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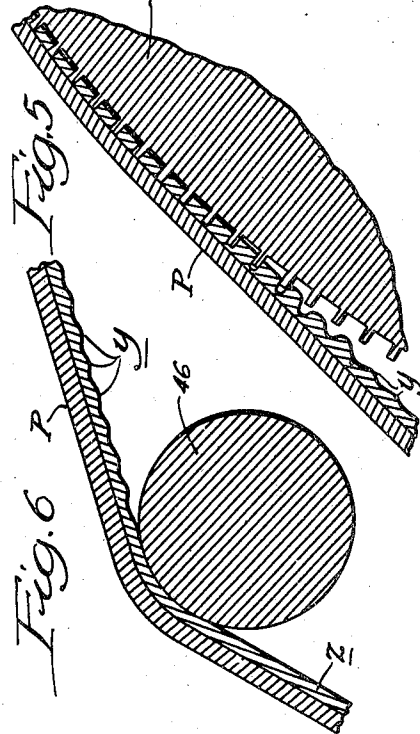
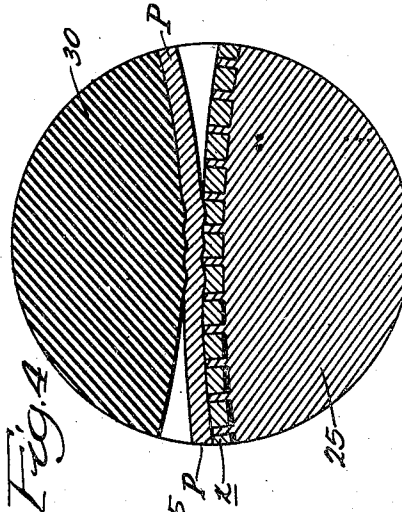
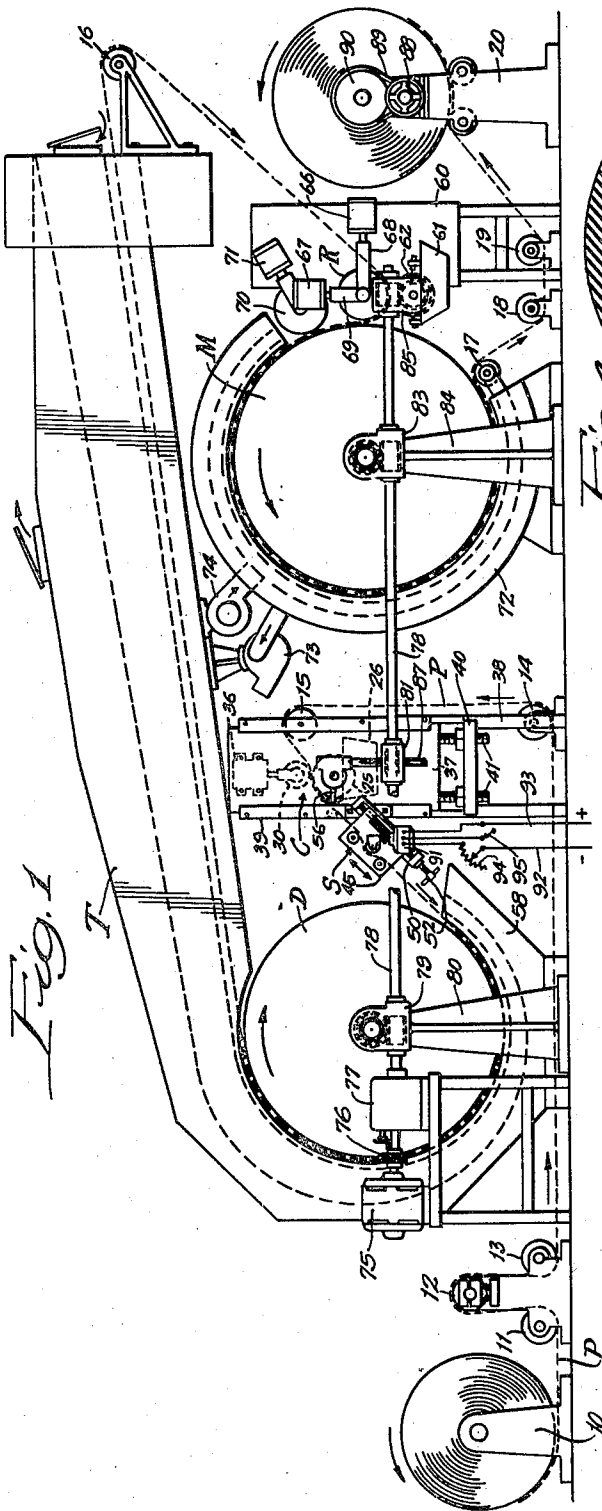
W. F. GRUPE

