Aug. 12, 1941. A. REILLY 2,252,204

METHOD AND APPARATUS FOR COATING PAPER

Filed March 7, 1939 3 Sheets-Sheet 1

Fig. 1.

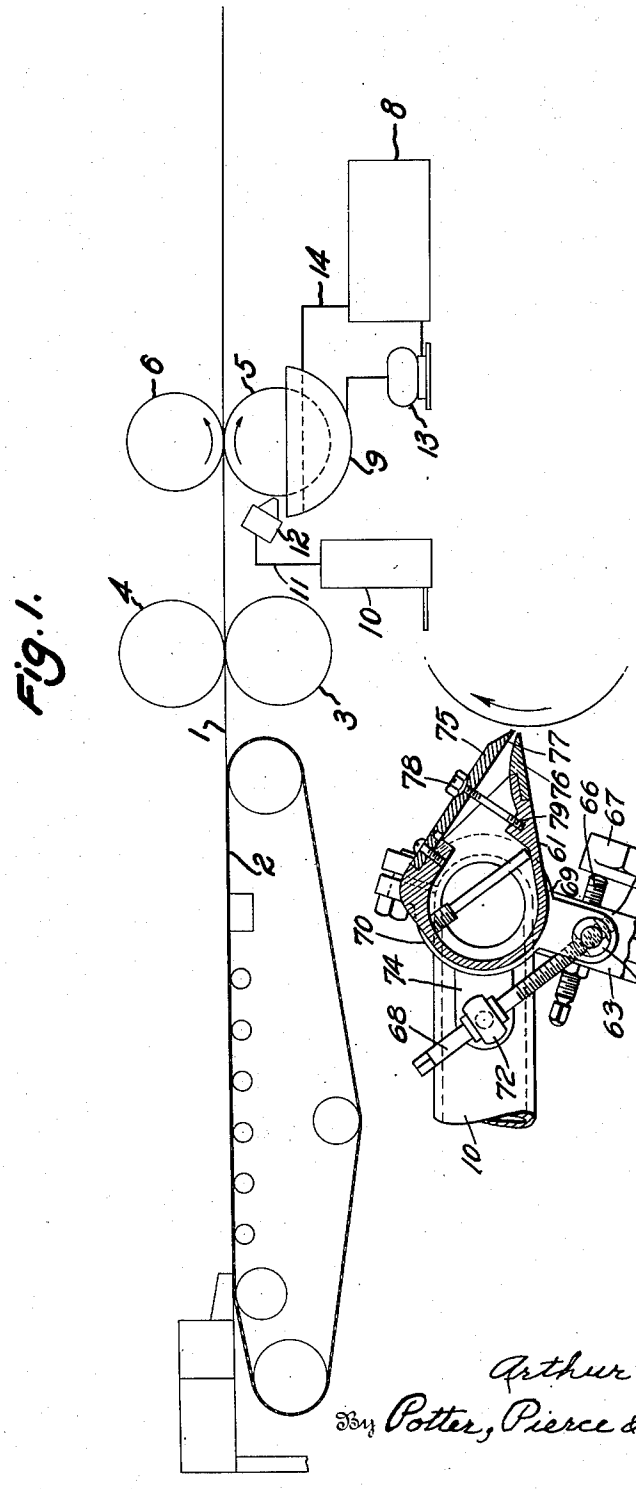


Fig. 7.

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Fig. 2.

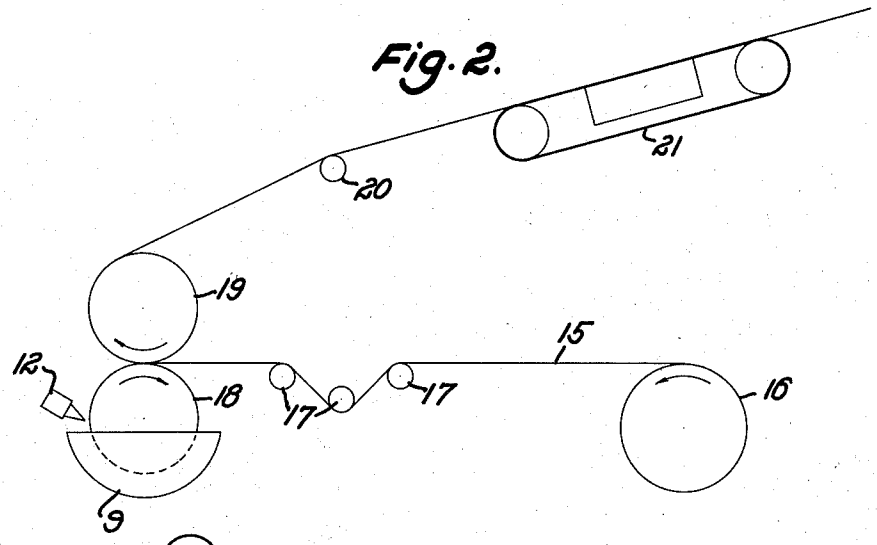


Fig. 3.

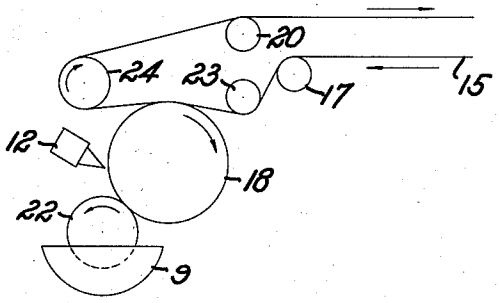


Fig. 4.

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Fig. 5.

