June 26, 1928. 1,674,848

S. W. WEBB ET AL

METHOD AND APPARATUS FOR FINISHING PAPER

Filed March 22, 1926 2 Sheets-Sheet 1

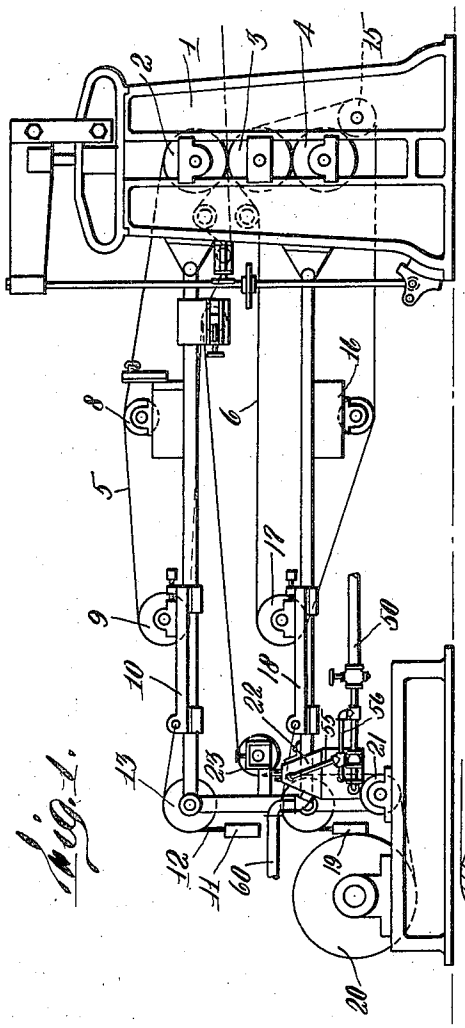


Fig. 1.

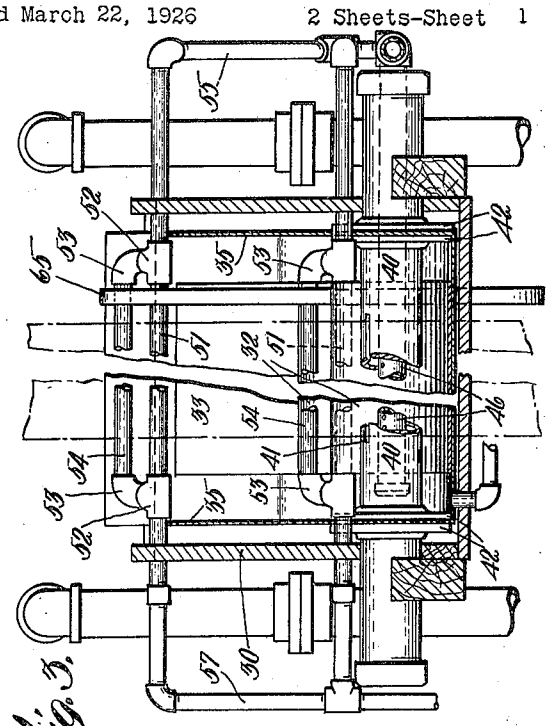


Fig. 3.

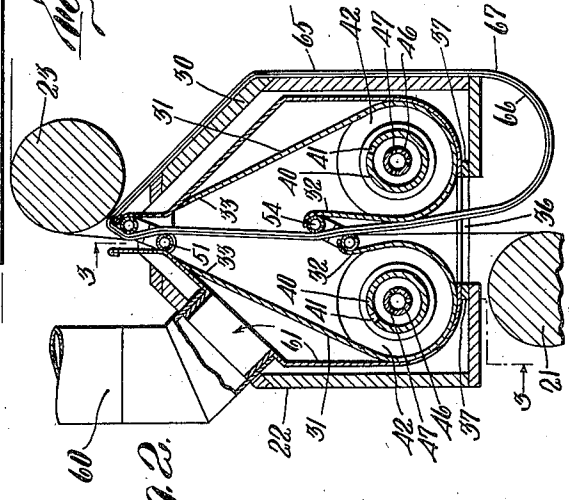


Fig. 2.

