Aug. 18, 1936. S. BOYER ET AL 2,051,403

PAPER COATING

Filed July 16, 1930 2 Sheets-Sheet 1

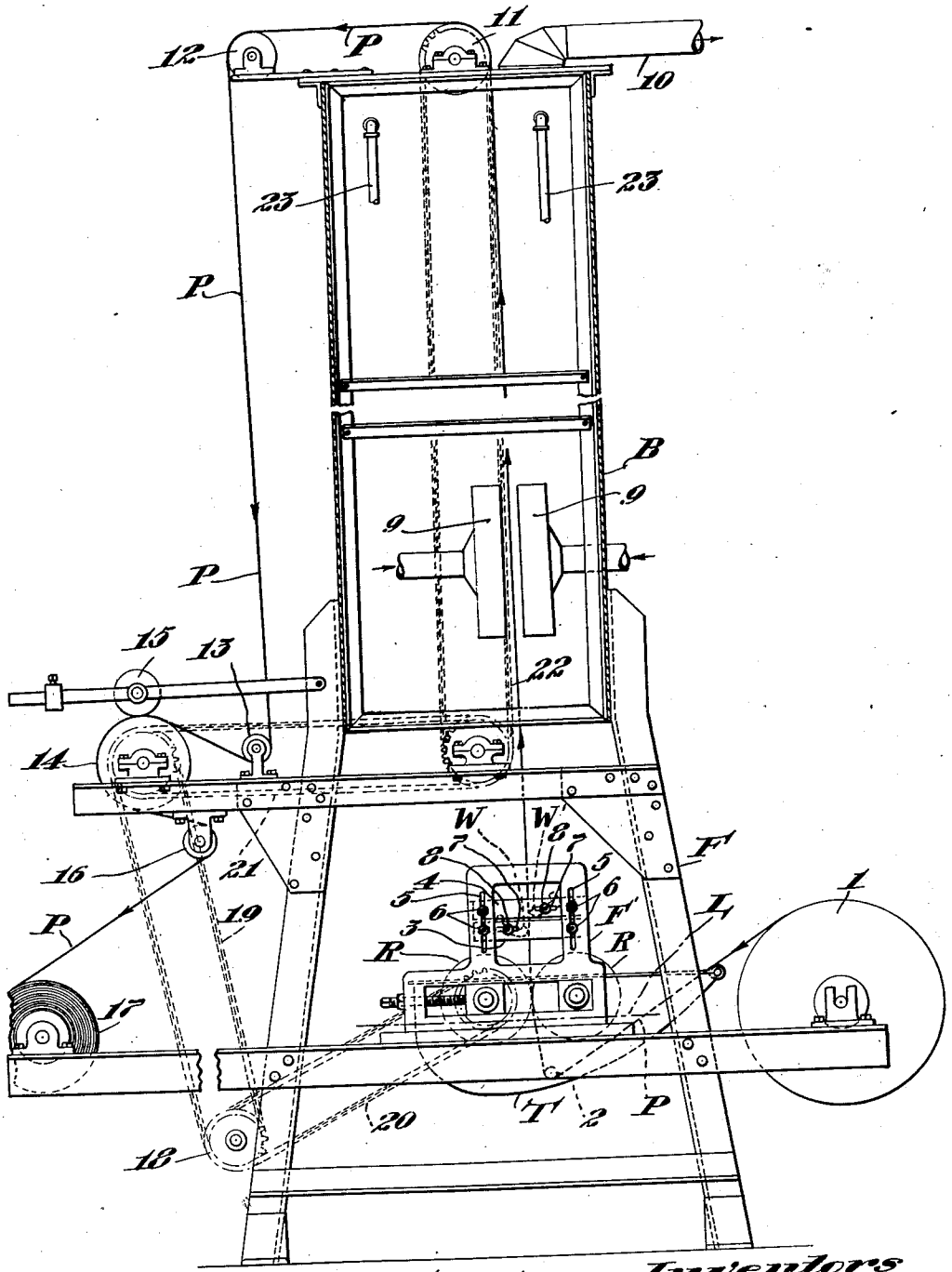


Fig. 1

Inventors
Sylvester Boyer
LeClare F. Parmeter
by Fabiato, Cushman & Woodberry
Their Attorneys