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MACHINE FOR COATING PAPER

Filed Nov. 9, 1942

3 Sheets-Sheet 1



Inventor.
William F. Grupe,
By *William F. Grupe*
Attorney

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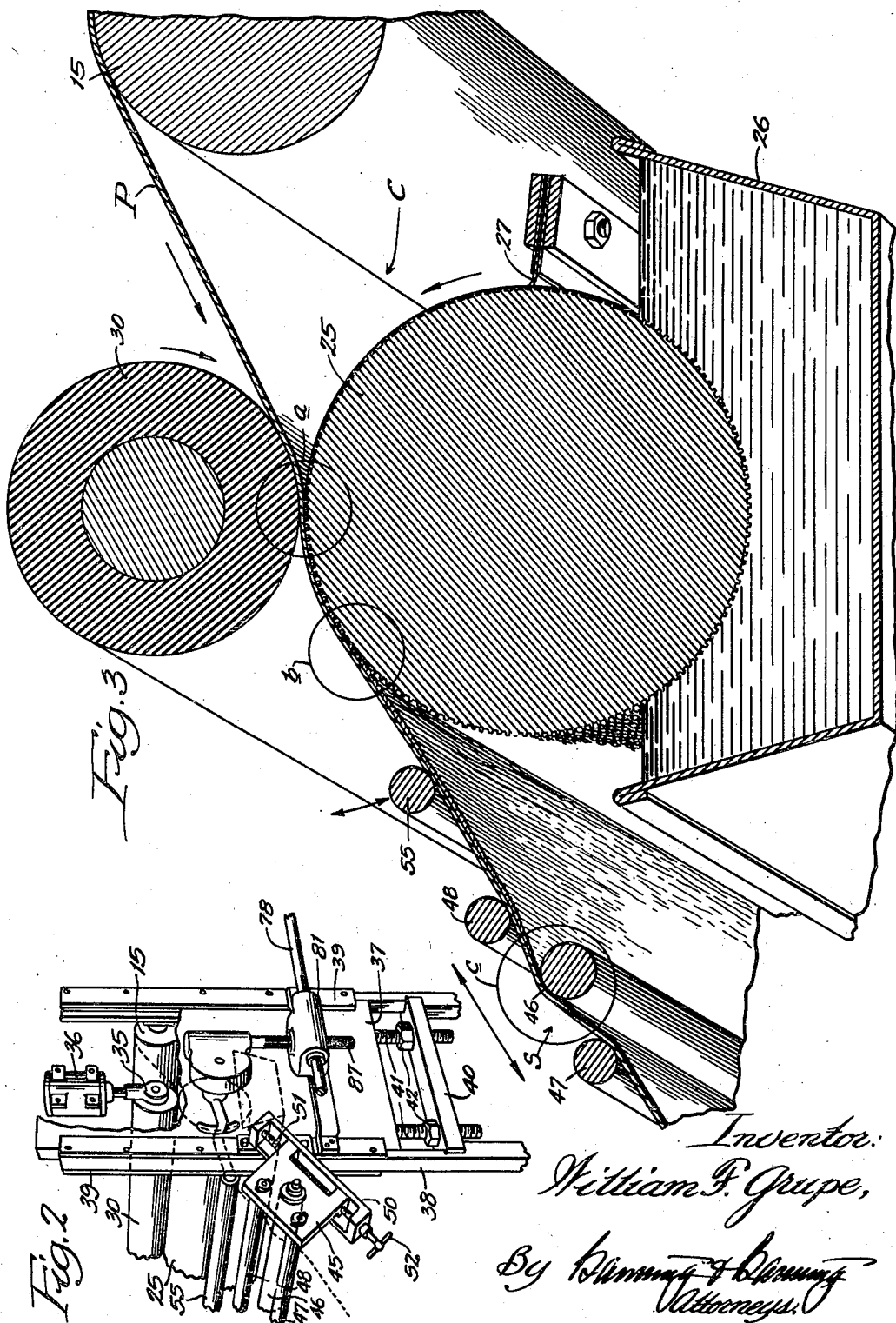
W. F. GRUPE