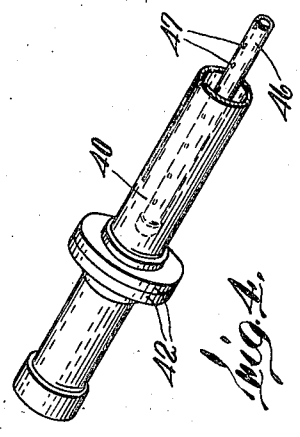


Fig. 4.

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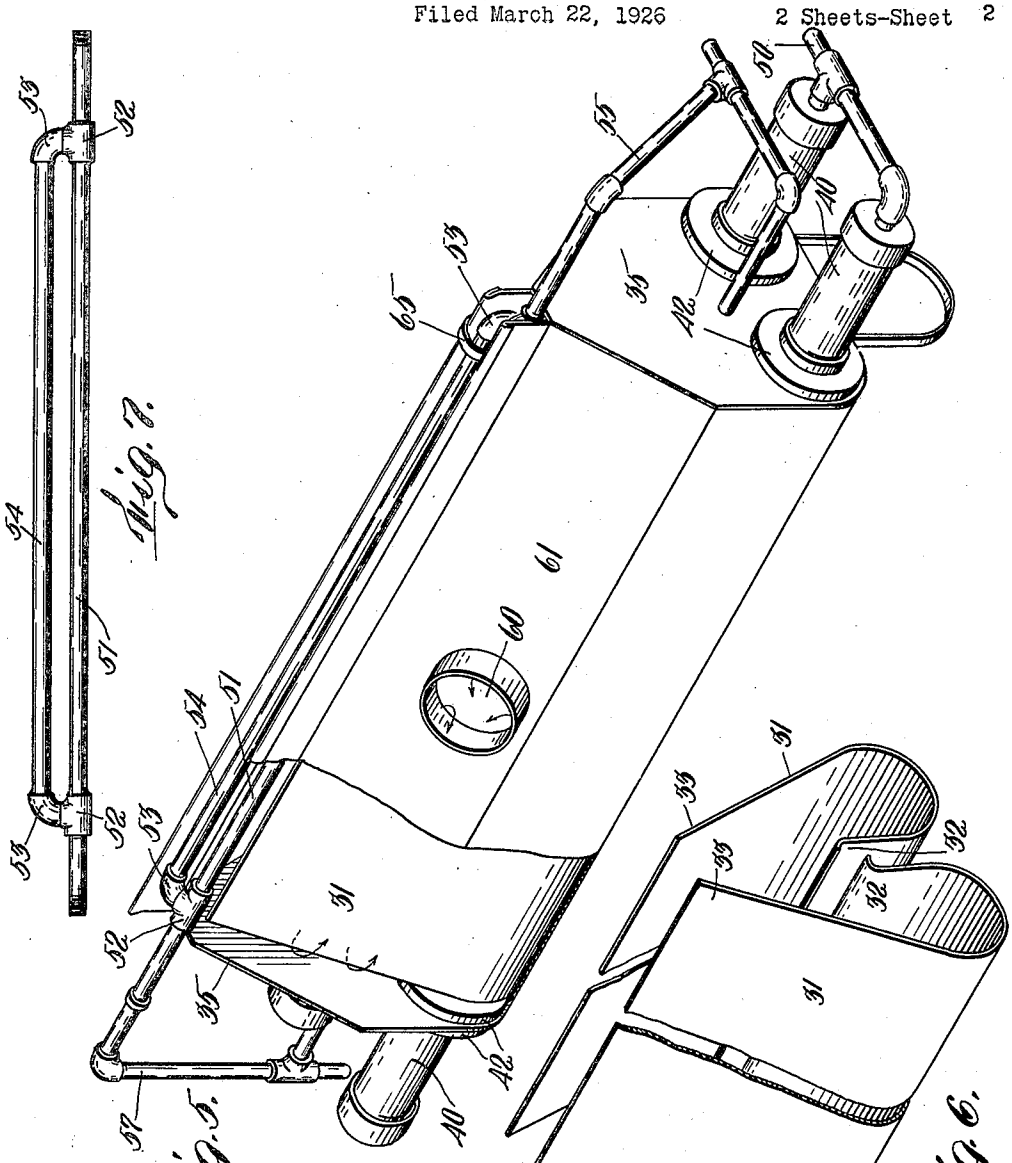


Fig. 7.

