

Aug. 30, 1960

E. W. FREEMAN

2,950,989

METHOD OF PRODUCING DRUM-FINISHED COATED PAPER

Filed March 17, 1958

2 Sheets-Sheet 1

Fig. 1.

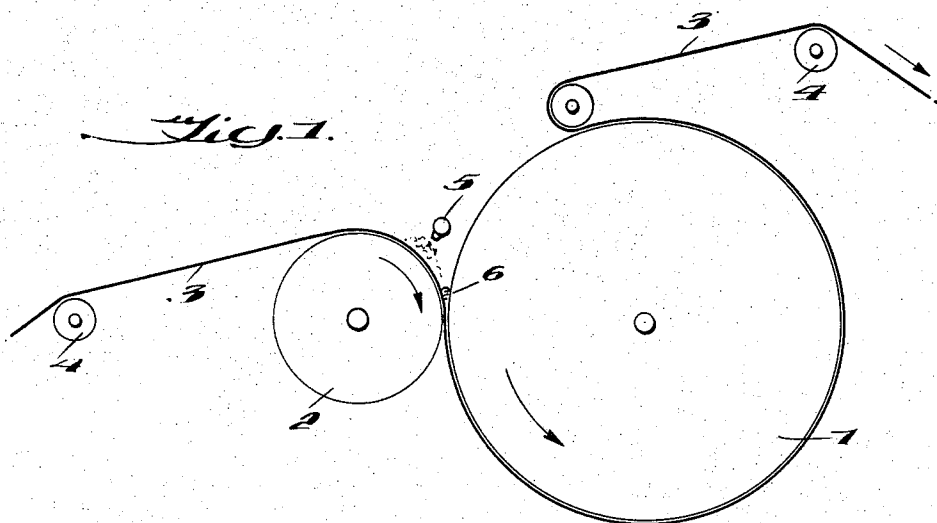


Fig. 2.

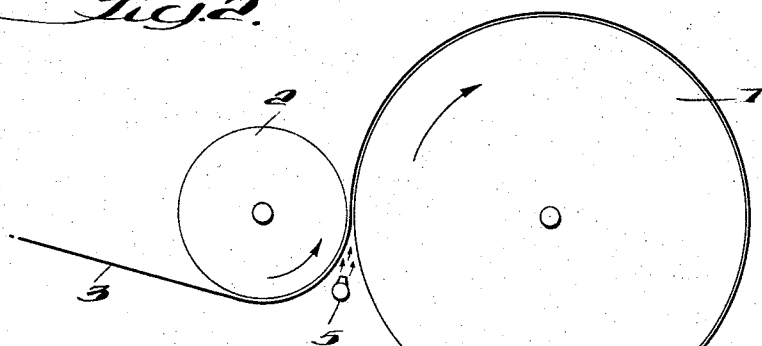
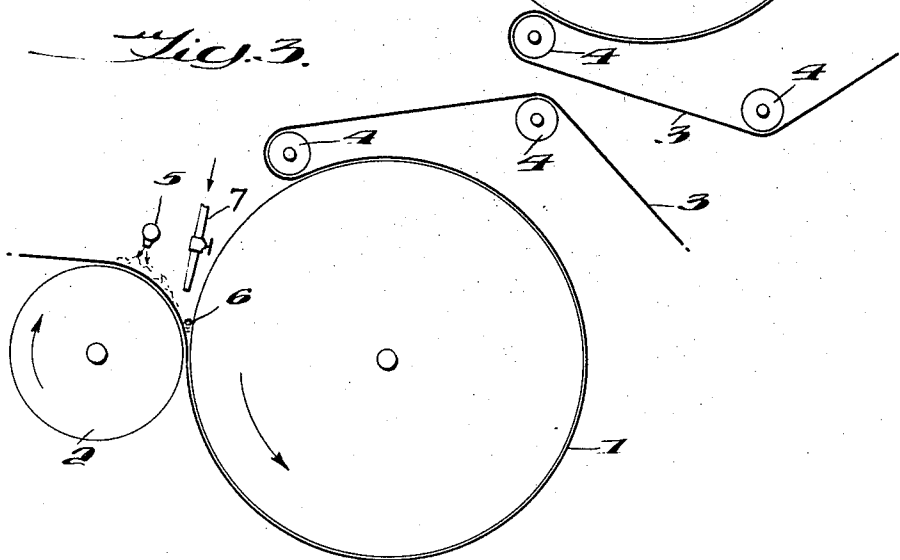


Fig. 3.



