atomizing spray units are preferably of the type discharging a fan-like or sheet-like spray, and disposed with the different fan or sheet-like sprays abutting one another edge to edge so as to provide a continuous sheet-like spray across the entire width of the web. Thus as the web travels edgewise through the various units 13, 20 and 27, it will receive a continuous coating of the sprayed or atomized coating material. A similar spray unit 40 is disposed in proximity to the upper face of the web 10 as it leaves the roll 26 of the calendar unit 20.

If it is desired to apply to the paper web a single coating of a water dispersion of a resinous or other coating material of the type which hardens by the evaporation of a solvent, this water dispersion may be placed in the box 37. The hot web passing through the paper mill is dried by the heat from the rollers 11 around which it passes, and this causes greater drying on the surfaces of the web than in the interior of the web. Since the web reaching the final rollers 11 of the usual paper mill is still hot and largely dried, it is usually advantageous and important to moisten the surfaces of this hot web somewhat before applying the water dispersion of the coating material thereto. If the water dispersion of the coating material is applied to the relatively dry surfaces of the web, such a coating does not spread as quickly and evenly over the surface as when the surface is premoistened. Furthermore, if the surface is premoistened before the application of the water dispersion of the coating material, there is less penetration of the coating material into the fibers of the sheet.

As soon as the freshly coated web is exposed to the air or a drying atmosphere, the solvent component of the coating, which is preferably of a readily vaporizable type, will be driven off before all the excess moisture is eliminated. The solvents in the coating material tend to remain largely on the surface of the web instead of striking in, and the water of the coating tends to strike in, and for that reason the evaporation of the solvents will be rapid as compared to the water. The water of the coating, being the outer phase of the emulsion, will strike into the porous object to some extent, and the inner phase of the coating which contains the solids of the coating material and the solvent, will be deposited as a thin layer on the surface of the web.

The hot web from the paper mill rollers 11 is thus preferably premoistened by water which is supplied to one or both boxes 35 and 36. If the coating material is to be applied to only one face of the web, then the coating material may be placed in the box 37 and the water or other moistening agent placed in the box 36, so that the surface of the web which is moistened by the water from the roll 16 will be the surface which is coated by the water dispersion of the coating material from the box 37. This coated surface passes around the outside of the roller 19, where it is exposed to the air, and then it passes to the top of the next unit 20. During such travel between units, the hot moist web tends to give

off steam and thus create a humid atmosphere around the freshly coated section of the web travelling between the units.

The heat of the web tends to drive off rapidly the small amount of solvent which is contained in the freshly applied coating, and the elimination of the solvent is sufficient, in the time interval of the travel from the roll 19 to the unit 20, to carry the coating past the tacky stage and cause it to set substantially before it reaches the unit 20 or at least before it has left the roller 21. Some of the moisture will also be driven off with the solvent, but the elimination of the moisture at the same time does not decrease or retard the evaporation of the solvent by the heat of the web. In this manner the coating is set and dried in passing between the units so that it will not stick to the rollers of the unit 20 as it passes successively between the rollers of that unit. The atmospheric condition above and around the freshly coated web as it passes from one unit to the next, causes a flocculation of the resin from the emulsion or dispersion, which gives an immediate film formation without the intermediate sticky condition usual with solutions applied to paper. This flocculation appears to be aided by the excess moisture present.

The additional moisture is then eliminated from the web by the rollers of unit 20, and when desired a further coating may be applied in the box 38 or sprayer 40, or both. It is unnecessary to cut down the usual or normal rate of operation of the paper machine in order to apply the resinous coating in this manner.

Fungus and termite resisting materials may also be included in any of the water dispersions of the coating materials, or water solutions of such materials may be placed in the boxes 35 and 36 in place of water to premoisten the web before the application of the coating materials. If the fungus and termite resisting materials and water solutions are placed in the boxes 35 and 36 as a premoistening agent, they will be carried further into the web than when applied in mixture with the coating materials. If the web is one that has been preformed and stored before being coated in apparatus such as shown, then the web must be premoistened substantially, such as by the boxes 35 and 36 before the coating material is applied. Such a preformed web that is subsequently coated in this manner should also be substantially heated before the coating is applied so that when the coating material is applied in emulsion form, the solvent will be quickly driven off from the travelling web while the web is passing between successive calendar units.

The coating obtained in this manner tends to produce a mat finish on the coating of the web which is particularly valuable as a primer coat or finish to receive paints or other coatings. If a higher gloss on the face of the coated web is desired, the preliminary moistening of the web before the application to the web of the water dispersion of the coating material may be materially reduced and in some instances may be eliminated.