Fig. 5.

Fig. 6.

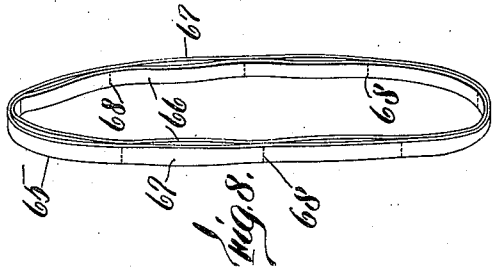


Fig. 8.

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UNITED STATES PATENT OFFICE.

STUART W. WEBB, OF BROOKLINE, AND JOHN G. CALLAN, OF CAMBRIDGE, MASSACHUSETTS, AND ALBERT ALLEN, OF BANGOR, MAINE, ASSIGNORS TO EASTERN MANUFACTURING COMPANY, OF BOSTON, MASSACHUSETTS, A CORPORATION OF MASSACHUSETTS.

METHOD AND APPARATUS FOR FINISHING PAPER.

Application filed March 22, 1926. Serial No. 96,507.

This invention relates to a method and apparatus for producing a fabric surface on paper in which a continuous web of paper is passed between two endless fabric belts through the nip between presser rolls and is intended to be used in connection with a machine for this purpose in which one of the rolls is relatively hard and the other relatively soft as set forth in Patent No. 1,277,714 granted September 3, 1918, to Eastern Manufacturing Company as assignee of Henry J. Guild for method and means for finishing paper.

The purpose of the present invention is the production of linen marked or other fabric marked paper of surface more exactly simulating or duplicating that of paper finished by the well known process of "plating" or even excelling it in those qualities recognized in the trade as defining a plated paper of the highest grade.

In order to understand the nature and operation of the improvements herein described, it is necessary to know something of the character of the fabric-like marking that distinguishes plated paper from other fabric marked paper, such, for example, as embossed paper, or as "wove" paper which still shows the wire mark.

For antithesis the two last named examples of fabric marking that are not plating will be described first. The "wire mark" on paper is due to the wet paper stock depositing on the wire gauze of the Fourdrinier wire or the cylinder mold as the case may be, like snow over slightly irregular ground, leaving more stock in the hollows and less on the elevations, so that not only the thickness, but the amount of paper material varies minutely from point to point of the sheet due to this cause. In the case of an embossed sheet one of the embossing rolls that produces the effect has engraved upon it a likeness of a fabric sheet "in cameo", and the other a conjugate likeness of the same sheet "in intaglio", so that the paper is slightly raised on one side at the same point, and in the same degree, that it is depressed on the other. Thus there is a "right" and a "wrong" side, one side being the inverse of the other. The embossing process does not change the thickness of the sheet from point to point, but only its surface conformation. Because of this, the pattern is not defined in lines of varying translucency visible on looking through, as described next in the case of plated paper.

All plated papers have certain characteristics in common, and good plated papers are differentiated from poor ones by the degree and relation of these characteristics. In all cases the plated paper is marked by being heavily compressed between marking members made up in one or another way of fabric—commonly of linen. There is no "right" or "wrong" side. The paper is unevenly compressed in a fabric-like pattern by the woven fabrics on its two sides; where a thread on one side registers with a thread on the other, the compression is maximum, and conversely, where a space on one side registers with a space on the other it is minimum. Heavy threads and particularly the varying compression due to random registration of threads and spaces give a desired irregularity. The paper is not merely embossed, but actually varies in thickness and inversely in density from point to point, but so far as the result of plating action is concerned, the amount of stock should remain the same at all points.