Aug. 30, 1960

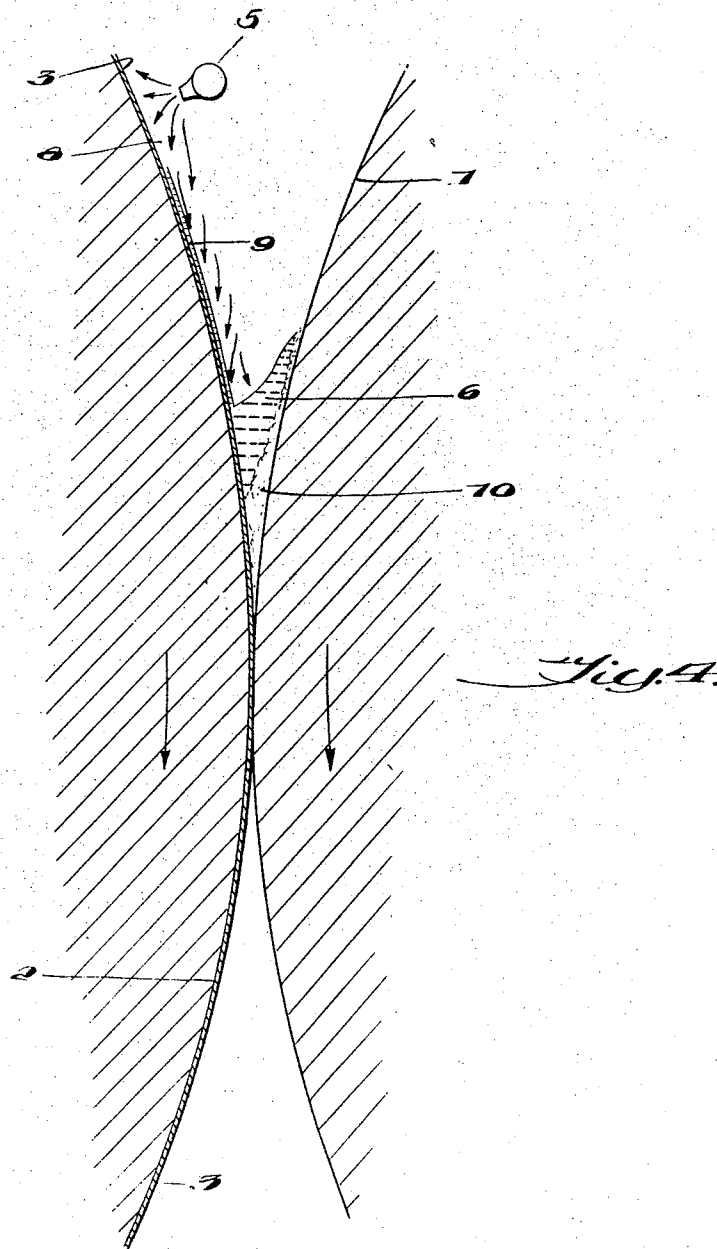
E. W. FREEMAN

2,950,989

METHOD OF PRODUCING DRUM-FINISHED COATED PAPER

Filed March 17, 1958

2 Sheets-Sheet 2



1

2,950,989

METHOD OF PRODUCING DRUM-FINISHED COATED PAPER

Eben W. Freeman, Portland, Maine, assignor to S. D. Warren Company, Boston, Mass., a corporation of Massachusetts

Filed Mar. 17, 1958, Ser. No. 721,813

13 Claims. (Cl. 117-64)

This invention relates to the production of drum-finished coated paper.

Drum-finished coated paper is made by pressing the coated surface of a coated web of paper, while the coating is wet, against a polished heated metallic finishing surface and drying the coating in contact therewith. If the wet coating adheres to the finishing surface in non-slipping relationship thereto until substantially dry the paper is customarily called cast-surface coated paper, and it then possesses a surface which is substantially a mirror-image of the metallic finishing surface. In some circumstances the wet coated paper can be dried against a polished finishing surface under such conditions that it slips slightly upon said finishing surface as it dries and yet it may acquire a finish which to the unaided eye is substantially equal to that of the best cast-surface coated paper as defined above. Such paper is likewise included herein under the designation drum-finished coated paper.