Successive coatings of different materials may be applied in successive calendaring units of the paper making machine in paper mills, and one very important application of successive coatings is in increasing the flame resistance of the webs, and the application of this invention for this purpose will now be described.

In my prior U. S. Patent No. 2,010,015, issued

August 6, 1935, I have disclosed and claimed a fibrous sheet which is rendered fireproof or flame resistant by impregnating it first with one flame resistant material, and then superposing a coating of another flame resistant material over the same sheet. Such sheets are used as wall board in building constructions and some types of such board have paper liners or sheets cemented to the opposite faces of a filler layer so as to provide a fibrous surface for the filler. Frequently, wall board is made sufficiently flame resistant by merely fireproofing or treating its surface layers and, in such case, the fireproofing may be performed upon these paper liners as the liners come from the paper making machine, or by treating the paper liner or web which is stored in large rolls, before it is cemented to the opposite faces of the filler of the board. The filler is also frequently made by cementing face to face, a plurality of webs of heavy or thick paper, and these webs may be treated with silicate of soda or other fire resisting material in this same manner before being cemented face to face to one another and to the liners. The treatment or coating of the liners or surface sheets and of the laminations of the filler webs may, therefore, be performed in apparatus such as shown, which, for this particular example, includes the treatment of the paper web as it comes from the paper making machine.

Silicate of soda is one of the best fireproofing materials, and is also very inexpensive, but because of its alkali content, ordinary paints cannot be used directly over it, because the silicate attacks and saponifies the fatty acids of the paint which is applied thereover, destroying the durability of the paint coating. Hence, I utilize the silica of soda as the impregnating layer or coating, and then apply thereover a second coating of fireproofing or flame resisting composition, which is neutral with respect to paints. Examples of such neutral compositions are chlorinated naphthalene and chlorinated diphenyl, which are chlorinated hydrocarbons and are solid at temperatures below 100° F. and which are also particularly valuable as coating materials because they are termite and fungus resistant, and also repellant to poultry. When wall board having its surfaces coated with these chlorinated products is used in the construction of a wall of a poultry house, the poultry will not injure or destroy the wall board by continually picking at it.

In the treatment of a paper web for use as a liner for wall board, to increase its flame resistance, I place silicate of soda in the water boxes 35 and 36, the silicate being reduced to a desired, free flowing consistency with water. As the paper web, which is hot, leaves the drying cylinders 11 and passes through the calender unit 13, the roll 15 will transfer a film of the silicate of soda from the box 35 to one face of the web 10, and the roll 16 will similarly coat the opposite face of the same web with silicate of soda from the box 36. The passing of the web between the other rolls of the unit 13 in succession, particularly under the pressure between the rolls which it separates, will result in a forcing or working of the silicate of soda film well into the fibers of the sheet for a substantial depth, and this working will be continued as the web passes between and around the rolls 21 and 22 of the second unit 20.

As the web passes from the first unit to the second, however, it will travel free of both units

for a substantial distance, so that the silicate of soda coating on the web has an opportunity of drying materially before reaching the unit 20. Since the web as it comes from the paper machine, still contains considerable heat, it will still retain some heat as it passes between the units 13 and 20. The drying, however, is substantially continued as the web passes in contact with the heated rolls 23 and 24.

In the water box 37 of unit 13 or box 38 associated with the second unit 20, I place an emulsion or water dispersion of the second coating material, which in this example, may advantageously be an emulsion or water dispersion of chlorinated naphthalene or chlorinated diphenyl, and the same emulsion or water dispersion is supplied to the spray device 40. The heated web leaving the roll 24 will pass in contact with the roll 25, where one face of the web will be coated with the emulsion of water dispersion from the box 38, and the opposite face of the web, as soon as it leaves the roll 26, will be coated with a film of the same material from the spray or atomizing unit 40. This hot web, freshly coated with the emulsion or dispersion, in traveling from one unit to the next, will be freely exposed to the air, so that the water and solvent of the second coating material will be largely driven off. The escape of steam from the heated web 10 while the web is traveling from unit to unit will create a humid drying atmosphere around the moving web and aid in eliminating the volatile solvent of the coating material, with the result that this coating of the emulsion or dispersion is largely set by the time that it reaches the next unit and has passed the tacky stage.

As the web passes through a third calendering unit 27, it receives a calendering pressure between all of the calendering rolls thereof, and it will be further rapidly and completely dried as it passes around the rolls 30 and 31, which are preferably heated as illustrated and explained. It will thus be noted that the paper or web may be continuously coated first with the silicate of soda which is worked well into the fibers of the web and then with a second coating which will be inert with respect to paints applied thereover.