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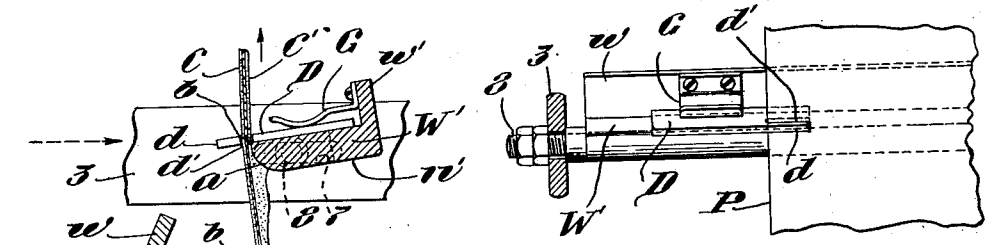


Fig. 4

Fig. 2

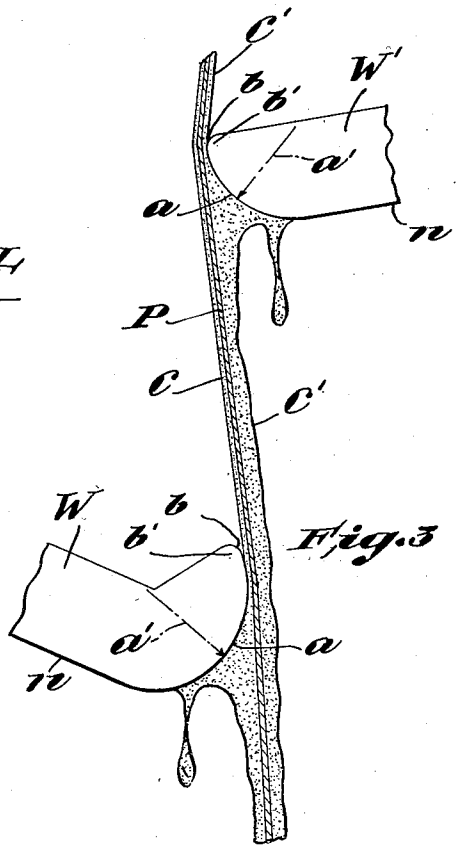


Fig. 3

Inventors
Sylvester Boyer
LeClare F. Parmenter
by Roberts, Cushman & Woodbury
their Attorneys

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PAPER COATING

Sylvester Boyer and Le Clare F. Parmenter, Portland, Maine, assignors to S. D. Warren Company, Boston, Mass., a corporation of Massachusetts

Application July 16, 1930, Serial No. 468,260

16 Claims. (Cl. 91—53)

This invention relates to the art of coating paper and is here presented in its aspects of method and mechanism. The main object of the invention is to coat paper more smoothly, and more expeditiously than by the methods heretofore generally practiced, whether the paper be coated on one side at a time, or on both sides simultaneously; obviously this object will be best served by the latter mode, and therefore sundry features of invention are concerned with this preferred mode of operation.

Any of the coating compositions employed in paper making may be employed; a typical example is a composition of china clay and starch in water. To secure the full advantage of the improvements herein to be described, however, the composition should be decidedly more viscous than those generally employed in normal paper mill practice, so that the time required to evaporate the water content down to the optimum percentage for the final coat forming and smoothing operation may be reduced to a minimum; and so that the residual coating left on the paper shall, as it leaves the smoothing instruments, be of such firm consistency that it will not flow, even if the paper surface be vertical.

In a coating machine such as that presently to be described, a composition of viscosity 600 to 800, as measured by the MacMichael viscosimeter with its disc rotating at from 40 to 50 turns per minute, has been found satisfactory.

In the drawings hereto annexed, of a coating machine exemplifying, in structure and mode of operation, the inventions herein claimed,

Fig. 1 shows the coating machine, partly in side elevation, partly in vertical section;

Fig. 2, the squeeze-rolls and coating-wipers, in detail and on a relatively large scale;

Fig. 3, the coating-wipers, in detail and on a still larger scale; and

Fig. 4, a detail of the back-scraper attached to a coating-wiper, on the same scale as Fig. 2, viewed in the direction indicated by the dotted arrow in Fig. 2.