In the early production of cast-surface coated paper, a layer of aqueous coating composition containing mineral pigment or filler and adhesive was spread on a paper web and thereafter, before the coating had dried, the coated surface was pressed into contact with a heated chromium plated cylinder against which the paper was dried. This process was disclosed in the Bradner U.S. Patent No. 1,719,166.

Results obtained by the early process were erratic, for it was found to be almost impossible to produce coated paper having a surface which was entirely free from uncast areas or blotches. Such defects were frequently attributed, probably with considerable justification, to air-pockets formed by air trapped between the layer of coating and the finishing surface. Indeed it appears doubtful that it would be possible to operate the early process without trapping air except under circumstances such that the surface of the coating would be still liquid at the instant of contact with the finishing surface.

Assurance of adequate liquidity of the surface of the layer of coating as well as avoidance of air entrapment is provided by a later process of making cast-surface coated paper in which a pool of aqueous coating composition is supplied at the entrance to the nip where the surface of the coating and the metal finishing surface come into contact. The same objectives can likewise be attained by an improved process according to which a layer of coating is reformed on a paper web and then is pressed against the heated finishing surface while the entrance to the nip between the surface of the coating and the finishing surface is kept filled by a pool of water or aqueous solution.

It is apparent that in practicing the process which uses a pool of coating composition in the entrance to the nip it is undesirable to have the pool at boiling temperature. Hence in that process it is not feasible to make use of finishing drum temperatures of 100° C. or higher in order to achieve speeds of operation comparable to the speed of other conventional coating procedures.

2

When the entrance to the nip is filled by a pool of water or aqueous solution either paper having thereon a previously dried layer of coating or freshly applied and still wet coating may be passed through the pool and into firm contact with the heated finishing surface. In either case it may be found that suddenly plunging the coated paper into a pool of boiling water in the entrance to the nip may have undesirable results. For instance, sudden expansion of air in the pores of a previously dried coated web when it enters the boiling pool may cause disruption of the coating. In the same way air dissolved in a wet layer of freshly applied coating may be released therefrom by the sudden rise in temperature resulting from entrance into a pool of boiling water. Furthermore many, if not most, coatings which are capable of being satisfactorily molded or cast by being pressed while wet against a hot finishing surface are not sufficiently resistant to withstand the action of boiling water unless they have been to some degree conditioned for such treatment.

It has now been discovered that several benefits result from the practice of releasing steam into contact with the coated surface of the paper in close proximity to the point where said coated surface comes into contact with the finishing surface and/or releasing steam into the entrance of the nip between the coated paper and the finishing surface. One benefit is a considerable increase in possible speed of operation. Other benefits will become apparent hereinafter.

According to the invention a moving web of paper having thereon a layer of coating containing pigment or filler and adhesive and which may be either dry or freshly applied and still wet is brought to a moving finishing surface and steam is emitted or generated near the coated surface of the web so that the steam comes into contact with said coating shortly before the coating is pressed into contact with the finishing surface. The steam is preferably emitted from a slit orifice which extends across the width of the paper web and directs the steam generally in the direction of the nip where the coated paper is pressed against the finishing surface. The jet or current of steam is effective in sweeping air from the entrance to said nip.

If desired the jet of steam may impinge against the coating on the web somewhat in advance of the entrance to the nip and thence be deflected toward the nip to sweep air therefrom. Alternatively the jet may be directed into the nip and then be deflected back to sweep across the surface of the coated paper approaching the nip. In cases where the coating has previously been satisfactorily conditioned, the steam may be provided solely by the boiling of a bead of water in the entrance to the nip. The water to form the bead may be carried into the nip entrance on the surface of the coating, or it may be trickled or injected into the entrance to the nip in any desired manner. Generation of steam in the aqueous pool itself may be accomplished by absorption of heat from contact with the surface of a casting drum having a surface temperature considerably above the boiling temperature of the aqueous liquid in the pool. Even in the case when steam is generated from an aqueous pool in the entrance to the nip it is generally preferred also to supply additional steam from an outside source.

Steam directed into the entrance of the nip is adequate to prevent entrapment of air in the nip even if no liquid pool is present in the nip entrance. If the steam used is either wet steam or dry saturated steam a film of water will be condensed on the surface of the coating and there is generally sufficient liquid water separated or condensed to form a small bead or pool of liquid at the nip entrance. Ordinarily the formation of such a bead of

3

liquid is not disadvantageous; on the contrary, in many cases such a bead is actually useful as a safeguard to ensure that the surface of the coating is sufficiently moist for good casting or molding at the instant it comes in contact with the finishing surface. When the steam used according to the invention is superheated steam it is especially advantageous to have a bead or pool of liquid at the nip entrance. If insufficient steam is condensed to form such a liquid bead or pool it may in some cases be advisable to supply liquid to the nip entrance from some other source.