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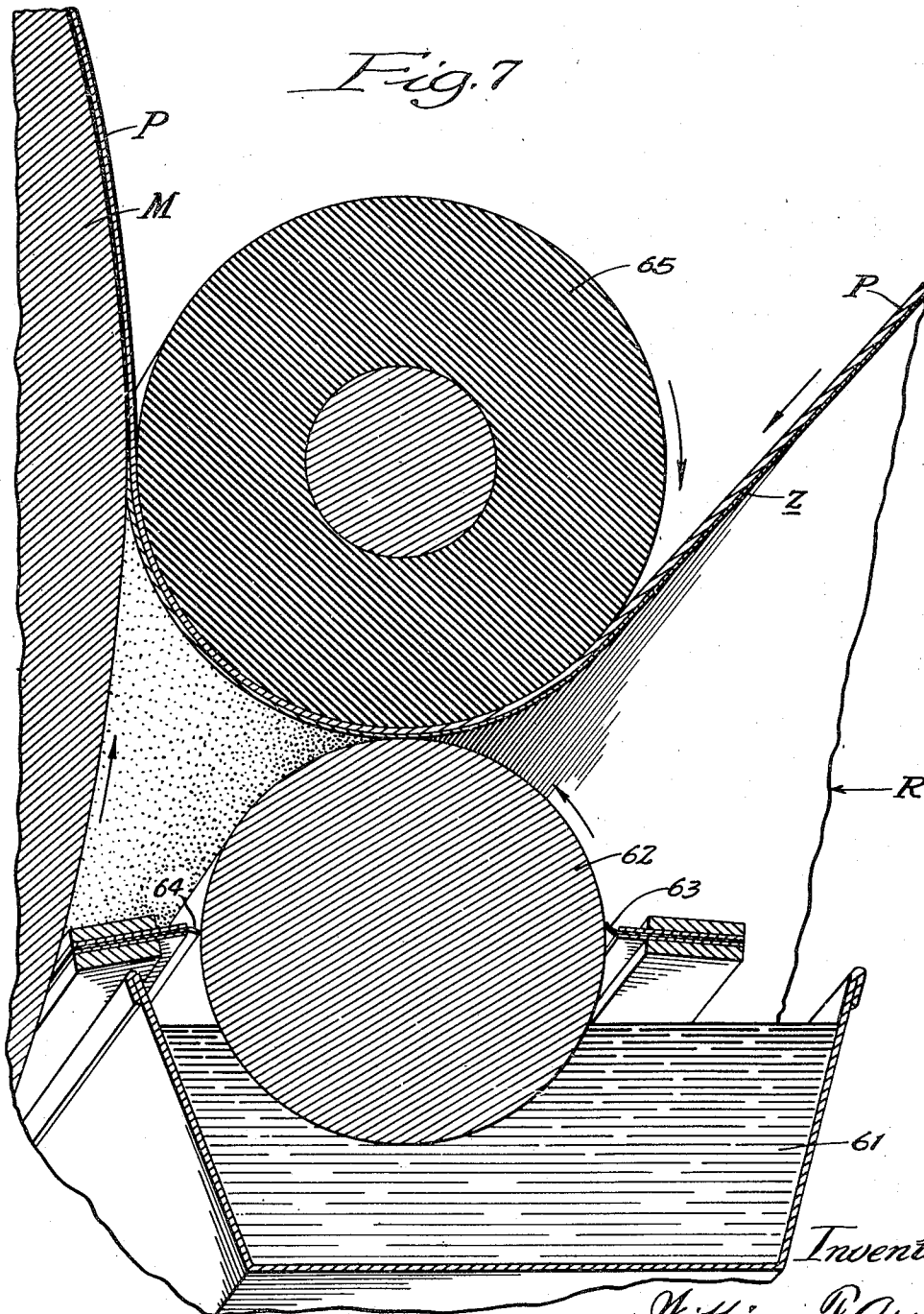
W. F. GRUPE

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MACHINE FOR COATING PAPER

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Inventor:
William F. Grupe,
By *Dimmick & Dimmick*
Attorneys.

UNITED STATES PATENT OFFICE

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MACHINE FOR COATING PAPER

William F. Grupe, Lyndhurst, N. J., assignor to
John R. Ditmars, New Brunswick, N. J.

Application November 9, 1942, Serial No. 464,967

10 Claims. (Cl. 91—33)

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This invention, which relates to the coating of paper, is concerned particularly with an improved mechanism for applying a free-flowing coating composition to a traveling paper web, for conditioning the applied coating for molding upon a finishing surface, and for performing the molding operation to render the coating hard, dense and very smooth. The coating composition may be made up according to any of the standard formulae in which a filler of mineral pigment, such as clay, baryta or satin white, is combined with a binder of casein, gelatine, starch, glue or other suitable material, all contained in an aqueous dispersion. The raw paper stock to which the coating composition is applied may be of any suitable kind, and for convenience in handling is desirably in the form of a web that is advanced at relatively high speed to receive treatment from the various agencies hereinafter described.