If desired, the emulsion or water dispersion used as the second coating may be of a nitrocellulose lacquer or of a water dispersion of any of the other coating materials above referred to. While such a nitrocellulose lacquer is not as flame-resistant as a chlorinated naphthalene or diphenyl, nevertheless it is not readily combustible and, therefore, not only provides a fairly good flame resistant surface, but also acts as an excellent foundation for receiving decorative coatings of paints and lacquers when the wall board formed from this paper liner is used. If only one face of the web is to be coated, then only one of the coating devices of each unit need be employed. For example, if the second coating is to be only upon one face of the web, then either the box 38 or the spray device 40 may be unutilized.

It will be understood that instead of the water box 38, a spray device similar to 39 or 40 may be disposed at the opposite side of the web 10 from the device 40, so that both faces of the web may be coated by spraying at the beginning of the travel of the web from the unit 20 to the unit 27. Similarly, the box 37 may be replaced by a spray device identical with 39, but disposed at the opposite face of the web from the device 39.

When fireproofing of the liner is not desired,

various other coatings may be applied with the same apparatus, and by the same method. For example, it may be desirable to first impregnate the liner with rosin or a synthetic or natural fossil resin and then to apply an emulsion of lacquer, such as nitrocellulose lacquer. In such case, a water dispersion of the rosin, or synthetic or natural resin of the type which sets or hardens upon evaporation of a solvent may be placed in the box 37 of the unit 13 and supplied to the spray device 39, and an emulsion or water dispersion of the lacquer is placed in the box 38 and supplied to the spray device 40 of the second unit 20.

The penetration of the first coating may be increased somewhat, when desired, by supplying water to the boxes 35 and 36 of the unit 13. As the web 10 passes through the unit 13, the opposite faces thereof may be coated with a film of water where the preliminary moistening is desired, and then adjacent the bottom of the unit 13, the web will be coated upon both faces with the water dispersion of the rosin or other resin, and this resin then dries or sets, aided by the heat of the web, as the web travels through the open space from the unit 13 to the unit 20. The web is subjected to a calendering or ironing operation as it passes downwardly through the unit 20, the web being heated further as it passes around the rolls 23 and 24, so that the first coating on the web is further dried or hardened before the web reaches the roll 25.

A second coating, such as the lacquer in water dispersion, is then applied through the box 38 to one face of the web. Then a similar coating may be applied through the spray device 40 to the opposite face of the web. The hot web thus freshly coated in passing to the unit 27 will be exposed to humid air, with the result that moisture and the solvent of the fresh coating will be driven off sufficiently to cause a setting of the coating, so that it will not be tacky as it starts through the unit 27. The double coated web will then be calendered and dried or ironed in the unit 27, during which the coating is smoothed out and thoroughly dried, after which the web passes to the winding or cutting mechanism.

Obviously, coatings of other materials may be applied alone or in succession to a web in this simple manner, and by the same apparatus. When the web employed is one coming directly from the paper making machine, which is preferred, it retains considerable heat because of its contact with the heated drying cylinders 11, and it is usually unnecessary to supply heat to the web while in the unit 13, although if desired, such as when the web comes from a roll in which it is stored, one or more of the rolls in the unit 13 may be steam heated in the same manner as in the units 20 and 27. It will be understood that any desired number of rolls in each calendering unit may be employed.

In making the paper web, it is necessary to dry it largely throughout as it passes around the cylinders 11, and the outer surface portions are dried to a greater extent than the inner zone, but in calendering the web so made, it is usually necessary or desirable to moisten the faces of the web before or as it passes through the calendering mechanism. The moistening of the faces of the web before the water dispersions or water miscible coatings are applied to the web is

advantageous, in that the emulsions or coating liquid then applied provide a better and smoother surface coating. Various coloring materials, either of the soluble or pigment type may be included in the coating materials when a colored coating is desired.

The preparation of water dispersions or emulsions of solutions of the coating materials is public knowledge, but I prefer to employ the dispersions in the water phase. The preparation of the water dispersions, while explained in the booklet hereinbefore referred to, may, however, be briefly described as follows, as employed for lacquers.

The first step in preparing a lacquer emulsion is to make up the base lacquer. The composition of this base lacquer depends upon the use to which the finished lacquer emulsion is to be put.