In the past it has been suggested to use steam to add moisture to or to soften a previously dried coated paper to aid in plasticizing the coating sufficiently to make it moldable on a casting drum. Such steaming, however, has been done at a distance from the finishing drum, and has not produced the results obtainable by practice of the present invention.

In the present invention steam contacts the surface of the layer of coating on the paper web near the entrance to the pressure nip where the coated surface is pressed against the finishing surface, so that the coated surface, from the moment the steam first strikes it, is hereafter continuously bathed with steam and/or a pool of water until the coating actually comes into contact with the finishing surface. Thus air is excluded from contact with the coating after it has been steamed, and the coating is delivered to the casting surface in a moist and air-free condition. Moreover, the web after having been steamed is delivered to the finishing surface still in a pre-heated condition which in itself makes possible some increase in speed of operation.

Furthermore, steaming the coated paper and keeping it enveloped in a cloud of steam is effective for removing air which may be entrained or dissolved in a freshly applied layer of coating on a paper web. If the paper has a dried coating thereon, treatment with steam moistens said coating and displaces air from the pores and interstices therein. Likewise, steam impinging on a coating, whether freshly applied or previously dried, may penetrate into the underlying paper web to displace therefrom air which is included in the interstices thereof or adsorbed on fiber or filler therein. Removal of such air is especially advantageous when using high temperatures at the finishing surface to obtain increased speed. Steaming not only lessens the liability of formation of blow-holes in the coating by removal of air from the web and coating layer, but also, by eliminating the insulating effect of adsorbed air, conditions the web for faster and more effective transmission of water vapor so that more rapid drying can be accomplished.

In some cases treatment with superheated steam is even more effective than the use of wet or dry saturated steam in conditioning the coated web to render the coating capable of withstanding passage through a pool of boiling water or water solution in the entrance to the casting nip. Coatings containing thermosetting resins or proteins which are hardenable by heat may be considerably hardened or toughened by exposure to the superheated steam. Coatings which are hardenable by removal therefrom of some volatile constituent such as ammonia, when treated by superheated steam may readily give up said volatile constituent and so become toughened enough to be cast or drum-finished when firmly pressed on a finishing surface considerably above 100° C. in temperature. Furthermore the action of superheated steam on a wet coated web can quickly reduce to a considerable degree the quantity of liquid water present in the coating and/or the underlying web, so that less remains to be evaporated while the coating is in contact with the finishing surface.

It is apparent that while the wet coating of a coated paper is being dried in contact with an impermeable finishing surface, such as a casting-drum, water evaporated

4

from the coating must escape from the exposed surface of the paper web after having passed through said web from the coating. The speed of drying in such a case depends, therefore, upon both the rate of transmission of water through the web and the total quantity of water that has to be transmitted. As pointed out previously conditioning the web with steam to remove air therefrom aids in improving transmission of water vapor through the web.

Probably the surest procedure for insuring that the surface of the coated paper going to the casting-drum is sufficiently wet for good casting is to pass the coated surface through a pool of water in the entrance to the casting-nip. At drum temperatures below 100° C., however, some excess water may be carried through the nip in this procedure. On the other hand if the temperature of the finishing drum is well above 100° C., then water at the entrance to the nip will boil vigorously and steam generated in the point of the V forming the entrance to the nip will push back the liquid water above it and substantially completely prevent water in the pool from actually entering the nip between the casting surface and the coated paper. Thus the water which has to be evaporated through the web is kept substantially to a minimum with corresponding advantage in speed of operation.

Accordingly the preferred procedure is to steam the surface of a coated paper, then immediately pass the coated surface through a shallow pool (less than about ½ inch in depth) of boiling water and then firmly press the coated surface into contact with a heated polished metal surface having a temperature above 100° C. In some cases, especially when the layer of coating contains ingredients which are caused to react or harden by heat, it is advantageous to use superheated steam for steaming the coating before it enters the pool of boiling water. In any case it is intended to contact the coating with steam and thereafter keep the surface of the coating moist and exclude air from contact therewith until the moist coating is pressed into contact with a heated finishing surface.