In the standard and well known plating process, where the linens used are of single ply and sheets of zinc are interposed between the linen-paper-linen units, a maximum of definiteness of impression results and the paper is called "lawn." A blurred effect used on "regular linen finish" may be secured by piling, say, eight sheets of paper alternating with nine sheets of linen—commonly two-ply—into a pack before interposing the next metal sheet. An ideal lawn paper has a surface of somewhat more than an eggshell gloss, but not shiny, this gloss being imparted by the slight repeated slip of paper on linen in the pack. The surface relief is appreciable, but appears to be much greater than it actually is, for the reason that the traces of threads that chance to register with thread traces on the opposite side are rendered darker to reflected light, and conversely more translucent, by compression of the fibers into contact and partial optical continuity, the optical effect being the same whereby white opaque snow may be compressed into a dark, translucent

ice-like mass. This irregular weave interference pattern in color contrast, giving an appearance of an irregular fabric, and of more relief than exists, is an important characteristic. On looking through the sheet, the fabric pattern is seen to be clearly though irregularly delineated by these lines of varying translucency, which do not reproduce the weave of a single linen, but rather the thread superposition of the two. If two ply linens are substituted for single ply, the back linens have an effect, but a much less sharp one than do those in direct contact with the paper on each side.

Up to the time of the present invention the various processes for fabric marking a continuous paper web have produced papers that lack in various degrees the distinguishing characteristics of high grade plated paper, and they have therefore been applicable only to the cheaper grades. Some of the differences between best current continuous process finishes and best plater finishes, are noticeable only to one reasonably skilled in judging linen finish papers, but in the aggregate they determine a difference in selling price amounting to many thousand dollars annually in the product of each machine. Our apparatus and process when constructed and operated as hereinafter described produces a finish quite indistinguishable from that of the highest grade of plated papers, particularly lawns.

In previous continuous linen finishing machines of the same generic type as that disclosed in the Guild patent hereinbefore mentioned it was found that no satisfactory impression either as to surface or as to "look through" could be made on paper of the degree of dryness commonly found in paper run off from the paper machine under ordinary conditions, and in commercial practice paper for such machines has been prepared for finishing by moistening as by sprays mechanically or compressed air actuated or applied by means of brushes. In all of the methods commercially attempted the paper was given, or was allowed to retain, a percentage of moisture usually between 7.5 and 8.5 of dry weight uniformly distributed through the whole of the paper substance. Where sprays were used, and there was some unavoidable initial streakiness, the paper was rolled up and allowed to stand long enough to insure absorption and equalization from point to point in the sheet and through the thickness thereof.

Paper carrying some such degree of moisture has sufficient plasticity so that it receives on the belt machine a strong surface impression, and shows on looking through a clear fabric-like pattern, but in comparison with a first rate plater lawn the finish of even the best of these papers made upon a "continuous finishing machine" has had an appearance which has been described variously as "dead", "mechanical" and "monotonous", even in papers from the machine using a hard and a soft roll in the nip, to which our improvements directly apply. The meaning of these characterizations will be grasped after the cause is explained.

In the machine to which our improvements directly apply, one of the nip rolls which force the marking fabric into contact with the paper is of some such material as compressed cotton or paper, and the maximum specific pressure that can be applied to any point of the paper to be marked is limited by that which can be continuously supported by this "soft" roll, and is for this reason considerably less than the maximum available in plating by the ordinary process; it is in fact not enough to give a sufficient mark on paper even of the soft "linen" grades containing so little as, say, 5% moisture; this weakness is considerably more apparent if the paper has been previously calendered. Even if the total loading on the nip be greatly increased, the "soft" roll compresses, and widens the concave area supporting this pressure, so that the specific pressure at any point is not increased proportionately. Further, the total pressure cannot be carried up beyond a certain point, variable from roll to roll, without causing rapid deterioration of the cotton, paper or other filling of the soft roll.