It is a primary object of my invention to provide a coating mechanism which will apply, condition and mold the coating composition while the web is in continuous high speed motion, the several units of the machine being operated in timed relation and in coordination to increase the capacity thereof. A coating so produced is also superior and advantageous in that it is non-porous, it is free of air pockets, it is hard and dense, it is uniformly spread so as to completely conceal the paper base at every point, and it may be applied very lightly with uniform hiding or covering power. The coating is also uniformly spread over the entire surface of the web, its weight per ream is substantially constant, and the amount that is applied to the web may be accurately metered to conform with that which is to remain thereon. As a result, such a coating will not pick or flake when a subsequent printing operation is performed, the impression will be uniform, and the ink receptivity will be excellent.

The apparatus herein disclosed will perform either a coating or a molding operation, or both, upon a fast-traveling web of paper. These operations may be carried out at different times with the aid of separate mechanisms, or they may be performed in quick succession in a single machine as illustrated herein, or they may be performed upon paper as a supplementary step in the operation of a papermaking machine. By the term "paper," as used herein, I mean to include any and all materials in sheet form whereon a coating may be applied and molded in accordance with the present invention, and no distinction is intended between various kinds or classes of papers such, for example, as printing and photo-

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graphic papers, and paper and paper board. A first disclosure of much of this invention was contained in my application (of which this case is a continuation in part) filed May 1, 1940, Serial No. 332,675, now Letters Patent No. 2,304,818 dated December 15, 1942.

Referring to the accompanying drawings,

Figure 1 is a side elevation of the coating, conditioning and molding apparatus in its entirety, showing the various coordinated units which are designed to operate upon a traveling web of paper;

Fig. 2 is a fragmentary perspective view, partly broken away, of the mountings for the coating and smoothing units;

Fig. 3 is a sectional perspective view in enlarged detail of certain parts of the coating and smoothing units;

Figs. 4, 5 and 6 are greatly enlarged sectional details of certain operating parts as enclosed within the three circles *a*, *b* and *c*, respectively, on Fig. 3; and

Fig. 7 is an enlarged detail in sectional perspective of the rewetting unit,

As shown, a web of raw paper stock *P* is unrolled from a stand 10, passing first over tension rolls 11, 12 and 13, and thence around certain idler rolls 14 and 15 to proceed through a coating unit *C*. From this point the web proceeds on through a smoothing unit *S*, and then on to enter a drying system which may comprise a cylinder *D* and a tunnel *T*. The paper web upon leaving the tunnel runs over an idler roll 16 and thence on to a rewetting unit *R* from which it passes immediately into contact with a molding drum *M*. Upon completing its travel for a predetermined distance around the molding drum, the web passes over a stripping roll 17, and thence around idler rolls 18 and 19 to be rewound upon a stand 20 in accordance with usual practice.

The features which are special to my invention reside particularly in the coating unit *C*, the smoothing unit *S*, the rewetting unit *R*, and the molding drum *M*, singly or together. Accordingly, a detailed description of each of these several units will now be given, it being an important consideration that the condition of the coating at the time of its treatment by each of these several agencies be as hereinafter described in order to produce the very superior results that are attainable by my invention.

The paper web upon reaching the coating unit passes over an intaglio roll 23 which is revolved in a pan 26 containing coating composition in a fluid plastic state. A flexible doctor blade 27 in

engagement with the intaglio roll acts to control the amount of coating which remains thereon. The multitude of receiving pockets which are desirably etched in the surface of the intaglio roll may each be of symmetrical form, a suggestive range of sizes being from .004" to .008", by .004" to .008", depth of from .001" to .004", and with their dividing walls of perhaps .001" opposite ones of which are substantially parallel. The coating deposited in receiving pockets so formed will aggregate a pre-determined amount so that, when transferred to the paper web traveling thereover, a measured or predetermined weight of coating will be uniformly applied thereover.

Associated with the intaglio roll is an impression roll 30 having a smooth yielding cylindrical surface adapted to bear against the upper side of the web at the linear point where it first contacts the intaglio roll. The web in traveling toward the coating unit proceeds in a direction which is other than transverse to a line between the axes of the intaglio and impression rolls, thereby being required to advance through an arcuate path which is coincident with the periphery of the impression roll. Upon emerging from the nip between these rolls the web continues on through an extended arcuate path coincident with the periphery of the intaglio roll, and thence to the smoothing unit S.