Apparatus suitable for carrying out the different embodiments of the invention referred to above and in the specific examples given below are diagrammatically illustrated in the accompanying drawings in which

Fig. 1 is a diagrammatic end elevation of apparatus designed to apply wet steam to the paper coating adjacent to the entrance to the nip,

Fig. 2 is a diagrammatic end elevation of apparatus designed to inject steam into the entrance to the nip,

Fig. 3 is a diagrammatic end elevation of apparatus designed to apply superheated steam to the coated paper web adjacent to the entrance to the nip and to supply water or aqueous solution to the entrance to the nip, and

Fig. 4 is a diagrammatic end elevation designed to illustrate the position of a pool of boiling water in the entrance to the nip, regardless of how the pool is formed.

In Fig. 1, 1 is the finishing drum, 2 is the pressure roll which serves to press the coated paper into contact with the surface of the finishing drum, 3 is the coated paper web which may be either dry or freshly coated, 4, 4 are carrier rolls for conveying the paper web toward and away from the finishing drum, 5 is a nozzle having a slit orifice for directing a jet of wet steam against the coating on the paper web and 6 is a bead or pool of water which accumulates in the entrance to the nip between the paper web and the finishing drum. The roll 2 preferably is formed of an elastic material or has an elastic outer layer such as rubber as disclosed in for instance U.S. Patent No. 2,316,202.

In Fig. 2 the parts of the apparatus are the same as in Fig. 1 excepting that no substantial pool of water is maintained in the nip and the nozzle 5 is positioned to direct the jet of steam directly into the entrance to the nip.

In Fig. 3 the parts of the apparatus are the same as in

5

Fig. 1 excepting that the nozzle 5 is designed to deliver superheated steam and the pool 6 is maintained by delivering water or aqueous solution thereto from a valved pipe 7.

In Fig. 4, as in Figs. 1 and 3, 1 is the finishing drum, 2 the pressure roll, 3 is the coated paper web, 5 is the steam nozzle and 6 is the pool of water. In this figure I have shown a cloud of steam 8 bathing the surface of the coated paper web adjacent the nozzle 5 and a film of water 9 on the paper web, formed by the cloud 8 and following the paper web into the pool 6. This figure also illustrates the pocket of steam 10 at the entrance to the nip, i.e. between the nip and the pool 6. In this embodiment it is assumed that the pool 6 is boiling and that the drum 1 is at a temperature sufficient to maintain the steam pocket 10 i.e. above 100° C.

In general, because of the obvious advantage of the possibility of resulting increased speed of operation, it is preferred to operate with the surface of the finishing drum at a temperature above 100° C. This is not to intimate, however, that the invention is not useful also when lower drum temperatures are used. Thus good results have been obtained according to the invention when the surface of the drum has ranged from about 80° C. to about 140° C. The optimum drum temperature has been found to depend both upon the composition of the layer of coating and upon the treatment the coating has received prior to being brought into contact with the drum.

The invention is illustrated by the following specific examples.

Example 1

To one side of a moderately sized paper web weighing about 96 grams per square meter was applied by means of an air-knife coater a layer of about 23 grams, dry weight, per square meter of an aqueous coating composition of about 45% solids content including the following ingredients in the proportions stated: paper-coating clay 60, fine calcium carbonate 40, casein solvated by ammonia 15, styrenebutadiene copolymer (added as a latex) 6, sulfonated tallow (release and anti form agent) 1.

The coated web, while the coating was freshly applied and still wet, was run with its coated side into contact with a polished chromium-plated drum maintained at about 85° C. while a jet of steam was supplied in one instance as shown in Fig. 1 and in another instance as shown in Fig. 2. In both instances the coating was dried in contact with the drum and when removed therefrom had a fine cast surface.

Example 2

A web of dry coated paper having on its surface a smooth and level layer of coating containing the following materials:

	Parts by weight
Paper coating clay	70
Fine calcium carbonate	30
Casein solvated by monoethanolamine	20
Stearate of monoethanolamine	1

The coated side of the web was pressed into contact with a rotating polished chrome plated drum maintained at about 95° C. and the coating was vigorously steamed prior to contact with the cylinder in one instance with wet steam as illustrated in Fig. 1 and in another instance with superheated steam as illustrated in Fig. 3. In both instances the sheet, after being dried in contact with the drum was found to have a fine cast surface.