Paper moistened throughout its thickness by any of the procedures enumerated above to a point where it marks well, is thereby rendered somewhat limp, plastic and susceptible of a sort of molding process under pressure. Such paper, when run through the unimproved continuous finishing machine, acquires a "look through" not very much different from that of plater lawn except that there is less of the slight general translucency that is imparted to the look-through of lawn by repeated extremely heavy pressure on paper that is resilient rather than soggy. The surface, however, is much less satisfactory; the imprint of the fabric is in the nature of an exact molded replica of the surface of the adjacent linen rather than an interference or coincidence pattern recording the weave registration of the linens on the two sides. This lack of diversity or "character" in the marking is the main reason that has led to the characterization of such paper as mechanical, monotonous or dead in appearance. A very large amount of work was done and many samples and comparisons made before it became apparent that the difference was due to the fact that the plater lawn was marked primarily with a pinched-in interference pattern of the marking fabrics on the two sides of the sheet, with only a slight and occasional surface molding sketchily repro-

ducing the adjacent fabric surface, while the reverse was true of the belt-finished or continuous finish linen marked paper which showed on each side a faithful mold of the adjacent surface, obscuring the true plated pattern. The exact way in which the plater brings this about has been studied, but the result alone is directly relevant at this point. The continuous machine molded the surface as well as pinched the sheet into a translucency pattern because the sheet was limp and plastic with diffused dampness.

Another difference between plated and continuous finish paper has resided in the character of the surface polish. Two factors are concerned, first, the lesser specific pressure in the continuous machine as compared with the plater, and the single pass in the former against usually two or four in the latter lead to less actual polish on the continuous finish paper, even from hard and soft roll machines which give some slip during the passage through the nip. Second, the close network of lines on the surface of the continuous finish paper compared with the relatively sparsely marked surface of the plated paper gives the former an appearance of lesser polish even when the actual ratio of specular to diffuse reflection as determined by polarized light test is the same in the two cases.

With paper moistened throughout to 8% or 9% the pleasing diversified "pinch" or weave interference pattern on the surface, even with the best possible belt construction, was found to be obscured by the monotonously regular plastic reproduction of the surface weave of the adjacent linen. With paper of 5% or 6% moisture, well absorbed, there is notable improvement in that the paper does not so fully hold the plastic surface mark, but the interference pattern also is less marked and with still drier paper there is no sufficient mark of any kind, though what there is consists of the high points of an interference pattern.

The best of this paper heretofore produced has had a good surface mark, but not a sufficient polish for high grade linen paper. If supercalendering was resorted to, to increase the polish, paper sufficiently wet to receive the linen finish was found liable to blacken due to becoming compacted to translucency. While some remarkably good samples have been produced by this combination of moisture and supercalendering it has been found commercially impossible to hold with reasonable consistency the distributed moisture content sufficiently uniform, low enough to avoid blackening in the supercalender and yet high enough to get a good pinch mark with the fabric after being hardened in the supercalender.

Further experiments have shown that moisture may be held in paper in various ways and that the behavior of the paper is much affected thereby. The cooking and beating operations are severe in character, and water absorbed by the fibers in these processes produces "hydration", either incipient or more advanced, that contributes to "slowness" on the wet end of the paper machine. Wet pulp in the furnish gives rise to this effect more than similar pulp that has been dried before it goes to the beaters. Paper that is taken from the paper machine with a high moisture content seems to have a part at least of its moisture in this state of close attachment or pseudo combination with the fibers and the fibers are rendered limp and plastic thereby. Conversely, paper that has been dried and is moistened again does not for a considerable time at least, incorporate the water into the fibers in so intimate a relation and the amount of limpness and plasticity due to a given moisture content is less. Finally, our experiments indicate that for a few moments after water is deposited on a specimen of paper, it resides upon the surface and in the interstices between the fibers without at once affecting the resiliency or other properties of the fibers themselves, unless it is forced into them by great pressure. We have found, therefore, that if the paper on the paper machine is dried to a low moisture content such as 4% to 5%, is then supercalendered and afterwards the necessary additional moisture is applied just before the paper enters the finishing machine, it is possible to produce consistently and continuously a linen finish equal to the best grades of plater lawn and having a similar market value.