The impression roll is desirably supported at each of its opposite ends within a bearing 35 (see Fig. 2) having connection with the piston rod of a cylinder mechanism 36 to which fluid under pressure is admitted for the purpose of maintaining the impression roll firmly against the paper web to force the web tightly against the intaglio roll at the linear nip point during movement of the web through the coating unit. The cylinder mechanisms at opposite ends of the impression roll may be connected to the same fluid conduit so that the operating pressures will be equalized. The intaglio and impression rolls, also the tank wherein the intaglio roll is revolved, are vertically adjustable, as a unit, being carried upon a common mounting plate 37 slidably supported upon a framework 38 which comprises a pair of vertical guides 39. Extending between these guides below the mounting plate is a fixed beam 40 through which is extended a pair of vertical threaded rods 41, each engaging at its upper end the mounting plate to afford support therefor. As by means of nuts 42 each in threaded cooperation with one rod and in engagement as well with the top surface of the beam, the mounting plate, together with the coating unit carried thereby, may be fixedly held in a desired position of vertical adjustment.

The smoothing unit comprises a mounting plate 45 (see Fig. 2) supporting a smoothing roll 46, desirably of steel or brass for durability, which is positioned between a pair of idler guide rolls 47 and 48. The paper web is threaded past the same side of the two idler guide rolls and past the opposite side of the smoothing roll whereby it is deflected slightly while proceeding through the smoothing unit to advance through a short arcuate path that is coincident with the periphery of the smoothing roll (see Fig. 3). The smoothing unit S is itself adjustable toward and from the coating unit C in response to movement of the mounting plate 45 which is slidably supported in a frame 50 with the aid of an adjusting screw 51 having an operating handle 52. The direction in which the paper web proceeds on leaving

the coating unit is fixed by the position of the next succeeding guide roll 43 or by a supplementary guide roll 55 carried upon arms 56 that may be pivotally supported coaxially with the coating roll so as to be adjustable toward and from the web in any selected position whereof it is adapted to be locked by suitable means (not shown). The extent of the arcuate path through which the web is required to travel while in contact with the intaglio roll may be lengthened or shortened depending upon the adjusted positions of (1) this supplementary guide roll and/or (2) the coating unit itself.

Upon leaving the coating unit the paper passes around the drying drum D surrounded for an extended distance by a hood 58 which is joined to the tunnel T to form in effect a curved end extension therefor. The drum D is desirably heated, and through the hood and tunnel hot air is circulated whereby to accelerate drying of the paper web, together with the coating composition thereon, during its travel therethrough.

After leaving the drying system and passing over the idler roll 16, the paper web passes through the re-wetting unit immediately prior to its contact with the molding drum. This re-wetting unit, as shown, comprises a framework 60 supporting a pan 61 wherein is revolved a wetting roll 62 having, if desired, an intaglio surface to better act as a conveyor in lifting liquid from the pan. Associated with this roll are flexible doctor blades 63 and 64, one shown on each side thereof (see Fig. 7); also a resilient companion impression roll 65 in linear contact with the wetting roll and also with the molding drum, being pressed thereagainst by two pairs of cylinder mechanisms 66 and 67, the former exerting its force through arms 68 and the latter through arms 69 in both of which the impression roll is rotatably supported. The direction of force exerted by the cylinder mechanisms 66 is radially toward the molding drum whereas the direction of force of the cylinder mechanisms 67 is radially toward the re-wetting roll, and by separate control of the fluid operating pressure the amount of applied force in each case may be regulated, as desired.

In its travel through the re-wetting unit, the coated side of the paper is presented to the re-wetting roll. The doctor 63 controls the amount of liquid wetting agent, such as water, which remains on the roll surface at the time of its contact with the coating, and the doctor 64 thereafter cleans off from the roll any coating or foreign particles which may possibly have lodged thereupon. The web, with the coating so re-wet, is thereupon promptly brought into contact with the molding drum whereon the coating is pressed as the result of force transmitted from the cylinders 66 through the impression roll 65. One or more additional rolls 70, each having an associated cylinder mechanism 71 exerting its force in a direction radially of the molding drum, may also be provided to afford added linear points of pressure for the paper web during its travel around the drum. As shown, a jacket 72 surrounds the drum for a major portion of its periphery, and separate blowers 73 and 74 may be provided for maintaining circulation therein of heated air which is thereby brought into contact with the uncoated side of the web during its travel around the molding drum.