The lacquer base and water containing the emulsifying agent are then mixed together, and agitated to obtain a uniform mixture which can be put through an emulsifying machine such as the Premier or Eppenbach colloid mill or Manton-Gaulin or Cherry Burrell homogenizer. However, many other machines of similar type are available, which probably would give comparable results. The ratio of lacquer phase to water phase will ordinarily vary between 2 parts of lacquer to 1 part of water and 3 parts of lacquer to 1 part of water. In general, the lower the percentage of water used in the emulsion, the higher the viscosity of the finished emulsion will be. In making all emulsions and especially those with a low percentage of water, it is best to use a procedure known as "seeding." By this procedure about a quarter of the lacquer base is first dispersed in the entire water phase and this mixture is passed through the homogenizer to form a dilute emulsion. To this is then added the remaining three-quarters of the lacquer base and the complete mixture again is emulsified. The size of the emulsion particles is decreased by repeated passes through the homogenizer. One or two passes is usually sufficient, however.

In making up a pigmented lacquer emulsion on the Manton-Gaulin, the following technique is recommended. The baffle ring on the second stage homogenizer should be left out and a properly supported 200-mesh screen placed over the outlet of the second stage homogenizer. All of the water phase should be added first with only a small part of the lacquer phase, and pumped through the machine; the only pressure should be that built up by the resistance of the screen. The remainder of the lacquer phase is gradually added during recirculation. When it is all added, the first stage pressure is increased to 2500 pounds, and 1500 pounds is put on the second stage. The emulsion is then passed through the machine two or three times. The same technique may be used on the unpigmented emulsions though they are usually made without the screen and with the second stage baffle ring in place.

Further examples of the preparation of emulsions or water dispersions for coating materials to be applied to paper webs in accordance with this invention are:

Example 1

	Pounds
Ester gum.....	100
Petroleum or coal tar naphtha.....	50
Triethanol amine (emulsion stabilizer).....	¼
Water	100

Example 2

	Pounds
Phthalic anhydride-glycerol-resin modified or plasticized with 50 lbs. drying oil fatty acid -----	100
Sodium oleate (stabilizer) -----	1/2
Water -----	100

These mixtures of these examples are passed through colloid mills or homogenizers, as explained above for the nitrocellulose lacquers.

There is a distinction in the drying of a solution of nitrocellulose in solvent. Such a solution dries by evaporation of the solvent, depositing a uniform continuous film, and with the addition of resin, a glossy film. A flocculation of the solids occurs on the coated sheet or web when a water phase dispersion of nitrocellulose in solvent is used as the coating material. The evaporation of the solvent and the water flocculates the solids and this flocculation deposits on the fibers.

The fact that any solvent of the coating, such as butyl alcohol or xylol employed in the water dispersion of the nitrocellulose lacquer, may have a higher boiling point than water, does not prevent the evaporation of such solvent before that of all or most of the water, because the solvents are part of the inner phase of the emulsion and tend to remain on the surface of the web, whereas the water is the outer phase of the emulsion and has a greater tendency to penetrate into the web. The heat of the web is sufficient to drive off the solvents rapidly, and the relative rates of evaporation of the liquid constituents of the coating are not necessarily proportional to their boiling points. Furthermore, since the solvent in the freshly applied coating tends to remain on the surface of the web and the water of such coating tends to strike into the web, the solvent will be freely exposed, whereas much of the water will be confined in the pores of the web where it is not as easily driven off by the heat of the web.

This method of coating, in its broadest concept, can also be used to coat webs or sheet strips of textile cloth with water dispersions of resinous coating materials, but the application preferred at the present time is to paper webs as they leave the drying rolls of a paper making machine so that no additional handling is necessary and the web already has sufficient heat and some moisture to facilitate the practice of the method.

It will be understood that various changes in the materials, details and arrangement of the parts, and of the coating materials employed, which have been herein described and illustrated in order to explain the nature of the invention, may be made by those skilled in the art within the principle and scope of the invention, as expressed in the appended claims.

I claim as my invention:

1. The improved method of applying a coating to a surface of a sheet of fibrous material such as paper and cardboard, which comprises coating a face of said sheet which before coating contains on its surface layer substantially more moisture than it will retain under normal atmospheric conditions and while at a temperature substantially above normal room temperature, with a water dispersion of a solution of a resinous coating material that is insoluble in and immiscible with water and contains coating solids with a volatile solvent for such solids, then immediately exposing the warm coated sheet to contact with air to eliminate a sufficient amount of the volatile solvent in said coating to carry it quick-

ly past approximately the tacky stage, and then further drying the coated sheet.