In order to derive the maximum benefit from the procedure of the present invention, however, it is important that the ply of fabric directly contacting the paper shall be so formed that the individual threads are stiff and hard while the interstices between them are unobstructed, since this brings the specific pressure of thread coincident lines higher for a given total pressure.

A satisfactory method of adding the moisture content is by the use of a steam box through which the paper passes immediately before it reaches the nip between the finishing rolls, the amount of steam being so adjusted as to supply sufficient quantity of moisture so that the weave interference pattern prevails over the plastic surface mark in about the same degree as in high grade plater lawn, and that the surface is free enough from deeply marked reticulation to exhibit the gloss to a proper degree.

Increase of moisture in the paper as it leaves the paper machine (1) decreases the supercalender pressure permissible or required, (2) decreases pressure required in

linen finish machine for getting pinch mark, (3) promotes plastic surface mark, so that in paper with excess of such moisture the surface mark catches up with and obscures the pinch or interference mark, and reticulates or cuts up the surface and obscures the polish. For No. 2 linen, 4% is low, and 5.5% high.

Calendering makes the paper glossy, hard to mark, and indisposed to plastic surface marking. Supercalenders differ so much that it is sufficient to direct a skillful operator to calender rather lightly, trying first with no weights other than the rolls.

Steaming develops susceptibility to pinch mark, without corresponding retention of plastic surface mark. We believe that the superficially deposited water is squeezed into such intimate relation with the fibers along the heavily compressed pinch lines as to materially help development of optical continuity and translucency, but that the pressure elsewhere is not enough to bring about this effect in such degree as to determine much permanent molding of the surface. Whether or not this explanation is correct, the results are as stated, that is, steaming as directed herein promotes pinch mark more than it does surface mark.

For a more complete understanding of this invention, reference may be had to the accompanying drawings in which

Figure 1 is a side elevation of a paper finishing machine embodying this invention.

Figure 2 is a transverse vertical section through the steamer and adjacent parts.

Figure 3 is a section substantially on line 3—3 of Figure 2.

Figure 4 is a fragmentary perspective of a steam distributor pipe.

Figure 5 is a perspective partly broken away of the steamer.

Figure 6 is a perspective of the steamer lining plates.

Figure 7 is a side elevation of a sealing member.

Figure 8 illustrates the construction of a paper threading belt.

Referring first to Figure 1, at 1 is indicated a stand in which is journaled in superposed relation three rolls 2, 3 and 4. Through the nip between the rolls 2 and 3, which are pressed together with heavy pressure, is passed a pair of fabric belts 5 and 6, one of these rolls, as 3, being relatively soft and the other being relatively hard. The belt 5 is shown as passed about the roll 2 past a belt-steering mechanism 8 and over a head roll 9, the tension of the belt being maintained by mounting the roll 9 on a slidable carriage 10 urged away from the stand 1 by means such as a weight 11 attached to a cable 12 passing about a pulley 13 and fixed to the slide 10. The belt 6 passes partially about the relatively soft roll 3 about an idler 15, a steering device 16 and a head roll 17. This head roll 17 is mounted on a slide 18 which is urged away from the roller stand as by means of a weight 19 similarly to the upper slide 10.

The paper to be finished is shown as in a roll 20 and is led from this roll about a guide roll 21, vertically through a steam box indicated generally at 22, about a roll 23 and from thence is guided to the nip between the rolls 2 and 3 between the confronting stretches of the belts 5 and 6. It will thus be seen that the paper passes through the steam box on its way to the nips between the rolls 2 and 3 and these rolls travel at a sufficiently high rate so that the time elapsing between the emergence of the paper from the steam box and its passage through the nip is very short preferably not over two or three seconds.