I have arranged for the present apparatus a coordinated drive whereby to assure a timed operation of each of its units. For this purpose

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It is feasible to employ a motor 75 whose power shaft connects through a coupling 76 with reduction gearing contained within a housing 77 from which the driven shaft 78 extends horizontally through multiple bearings lengthwise of the machine. The first of these bearings 79 is carried upon the stand 80 which supports the drum D; the second bearing 81 upon the framework 38 which supports the coating unit; the third bearing 83 upon one of the stands which supports the molding drum M; and the fourth bearing 85 upon the supporting framework 60 for the re-wetting unit. Within each bearing is a worm and pinion drive for the associated units—the drum D, the coating roll 25, the molding drum M and the re-wetting roll 62 and in the case of the coating roll this includes a splined shaft 87 (see Fig. 2) vertically adjustable with the coating unit whereby to maintain the driving connection therefor in all positions thereof. For the takeup reel which is carried on the stand 20 I may utilize a stalling motor 88 with a belt drive 89 running over a pulley 90 which is co-axially mounted on the reel.

The smoothing roll 46 is also driven as by a reversible motor 91 carried by the mounting plate 45 so as to move in unison with the smoothing unit when it is adjusted toward and from the coating unit. Power is supplied to this motor from a suitable source of electricity through leads 92 and 93 in one of which is interposed a rheostat 94 whereby the motor may be caused to operate at a desired speed, there being also a reversing switch 95 in connection with a third pole of the motor to control the direction of movement thereof.

In operation, the web of paper will be advanced continuously and rapidly to receive application of the coating composition which is in a free-flowing condition at the time it is deposited on the web in the form of closely-spaced symmetrical mounds *x* (see Figs. 4 and 5). As the intaglio roll revolves through the pan, its receiving pockets pick up coating composition to the extent of exactly filling each pocket, any excess being wiped off by the doctor blade 27. At the moment of its passage through the nip between the coating and impression rolls the web is compressed and is forced slightly into the filled pockets to express some of the water content from the coating material therein into the web which is thereby wetted to promote bonding of the coating to the paper; immediately thereafter the impression roll breaks contact with the web, the latter then expanding slightly and resuming its smooth form while remaining in contact with the coating roll. In so doing the coating, condensed somewhat by pressure from the web, is lifted slightly from the receiving pockets (see Fig. 4), leaving a slight clearance at the bottoms thereof. From and after the moment that the coating is deposited on the web, a migration of water starts from the wet coating into the relatively dry paper base. With lapse of time consequent upon continued travel of the web, more and more of the water content of the coating is yielded up to the paper, resulting in a rapidly increasing viscosity of the coating which tends to stabilize the mound formations upon the web. It is desirable that a sufficient time interval be allowed for a substantial portion of the water content in the coating to migrate into the paper before contact thereof with the intaglio roll is broken, and it is largely for this reason that I require the web to remain in contact with the coating roll for an extended

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distance during its movement therewith through an arcuate path, this distance being variable according to adjustments of the guide roll 55 and/or the vertical position of the coating unit itself, as already described.

When the web breaks contact with the coating roll, it proceeds therefrom tangentially in a direction which is determined by the guide rolls 55 or 48. In changing from a movement path which is arcuate to one which is straight, at the point of web separation from the coating roll, the mounds *x* of coating material deposited on the web are lifted out of the receiving pockets of the intaglio roll and at the same time are sloughed, slurred, or swiped by the dividing walls which separate the pockets thereof. The consequence is that the material forming the mounds is pushed and displaced over the web surface to a form somewhat as indicated at *y* (see Figs. 5 and 6), but without disturbing the general uniformity of its distribution thereover.

The web next proceeds on to the smoothing unit S where a leveling and smoothing of the mounds of coating material takes place. This is accomplished by advancing the web to pass through an arcuate path while receiving engagement from the smoothing roll 46 which in practice is of small diameter (about 2") of bronze, chromium plated. This roll is driven, either direction, at a speed which is relatively different from that of the web. It is desirably of small diameter, and its speed of rotation is such that its surface remains always wet from recurring contact with the coating. In other words, the surface of the smoothing roll which is wet when it breaks contact with the coating is still wet when it re-establishes contact therewith, and this is important because in this condition the wetness or moisture then in the coating, without the addition of any moisture thereto acts as a lubricant to permit the smoothing roll to level the coating without picking off or re-laying any of its particles. As a result of this operation, the coating material is uniformly redistributed at this point in the web travel, and its surface is leveled, evened and smoothed as indicated at *z* (see Fig. 6). Smoothing of the coating up to this point has been arrived at in two stages, the first by slurring concurrently with its measured application to the web in the form of mounds and while the coating is in a state of relatively high fluidity, and the second, after sufficient of the coating moisture has migrated into the web to materially reduce the water content of the coating, in which condition it is no longer free-flowing but still susceptible of being leveled out and staying so without re-flowing.