Example 3

To a web of paper having on its surface a dry base coat of clay, calcium carbonate and casein was applied by means of a blade coater a layer of ammoniacal aqueous coating composition amounting to 15 grams, dry weight, per square meter containing the following materials in the proportions given:

6

Paper coating clay	100
Casein solvated by ammonia	18
Styrene-butadiene copolymer (in form of latex)	7
Aluminum tartrate complex	2
Ammonium stearate (release agent)	1
Tributyl phosphate (anti foam agent)	0.5

The freshly coated web was fed to a casting drum and on its way was steamed copiously with superheated steam as illustrated in Fig. 3 to displace ammonia from the coating and cause gelation of the coating. The coated surface, cloaked by steam, passed through a pool of boiling water as illustrated in Fig. 4 and then immediately was pressed into firm contact with the polished chromium plated drum which had a surface temperature of about 115° C. The dried paper had a good cast finish.

I claim:

1. Process which comprises imparting translatory motion to a web of paper bearing a water-wettable surface layer of coating containing mineral pigment and adhesive material, directing steam against said layer of coating, thereafter maintaining said layer of coating out of contact with air and delivering it in a moist and heated condition into firm contact with a heated metallic finishing surface, eliminating water from said layer of coating and removing and carrying away the coated web from said finishing surface.

2. Process as defined in claim 1 in which the coating on the web is a predried coating when the steam is directed against it.

3. Process as defined in claim 1 in which the coating on the web is a wet coating when the steam is directed against it.

4. Process as defined in claim 1 in which the steam is superheated steam.

5. In a process of drum-finishing coated paper the steps of coating a paper web, passing the coated web through a nip between two rolls one of which is provided with a finishing surface with the coated side of said web against the said finishing surface, and substantially eliminating air adjacent to and entrapped in the surface of said coating by directing steam into the entrance to said nip on the inlet side thereof.

6. The process of drum-finishing coated paper as defined in claim 5 in which the surface of said coating is wetted by maintaining a pool of aqueous liquid in the entrance to said nip.

7. In a process of drum-finishing coated paper the steps of coating a paper web, heating said coated web, eliminating liquid moisture from said coated web and eliminating entrapped air from within said coated web by subjecting said coated web to superheated steam and thereafter passing said coated web through the nip between two rolls one of which is provided with a finishing surface with the coated side of said web against said finishing surface.

8. The process of drum-finishing coated paper as defined in claim 7 in which a pool of aqueous liquid is maintained in the entrance to said nip so that the surface of said coating is superficially moistened at the point of entrance of said coating into said nip.

9. Process which comprises applying to a moving web of paper a layer of aqueous coating composition, thereafter while the said layer of coating is in plastic condition pressing the coated side of the paper into firm contact with a heated polished metallic finishing surface, and blowing steam into the space adjacent the line of first contact between said coated surface and said finishing surface whereby entrapment of air between said surfaces is substantially prevented.

10. In a process of drum-finishing coated paper where-in the wet and plastic surface of a coated paper is pressed and dried against a heated polished finishing surface the step of blowing steam into the space adjacent the entrance of the nip wherein the coated surface contacts the finishing surface thereby to sweep air from the said space.

7

11. Process which comprises applying to a moving web of paper a layer of aqueous coating composition, heating the coating by contacting the exposed coated surface with steam, and immediately thereafter while excluding air from contact with the coated surface and while the layer of coating is still plastic pressing the coated side of the paper into firm contact with a heated polished metallic finishing surface, and drying the surface of the coating while it is in such contact.

12. In a process of drum-finishing mineral-coated paper wherein the wet and plastic surface of a coated paper is pressed and dried against a heated polished finishing surface the improvement which comprises forming a film of water on the surface by condensing steam thereon and immediately thereafter while excluding air from contact therewith pressing the coating against said finishing surface.

8

13. In a process of drum-finishing mineral-coated paper wherein a gelled, but still wet and plastic layer of mineral-coating borne by a paper web is pressed and at least partially dried against a heated polished finishing surface, the improvement which comprises the steps in quick succession of exposing the wet coated surface to an atmosphere of steam, passing the coated surface from said atmosphere of steam while excluding contact with air into and through a pool of boiling water, and pressing the wet coating firmly against a heated polished finishing surface.

References Cited in the file of this patent

UNITED STATES PATENTS

15	1,719,166	Bradner	July 2, 1929
	2,678,890	Leighton	May 18, 1954
	2,780,563	Frost et al.	Feb. 5, 1957