The steam box itself comprises an outer casing 30 which may be made of waterproofed wood, and within this casing, and spaced therefrom lengthwise thereof, is a metal inner lining. This lining is shown as composed of a pair of plates 31 having their lower ends bowed upwardly as at 32, as best shown in Figure 6, and their upper ends 33 converging toward the outlet opening for the paper. These plates 31 terminate somewhat within end plates 35 of the steamer, as shown best in Figure 5, so that steam admitted between them in the manner presently to be described may escape about their ends and pass between them and the casing 30 by which means they are maintained hot so that after the first few minutes of operation the moisture from the steam is not condensed thereon. The outer casing 30 is provided with a slot 36 for the passage of the sheet of paper into the steamer and strips 37 along opposite edges thereof form supports to receive the lower rounded faces of the plates 33. Extending within the plates above these faces and within the looped lower portions thereof are positioned the steam distributor pipes 40. Each of these pipes is provided with a longitudinally extending slot 41 opening into the space defined by the lower curved portion of the corresponding plate 33, these pipes being positioned substantially concentrically of these spaces. Positioned on these pipes beyond the extremities of the slot 41 are collars 42 between which the end plates 35 are clamped.

Arranged concentrically within the distributor pipes 40 are the steam mains 46. These mains extend forwardly from one end only of the distributor pipes and are perforated at intervals as at 47 to permit the steam to escape therefrom into the annular space between them and the inner faces of the distributor pipes from which the steam escapes through the slots 41 into the steamer within the plates 33. If desired the dis-

tributor pipes 40 may be so mounted as to permit them to be rotarily adjusted so as to permit the slot 41 to be directed in the best possible direction for the particular installation as may be determined by experiment. The pipes 46 as shown lead to a main steam supply pipe 50.

In order that there may be no drip of condensed steam which shall reach the web of paper passing up through the steamer, the entrance and exit openings for the paper are partially closed off by heated members such as shown in detail in Figure 7. Each of these members comprises a main pipe 51 to which is fixed spaced T fittings 52 which join through elbows 53 with a pipe 54 extending parallel to and spaced from pipe 51. The ends of the plates 31 are preferably bent over to partially engage about the pipes 51 and 54 and the plane of the central axes of these pipes is arranged at such an angle to the passage of the paper that the paper passes therebetween and together therewith substantially seals the entrance and exit openings through which the paper passes. These pipes are connected through pipe connections 55 and 56 with the main steam lines, and for the purpose of removing condensation therefrom, the opposite ends of the pipes 51 are shown as connected to the pipes 57 and lead to a suitable exhaust or condensation device (not shown). Thus the paper passes between members which act to substantially seal off the interior of the steamer but which are maintained heated so that there is no tendency for steam to be condensed thereon and to drip onto the paper, the paper as it passes through the steamer being supported by the wooden rolls 21 and 23 and maintained in a substantially vertical plane through the steamer. Preferably the pipe 54 is so connected to the pipe 51 as to permit the angularity of the planes of the axes of these two pipes to be adjusted to suit the paper passing therethrough, the pipes on the opposite side of the web being relatively offset lengthwise thereof, permitting as close a sealing contact as may be necessary without actually causing contact to be made therebetween. At 60 is shown the steam exhaust which communicates with the space between the plates 31 and the outer lining walls 61 of the casing 30.

During the operation of the machine the paper passes rapidly from the roll 20 about the guide roll 21 and through the steamer space, the paper then being relatively cold and acting to immediately condense moisture from the steam thereon which remains on or substantially near the surface of the paper on both sides until such time as the finishing has been accomplished. The amount of moisture distributed on the paper depends on the proportion of steam to air in the casing which, in turn, is dependent on the rate to which the steam is supplied thereto. The amount of moisture deposited is dependent upon the ratio between the steam and the air for the reason that the surface condensation of the moisture causes the air adjacent to the surface to be freed from its moisture which thereupon acts as a heat insulator and prevents further condensation thereon. The supply of steam is so adjusted by suitable valves as to sufficiently moisten both sides of the paper equally, which is shown by absence of any tendency for it to curl. As soon as it has passed through this steamer the paper passes to and through the nip between the relatively hard and soft rolls and between the fabric impression belts so that the desired fabric finish is imparted thereto.