The ability of the smoothing unit to successfully level and even the coating depends in some degree upon the consistency of the coating at the time of this treatment. This is affected in large part by the extent to which the water content of the coating has migrated into the web, and this, in turn, depends upon the interval of time which has been afforded for this migration. Inasmuch as the web will be traveling at high speed during the coating and smoothing operations just described, it is important that means be provided for varying this time interval so that the coating may be in an optimum condition when acted upon by the smoothing unit. It is for this reason that the smoothing unit is mounted for adjusting movement toward and from the coating unit, thereby shortening or prolonging the time interval for travel of the web

therebetween, with a consequent decrease or increase in the migration of some of the water content from the coating into the web.

At the time the web is advanced into contact with the drum D the coating is sufficiently stable to remain undisturbed for the balance of its travel through the drier, during which it is relieved of sufficient of its moisture content to arrive at a "set" condition, although still very damp. At this point its moisture content will be perhaps only 20% or so of that which obtained when the coating was first applied, although the amount of deposited coating will have remained substantially constant and continue to remain so. A transformation of the coating from a free-flowing plastic state to one which is non-plastic will have occurred during travel of the web up to this point. Assuming the mound heights to be initially .003" upon a web of the same thickness, the smoothed coating when brought to non-plastic condition will have been reduced in thickness to perhaps .001" due to leveling of its mass and to shrinkage of the coating binders consequent upon a decrease in its water content.

Upon arriving at the re-wetting unit, the coating is contacted by the roll 62 (see Fig. 7), whose surface carries a controlled amount of wetting agent, desirably water, to be transferred to the coating which at that moment is sufficiently damp to be capillary sensitive. The added water is thereupon absorbed with great rapidity into the coating. The time required for absorption of this added water to the already damp coating will be very brief—so brief, in fact, that the re-wetting roll may occupy a position close to the molding drum and the web continue advancing at a speed of perhaps several hundred feet per minute, and yet afford sufficient time for this added water to soften and swell the coating to the point of pliability for molding upon the drum with which it establishes pressure contact almost immediately. The binders in the coating are softened both by the water and the heat from the drum. In this softened condition the coating is molded upon the drum (see Fig. 7). The impression roll 65 is advanced with pressure toward this drum so as to compress the coating at the moment of its first contact therewith. Repeated compression at other linear points may be applied by supplemental rollers 70. This molding drum which is heated accelerates drying of the coating whose moisture content tends to remain in equilibrium with that in the web.

No matter how much care is exercised, the surface of a molding drum cannot be made entirely free of imperfections, pinholes, blemishes, etc., nevertheless a coating which is molded while in pressure contact therewith will acquire a very superior finish. For general serviceability and durability, a smooth-surfaced drum of steel, chromium plated, is suitable. During travel of the web around the drum for the greater part of its rotative cycle, the coating remains in close contact therewith, being continually relieved of its water content up to the point that it is dried sufficiently to break clean from the drum and snap away therefrom at the conclusion of its movement thereon. As a result of this finishing treatment the coating thickness will have been reduced somewhat—to perhaps one-half of what it was when first placed in contact with the molding drum.

Starting with a coating composition in free-flowing plastic condition, it will be observed that

the several agencies comprised in the mechanism of my invention have acted first to transform the coating to a non-plastic state, then to a semi-plastic state in which the coating is soft, pliable and amenable to molding, and finally to a non-plastic state again in which the coating finish is very superior in the respects of density, uniform spread and freedom from air and pinholes, and other blemishes. In practice such a finished coating may be controlled as to weight within wide limits, and a lesser weight of coating will also suffice to provide uniform hiding or covering power. Also, because molding upon the drum is performed while the coating is semi-plastic, i. e., soft and pliable, there will be no transference to the coating from the drum surface of ever-present minute imperfections, such as small recesses, holes, points of unevenness, etc., as would occur if the coating were in a fluid or free-flowing state which would permit it to run into and acquire each such minute imperfection.

I claim:

1. In a machine of the class described, the combination of means for continuously applying to a traveling paper web an aqueous fluid plastic coating, means for continuously smoothing the applied coating comprising a roll rotatable at a speed relatively different from the travel speed of the web and shiftable toward and from the coating means to vary the distance of web travel therebetween, means for dehydrating the coating, means for rewetting the coating, and means for molding the smoothed coating promptly after rewetting comprising a heated finishing surface, and means for pressing the smoothed coating against the finishing surface.

2. In a machine of the class described, the combination of means for applying to a traveling paper web an aqueous fluid plastic coating in the form of closely spaced mounds and concurrently slurring the mounds to initiate a redistribution of the coating, means for leveling the mounds and smoothing the coating, means for dehydrating the coating, means for rewetting the coating, and means for molding the smoothed coating promptly after rewetting comprising a heated finishing surface, and means for pressing the smoothed coating against the finishing surface.