The general assembly of the coating machine is shown in Fig. 1, in which F designates a supporting frame, B a vertical box, provided at top and bottom with openings to permit the passage of a paper web or strip P; a sub-frame F′ which supports the coating tank T, squeeze-rolls R, R, and coating-wipers W, W′. Coating material is maintained at a suitable level, such as L, in the tank T.

Paper P, drawn from a supply roll 1, passes under a guide roll 2, located in the tank T below the surface of the liquid coating material, thence upward between the squeeze-rolls R, R, which are adjusted to reduce the load of coating material adhering to the paper to a predetermined regular quantity. From the rolls R the paper P passes over the wipers W, W′, in succession; these wipers are horizontally adjusted so that the paper, with its adhering coating material, is stressed against the working faces of the wipers (see Figs. 2 and 3). The wipers W, W′ are mounted at each end on bars 3, 4, which are vertically adjustable in slots 5, 5, by means of nuts 6, 6. The horizontal adjustment of the wipers is obtained by means of slots 7, 7, and nuts 8, 8 (see also Figs. 2 and 4).

From the wipers W, W′, the paper passes upward into, through, and out of, the box B. Drying air is blown against the coated paper by the air-chests 9, 9; the air eduction pipe is shown at 10. Steam coils, indicated by 23, may also be provided. After emergence from the box B, the paper P, on which the coating material has been set by drying, passes over rolls 11, 12, and 13, to the draft roll 14, which is preferably a felt covered roll, over roll 16, to the winding-up roll 17. Rolls 13 and 16, and the pressure roll 15, provide for effective draft action by roll 14 on the paper strip P.

Power is applied to the shaft of the sprocket wheel 18; sprocket chains 19, 20, 21, and 22 drive the rolls R, R, 11 and 14.

The salient instrumentalities in the coating machine, above generally described, are the wipers W, W′, and their immediate adjuncts. Each wiper consists of a metal bar, made rigid by the provision of integral webs (w, w'); hard bronze has proved to be an excellent material of which to make these bars. The active surfaces of the wipers are (generally speaking) cylindrical in character, and preferably comprise surfaces a, of major radius a', and b, of minor radius b' (see Fig. 3); a major radius of ¾ inch and a minor radius of $^3/_{64}$ inch has been found suitable. Experiment has demonstrated that relatively gradual approach to, and relatively abrupt departure from the wiper-surfaces by the coated paper surface, constitutes a preferable condition and conduces to regularly good results, and that while a working compromise can be reached by the use of a cylindrical working face of one radius (intermediate between the major and minor values above recommended), such a compromise condition is not wholly dependable.

The wipers W and W′ are, by means of the slots 7, 7, and set-nuts 8, 8, adjusted horizontally so that the moving strip of paper is drawn against each wiper-face with pressure sufficient

to wipe back the surplus of viscous liquid coating material and thus to leave attached to the paper the predetermined weight of coating; and in inclination so that the line of departure of paper from wiper face shall be from that part of the face which has the minor radius of curvature. Also, the wipers are so designed that, when thus presented to the paper, their under surfaces *n*, *n'*, incline upwardly from the surfaces *a*, *a*; this detail of conformation prevents surplus coating material from running back and caking on the wipers.

The vertical spacing, the horizontal overlap, and the distance from the nip of the squeeze-rolls to the lower wiper, are all variable, and will be determined in practice to meet variations in the character and consistency of the coating material, the weight of coating to be laid on the paper, the quality and type of the paper, and the rate of paper-travel; perhaps also, the atmospheric conditions. Adjustments should be made to the end that the coating material, while still sufficiently fluid to be in part wiped back and removed from the predetermined residue which is to be permanently fixed on the paper, shall be of such consistency as not to run by its own weight after its thickness has been reduced by the action of the wiper.

The squeeze-rolls R, while contributorily useful in regulating the weight and thickness of coating material which is to be acted on finally by the wipers, may be dispensed with, though this is not recommended.