2. The improved method of applying a coating to the surface of a fibrous web, which comprises coating a face of said web while hot and which before coating contains substantially more moisture than it will retain under normal atmospheric conditions, with a water dispersion of a solution of a resinous coating material of the type which is insoluble in and immiscible with water and hardens by evaporation of solvents, and which dispersion contains some readily vaporizable solvent for the solids of the coating material, then immediately exposing the hot coated web to contact with air to eliminate a sufficient amount of the volatile solvent from the coating to carry it quickly past approximately the tacky stage, and then further drying the coated web.

3. The method substantially as set forth in claim 1, in which the further drying of the coated sheet includes calendering of the sheet.

4. The improved method of applying to a surface of a travelling paper web immediately as the hot web leaves the drying rolls of a paper making machine, a coating of a material of the type which is insoluble in and immiscible with water and hardens upon the evaporation of a solvent therefor, which comprises moistening that surface of the travelling web to be coated with an aqueous liquid, then applying to that moist, hot surface of the travelling web and while the web is travelling, a water dispersion of a solution of said coating material which is insoluble in and immiscible with water and contains coating solids and some of a readily vaporizable solvent for said solids, then running said coated hot web with said coated surface exposed for a distance enabling evaporation of enough of the solvent of the coating to carry the coating past the tacky stage, and then calendering and drying the travelling, coated web.

5. The improved method of applying to a surface of a travelling paper web immediately as the hot web leaves the drying rolls of a paper making machine, a coating of a water insoluble material of the type which hardens upon the evaporation of a solvent therefor, which comprises moistening that surface of the travelling web to be coated with an aqueous liquid, then applying to that moist, hot surface of the travelling web and while the web is travelling, a water dispersion of a solution of said coating material which is insoluble in and immiscible with water and contains coating solids and some of a readily vaporizable solvent for said solids, and in which the water is the outer phase of the dispersion, the solvent is in the inner phase thereof, and the size of the particles of the solids prevents substantial penetration of said solids into the web, then running said coated hot web with said coated surface exposed for a distance enabling evaporation of enough of the solvent of the coating to carry the coating past the tacky stage, and then calendering and drying the travelling, coated web.

6. The improved method of applying to a surface of a travelling paper web, a coating of a material of the type which hardens upon the evaporation of a solvent therefor, which comprises coating said surface of said web while travelling and while containing more moisture than it will retain under normal atmospheric conditions and while at a temperature substantially above normal room temperature, with a water dispersion of a solution of said material which

is insoluble in and immiscible with water and contains coating solids and some of a readily vaporizable solvent for said solids, and in which the water is the outer phase of the dispersion and the solvent is in the inner phase thereof, then immediately exposing the warm, freshly coated surface of the travelling web to contact with air until the volatile solvent in the coating is eliminated sufficiently to carry the coating past approximately the tacky stage, and then calendering and drying the travelling web.

7. The improved method of treating a travelling paper web immediately as the hot web leaves the drying rolls of a paper making machine, which comprises moistening the hot travelling web with water, allowing the water to penetrate into the fibers of the web, then applying to the moistened, travelling hot web a film of a water solution of a water soluble impregnating agent, partially drying the coated web while travelling, and then depositing on the coated face of said heated, travelling web a coating of a water dispersion of a solution of a coating material of the type which is insoluble in and immiscible with water and hardens upon the evaporation therefrom of a solvent, and which contains coating solids and some of a readily vaporizable solvent for said solids, and in which the water is the outer phase of the dispersion and the solvent is in the inner phase thereof, then conducting the travelling, double coated web with said coated surface exposed to atmosphere

for a distance enabling evaporation of enough of the solvent of the second coating to carry that coating past the tacky stage, and then calendering and drying the travelling coated web.

8. The improved method substantially as set forth in claim 7, in which the water dispersion is of a chlorinated flame resisting hydrocarbon compound which is a solid at temperatures below 100° F.

9. The improved method of treating a paper web while the web is travelling, which comprises moistening the surface of a travelling, hot web, then applying to the moistened, heated web a coating of a water solution of an impregnating agent, conducting the coated web successively through a series of rolls under pressure to work the coating into the fibers of the web, then applying to the surface of the coated web while still moist and travelling a coating of a water dispersion of a solution of a coating material which is insoluble in and immiscible with water and contains a readily vaporizable solvent for the solids of the coating material, then conducting the hot, double coated web in an exposed atmosphere for a material distance in which the heat of the web and the surrounding atmosphere may drive off sufficient solvent to carry the second coating past the tacky stage, and then immediately calendering and drying the double coated web.

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