3. In a machine of the class described, the combination of means for applying to a traveling paper web an aqueous fluid plastic coating in the form of closely-spaced mounds, and means for leveling the mounds comprising a rotatable smoothing roll in engagement therewith, a mounting for the smoothing roll adjustable toward and from the coating-applying means whereby to vary the time interval therebetween, and means for rotating the smoothing roll in all its adjusted positions.

4. In a machine of the class described, the combination of means for applying to a traveling paper web an aqueous fluid plastic coating in the form of closely-spaced mounds, and means for leveling the mounds comprising a rotatable smoothing roll in engagement therewith, means for guiding the web through an arcuate path over a substantial portion of the surface of the smoothing roll, a common mounting for the smoothing roll and guiding means adjustable toward and from the coating-applying means whereby to vary the time interval therebetween, and means for rotating the smoothing roll in all its adjusted positions.

5. In a machine of the class described, the combination with a rotatable finishing drum for molding the coated side of a traveling paper web, of a moistening roll for wetting the coated web side at a point immediately in advance of its contact with the drum, a guide roll proximate to the drum in engagement with the uncoated side of the web adjacent the moistening roll, and pressure mechanism acting on the guide roll to force the web against the moistening roll and also against the drum whereby the coating, immediately upon being wetted, is pressed against the drum for molding thereupon.

6. In a machine of the class described, a pair of spaced guide rolls for a traveling paper web, a coating unit between the rolls and comprising companion rolls between which the web is passed, the axes of the companion rolls defining a line at an angle other than 90° to a line between the guide roll axes whereby the web is required to travel through an arcuate path while proceeding between the companion rolls of the coating unit, and means for shifting in unison the coating unit companion rolls in a direction parallel with a line between the axes thereof whereby to vary the distance of arcuate travel of the web therebetween.

7. In a machine of the class described, a coating roll, an impression roll, means for urging the impression roll toward the coating roll for engagement therewith, means for guiding a traveling paper web between the two rolls and through an extended arcuate path of engagement with the coating roll, and means for shifting the coating roll and impression roll in unison to various positions of adjustment relative to the guiding means whereby to vary the extent of arcuate engagement with the coating roll of the paper web passing thereover.

8. In a machine of the class described, the combination of means for continuously applying to a traveling paper web an aqueous fluid plastic coating, means for continuously smoothing the applied coating comprising a roll rotatable at a speed relatively different from the travel speed of the web and shiftable toward and from the coating means to vary the distance of web travel therebetween, and means for dehydrating the coated web.

9. In a machine of the class described, the combination of means for applying to a traveling paper web an aqueous fluid plastic wet coating in the form of closely spaced mounds having substantially rectangular bases and concurrently slurring the mounds to initiate a redistribution of the coating, and means for leveling the mounds and smoothing the coating while still wet, said last means comprising a smoothing roll engageable with the coating and positively driven at such a speed in relation to its circumferential distance as to remain wet at every peripheral point through successive contacts with the wet coating, and idler guide rolls disposed fore and aft of the smoothing roll in the general direction of travel of the web, the idler rolls engaging the

side of the web opposite to that engaged by the smoothing roll and being so positioned with respect thereto as to deflect the web for limited arcuate engagement with the smoothing roll.

10. In a machine for applying and smoothing a clay coating upon a traveling web of raw paper, the combination of a coating unit including a pan for supplying a free-flowing aqueous clay coating composition, a rotatable intaglio roll disposed in part within the pan from which some of the coating composition is thereby transferred to the surface pockets of the intaglio roll, an impression roll having a yielding surface in pressure engagement with the intaglio roll, means for guiding the moving raw paper web between the intaglio and impression rolls and through an extended arcuate path over the intaglio roll whereby the coating composition contained in the pockets of the intaglio roll is transferred onto the contacted surface of the web in the form of mounds in a free-flowing plastic wet condition, and then slurred and compressed to the point of expressing some of the water content therefrom to promote bonding of the coating mounds to the web, a smoothing unit spaced from the coating unit a distance sufficient to permit migration into the web of water content from the coating mounds to the extent that the latter becomes stabilized and non free-flowing, although still wet, the smoothing unit comprising a smooth hard-surfaced rotatable roll engageable with the coating mounds to produce a smoothing and evening thereof, and means for driving the roll at a peripheral speed sufficient to bring every portion of its surface in repeated contact with the still wet coating mounds at intervals so short as to maintain the roll surface in a constantly moist condition of lubrication whereby to avoid redeposition of the coating material during smoothing and evening thereof.

WILLIAM F. GRUPE.

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