Theoretically, and if perfectly uniform smooth consistency of coating material could be guaranteed, the two wipers W and W' might be placed in opposition to each other; their arrangement in succession of operation is advantageous as providing that each shall be opposed only by the tension of the unsupported paper web or strip, for automatic adjustment of the thickness of the coating in response to the plastic insistence or viscosity of the coating, and for relief if and when a lump of coating material or other abnormal object is carried into the load of coating on the paper. With directly opposed wipers, also, it is difficult to obtain and maintain that nice adjustment which is indispensable if the final coating layer on either side of the paper is to be uniform in thickness.

With the described preferred mode of vertical spacing of the successively operating wipers, the coating load C' (Fig. 2) creeps around the edges of the paper P to the opposite side and marginally overlies the coating C after the latter has been wiped down to its final weight by the wiper W. A back-scraper (Figs. 2 and 4) is provided at each end of wiper W' to remove such coating material. This instrument consists of a metal plate D, deeply notched at *d'* to form the scraping finger *d*, and held in place on the upper surface of the wiper W' by means of a stout holding-down leaf-spring G, secured to the upstanding flange *w'*. The finger *d* is made long enough to reach and remove any coating material which has crept around the edge of the paper. One only of the necessary two back scrapers is shown in the drawings.

The operation of the above-described coating machine is as follows:

The paper strip, rising from the pool of coating material in the tank T, carries with it a layer of viscous liquid coating, on each side; these layers are first reduced in thickness by the action of the squeeze-rolls R, R,—which leave layers in excess of the predetermined final weight of coating still adhering to and carried by the paper. The paper is drawn against the smooth curved acting face of wiper W, making relatively gradual approach as the viscous coating yields to displacement by the wiper under the resultant force of the longitudinal tension on the paper strip to that part of the wiper face which has the curvature of major radius. This radius may be very large, even to infinity. The excess of still fluid coating material is wiped back by the wiper, a pool—so to speak—of coating material forms below the line of initial pressure between the longitudinally tense paper and wiper-face, and from this pool the excess flows back over the paper strip to the squeeze-roll beneath, by which it is carried into the tank. By reason of the upward inclination of the lower side of the wiper, the coating material accumulating between the wiper-face and the paper can not run back on to the wiper and dry there, but must flow or drip down to the squeeze-roll. The action of the portion of the wiper-surface of major radius is to wipe back liquid coating material, reducing the thickness of the layer progressively, until the layer attains that degree of thinness at which force of adhesion to the paper overmasters the wiping-back effect of the wiper. After the paper strip has passed this point where the wiper ceases to remove fluid material from the layer, the wiper surface exerts a frictional smoothing effect on the residue which clings to the paper, until the paper reaches the part of the wiper face which has the minor radius of curvature. From this more abruptly curved surface the paper and its residue of coating makes an abrupt departure, of which the effect is to leave the coating smooth, free from ridges, depressions, pits, or pimples. This residue, which ultimately forms the coating on the finished paper, while still containing water, to be subsequently evaporated, is of such consistency, and so closely adherent to the paper, that on leaving the wiper surface, it is fixed, and incapable of internal flow in response to gravitative force. The performance of the wiper W' on the other side of the paper is in all respects like that of wiper W. With any selected horizontal adjustment of the wipers in relation to each other and the paper strip, each wiper will, by rotative adjustment, be given that inclination which will ensure the approach of the paper to, and its departure from, the wiper surfaces in the manner above described. After the coating has been thus treated, the passage of the paper strip through the drying box B sets the coating and the process is completed.

The curvatures of the wiper faces need not be circular (in section); that of the wiping portion, represented by the surface *a* in Figs. 2 and 3 may be of any conformation consistent with performance of the desired function, viz: removing or wiping back fluid coating material in excess of that which, by its adhesion to the paper effectively resists displacement by said wiping action; that of the portion represented by the surface *b* may be of any conformation between two limiting conditions, viz: a sharp edge, which experiment has demonstrated to be liable to produce ridges in the residual coating, and a surface of large-radius curvature, from which the departure of the coated paper surface is so gradual as to permit adhesions to form between the said wiper surface and the coating material, with consequent production of pimples or pits, or both, on the coating, which, under the conditions pre-

scribed, is incapable of fully healing such blemishes by internal flow.