In order that the initial threading of the paper through the steamer may be readily effected, means for drawing the paper through the steamer may be provided. As shown in Figures 2, 3, 5 and 8 this means may comprise an endless belt 65 which passes through the steam space within the steamer and returns outside of the casing. This belt is preferably formed of two layers of material as at 66, 67 which are stitched together at intervals at 68 to form loop portions which may be separated to permit the insertion of the end of a web of paper, this end being somewhat crumpled and passed through between the two belts between the stitching so that the belts tend to grip this end portion. The operator may then pull the belt around by hand and draw the paper through the steamer. After the threading has been accomplished the end portion of the paper engaged with the belt may be torn off and the belt moved to one side where it is out of contact with the paper being fed through.

Having thus described an embodiment of this invention, it should be evident to those skilled in the art that various changes and modifications may be made therein without departing from its spirit or scope as defined by the appended claims.

We claim:

1. The method of finishing paper which comprises surface moistening the comparatively dry paper, and immediately thereafter subjecting it to heavy pressure between finishing surfaces.

2. The method of finishing paper which comprises calendering the paper while it is relatively dry, surface moistening the paper, and immediately thereafter subjecting it to heavy pressure between finishing surfaces.

3. The method of applying fabric finish to paper which comprises supercalendering the comparatively dry paper, subjecting the surface of the paper to moisture, and immediately thereafter passing the paper inter-

posed between fabric surfaces through the nip between relatively hard and soft surfaced rolls.

4. The method of imparting a fabric finish to paper, which comprises superficially moistening the paper, and immediately thereafter passing the paper between fabric plies through the nip between a relatively hard and a relatively soft roll pressed together under heavy pressure.

5. The method of imparting a fabric finish to paper, which comprises imparting a slight gloss to the surface of relatively dry paper, superficially moistening the paper, and immediately thereafter passing the paper between fabric plies through the nip between a relatively hard and a relatively soft roll pressed together under heavy pressure.

6. The method of imparting a fabric finish to paper which comprises lightly calendering paper having a low moisture content, superficially moistening the paper, and immediately thereafter passing said paper between plies of fabric through the nip between a relatively hard and a relatively soft roll pressed together under heavy pressure.

7. The method of continuously finishing paper with a fabric finish, which comprises supercalendering the relatively dry paper, progressively moistening the surface of the paper, and immediately thereafter progressively subjecting the paper to heavy pressure between fabric surfaces.

8. The method of continuously finishing paper, which comprises progressively supercalendering the paper, progressively subjecting the paper to steam for a period of sufficient length to moisten the surface only, and immediately thereafter subjecting the moistened paper to heavy pressure between fabric surfaces.

9. The method of continuously finishing paper, which comprises progressively supercalendering the paper, progressively subjecting the paper to steam for a period of sufficient length to moisten the surface only, and immediately thereafter passing the paper between fabric plies through the nip between rolls of different hardness pressed together under heavy pressure.

10. An apparatus of the class described, comprising a pair of rotary pressure rolls, a pair of fabric surface belts passed through the nip between said rolls, means for presenting paper to be finished between said belts to pass through the nip therewith, and means for moistening the surface of the paper before it reaches said nip.

11. An apparatus of the class described, comprising a pair of rotary pressure rolls, a pair of fabric surface belts passed through the nip between said rolls, means for presenting paper to be finished between said belts to pass through the nip therewith and a steam box through which the paper passes on its way to said nip, means for directing steam into said box into contact with the paper, and means for moistening the surface of the paper before it reaches said nip.

12. In combination with a paper finishing machine comprising a pair of rotary pressure rolls, one of said rolls being softer than the other a pair of endless finishing belts passed together through the nip between said rolls, and means to direct paper to be finished through the nip between said rolls between said belts, of an enclosure through which the paper passes on its way to said nip, and means for directing steam into said enclosure into contact with both faces of the paper.

In testimony whereof we have affixed our signatures.

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JOHN G. CALLAN.
ALBERT ALLEN.