The weight of coating per unit area of paper is regulable by adjustment of the following factors: First, the consistency or viscosity of the coating composition; second, the time of exposure of applied coating material to evaporative agencies before subjecting it to the action of the wiper; third, the stress of the paper sheet against the working face of the wiper, and fourth, the angle of inclination of the curved surface of major radius of the wiper, relative to the plane of the path of travel of the web or paper sheet. It is here assumed that the rate of movement of the paper strip is a constant, and at the maximum found practicable. When constant values of the three variables above named are determined and maintained, the weight of coating material per unit of paper area in the finished product will be the solid residue of that fraction of the originally applied layer of fluid coating which, by force of adhesion to the paper effectively resisted displacement by the wiper.

Since return-flow of the wiped-back excess of a fluid layer of coating is a characteristic of this method, and of the operation of a coating machine exemplifying the principle of the invention, the direction of the paper-strip movement, at the point of wiper-application should preferably be upward and substantially vertical, that is to say, a direction consistent with gravitative back-flow of the removed excess of coating composition. The word "vertical" (with its correlatives) is herein used in this general sense, and not necessarily in the strict sense, although for the preferred method of simultaneously coating both sides of a paper strip, truly vertical movement thereof is the best adapted.

Nevertheless, while the upward and substantially vertical movement of the paper strip to and through the system of coating instruments appears to be on the whole preferable, suitable means for applying coating, and removing excess coating, while performing the characteristic wiping and smoothing operations above described, may readily be contrived by persons skilled in the art and made familiar with the principles on which the herein described apparatus works, to adapt it either to downward vertical movement of the paper strip, or to movement in a horizontal direction.

We claim:

1. In a paper coating machine, paper-strip moving means, means to apply fluid coating composition to the paper, a wiper mounted to press against the coated surface of the moving paper at a point in the travel thereof where the composition thereon is still fluid, said wiper furnished with a surface of major radius to which the paper approaches, and a curved surface of minor radius from which the paper departs, whereby a portion of the composition applied to the paper is wiped back and an immobile residue left adherent to the paper, and means for setting said adherent residue.

2. In a paper coating machine, paper-strip moving means, means to apply fluid coating composition to both sides of the paper, two curved-surfaced wipers mounted to press in succession against opposite coated surfaces of the paper strip while the composition thereon is still fluid, back-scrapers applied to the margins of the paper strip on the side thereof treated by the first wiper to act thereon, whereby a portion of the composition applied to the paper is wiped back and an immobile residue left adherent to both sides of the paper, and means for setting said adherent residue.

3. In a paper coating machine, paper-strip moving means, means to apply fluid coating composition to both sides of the paper, two wipers mounted to press in succession against opposite coated surfaces of the paper strip while the composition thereon is still fluid, each wiper furnished with a surface of major radius to which the paper approaches, and a curved surface of minor radius from which the paper departs, whereby a portion of the composition applied to the paper is wiped back and an immobile residue left adherent to both sides of the paper, and means for setting said adherent residue.

4. In a paper coating machine, paper-strip moving means, means to apply fluid coating composition to both sides of the paper, two wipers mounted to press in succession against opposite coated surfaces of the paper strip while the composition thereon is still fluid, back-scrapers applied to the margins of the paper strip on the side thereof treated by the first wiper to act thereon, each wiper furnished with a surface of major radius to which the paper approaches, and a curved surface of minor radius from which the paper departs, whereby a portion of the composition applied to the paper is wiped back and an immobile residue left adherent to both sides of the paper, and means for setting said adherent residue.

5. In a coating machine of the type having means for moving a web under longitudinal tension and means for applying a fluid coating composition to one of its faces, a wiper mounted to press against the coated surface of the moving and tense web, said wiper having a curved surface of major radius to which the web approaches, and a curved surface of minor radius from which the web departs, whereby a portion of the coating composition applied to the web is wiped back and an immobile residue left adherent to the face of the web.

6. In a coating machine of the type having means for moving a web and means for applying a fluid coating composition to one of its faces, a wiper mounted to press against the coated surface of the moving web in opposition to the tensile stress on the web, said wiper having a curved surface of major radius to which the web approaches, and a curved surface of minor radius from which the web departs, whereby a portion of the coating composition applied to the web is wiped back and an immobile residue left adherent to the face of the web, and means for adjusting said wiper to vary the angle of inclination of its curved surface of major radius, relative to the plane of traverse of the web, whereby to regulate the amount of coating left on the web.

7. In a coating machine of the type having means for moving a web in a tense state in a substantially vertical path and means for applying a fluid coating composition to the face of the moving web, a wiper mounted to press against the coated surface of the moving web, said wiper having a curved surface of major radius to which the web approaches, and a curved surface of minor radius from which the web departs, whereby a portion of the coating composition applied to the web is wiped back and an immobile residue left adherent to the face of the web, and means for adjusting the horizontal and angular position of said wiper, relative to the path of the moving web, whereby the tension on and the

amount of coating applied to said web may be regulated.

8. In a coating machine of the type having means for moving a web in a substantially vertical path and means for applying a fluid coating composition to the face of the moving web, a wiper mounted to press against the coated surface of the moving web and hold the same under tension, said wiper having a curved surface of major radius to which the web approaches, a curved surface of minor radius from which the web departs, and an under surface inclined upwardly from the path of the moving web, whereby surplus coating material is continually fed back to the unwiped face of said web.

9. Method of coating paper, comprising applying a layer of fluid composition to the surface of a paper strip, moving the coated paper strip longitudinally, under tension, and subjecting the same to a wiping action, comprising a gradually increasing wiping pressure followed immediately by a less gradually decreasing wiping pressure.

10. Method of coating paper, comprising applying a layer of fluid composition to the surface of a paper strip, moving the coated paper strip longitudinally, under tension, and subjecting the same to a wiping action comprising a gradually increasing wiping pressure followed immediately by a less gradually decreasing wiping pressure, and leaving adherent to the paper a coating of an immobile residue of a thickness determined by the tension of the strip and the viscosity of the coating.

11. Method of coating paper, comprising applying layers of fluid coating composition to the two surfaces of a paper strip, moving the coated paper strip longitudinally, under tension, and subjecting the same, on both sides of the sheet, to a wiping action comprising a gradually increasing, followed immediately by a less gradually decreasing wiping pressure.

12. Method of coating paper, comprising applying layers of fluid coating composition to the two surfaces of a paper strip, moving the coated paper strip longitudinally, under tension, and subjecting the same, on both sides of the sheet, to a continuous wiping action comprising a gradually increasing, a sustained, and a less gradually decreasing wiping pressure.

13. Method of coating paper, comprising applying a layer of fluid coating composition to the surface of a paper strip, moving the coated paper strip longitudinally, under tension, and subjecting the same, on the coated side of the sheet, to a continuous wiping action comprising a gradually increasing, a sustained and a less gradually decreasing wiping pressure.

14. Method of coating paper, comprising applying a layer of fluid coating composition to the surface of a paper strip, moving the paper longitudinally under tension, diverting the path of the paper first through a curve of major radius and then through a curve of minor radius and simultaneously wiping back from said layer a portion of the fluid coated composition, leaving adherent to the paper a coating of immobile coating residue.

15. Method of coating paper, comprising applying a layer of fluid coating composition to the surface of a paper strip, moving the paper longitudinally under tension, diverting the path of the paper first through a curve of major radius and then through a curve of minor radius and simultaneously wiping back from said layer a portion of the fluid coating composition, leaving adherent to the paper a coating of immobile coating residue of a thickness determined by the tension of the strip and the viscosity of the coating.

16. In a paper treating apparatus, means for applying an excess of aqueous mineral coating composition to a web of paper, means for moving the paper longitudinally and a rounded leveling device to contact with the coated side of the paper to remove excess coating composition and leave residual coating composition in the surface of the paper, said leveling device having a radius of curvature of not more than $\frac{5}{32}$ inch at the point where the paper leaves the scraper and a greater radius of curvature at the point where the paper first contacts the leveling device.

SYLVESTER BOYER.
LE CLARE F. PARMENTER.