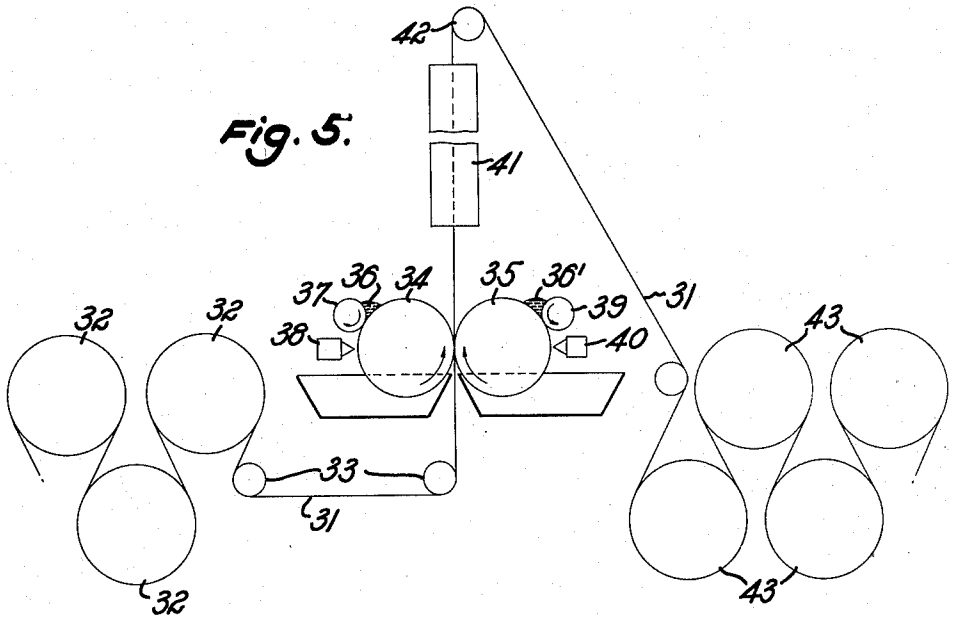
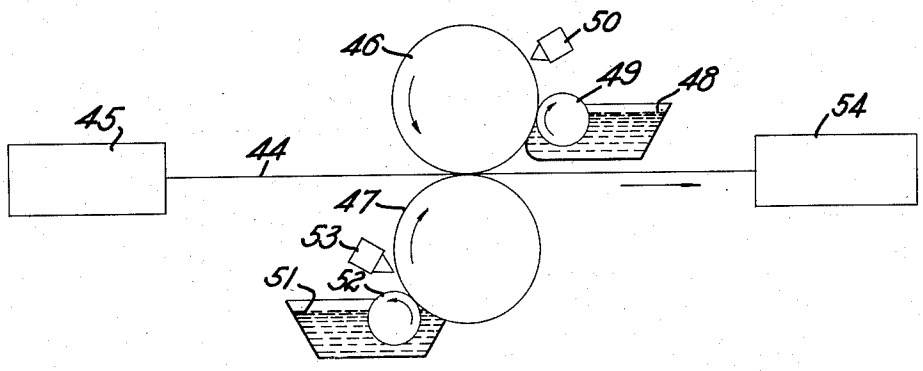


Fig. 6.



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UNITED STATES PATENT OFFICE

2,252,204

METHOD AND APPARATUS FOR COATING PAPER

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Application March 7, 1939, Serial No. 260,389

5 Claims. (Cl. 91—18)

This invention pertains to a method of and apparatus for applying coating compositions to paper and similar sheet materials.

In coating sheet material it is common practice to apply thereto a coating composition comprising solid matter dissolved or dispersed in a suitable liquid medium, said coating composition being applied in excess of the quantity desired to be retained; and to remove the excess of coating composition and smooth the remainder by suitable means. In some cases, however, the application and subsequent removal of an excess of coating is undesirable. For instance, the base to be coated may be so absorbent (as in the case of an undersized paper or fabric) that the liquids of the coating mixture may be taken up to an undesirable extent. Or in another instance the base may be so fragile (for example, a very thin paper, or the undried or partially dried web on a paper machine) that the application and subsequent removal of the excess coating may be likely to break the sheet. Also, in some instances it is desired partially to concentrate the film of coating material before its application to the web.

For these and other reasons, therefore, it is often desirable to apply to the web a definite predetermined quantity of coating material. In the past to serve this purpose the custom has been to use an applicator roll or belt with the quantity of coating mixture thereon limited by a doctor roll or scraper, the layer of coating mixture being transferred from the applicator to the sheet material. This method of limiting the quantity of, and smoothing, the coating layer has not been wholly satisfactory, however. A doctor-roll, for instance, is likely to leave roll marks or ridges in the layer of coating material upon the applicator member. In the transfer of the layer to the web these roll marks or ridges may reappear in the exposed surface of the final coating. On the other hand, when a doctor-blade of metal or other composition is used, lumps or foreign particles in the coating mixture may stick to the blade to cause "drags" or streaks, and these latter may reappear in the exposed surface of the coating after the latter has been transferred to the web. It has been proposed to feed applicator rolls from fountains by means of a series of distributing rolls similar to those feeding ink on a printing press: this system is rather complicated, and may be difficult to keep clean.

In all of the cases mentioned the machining of the metal surfaces (e. g., of the applicator roll, the scraper or the doctor) relied upon for the control of the weight and smoothness of the coating layer must be very accurate, and frequent grinding may be necessary to take care of unequal wearing away of the parts. Furthermore, temperature variations must be avoided if the parts are to remain accurately in position.

Generally speaking, when a web of paper or the like, bearing a layer of fluid coating composition, parts from a roll surface traveling at the same speed, surface tension is liable to pull the coating layer into ridges or roll-marks which mar the coated surface. If the coating layer is extremely limpid, as in the case of true solutions or very dilute suspensions, the coating may immediately flow back to a level surface and the marks will disappear; but in the case of most mineral-coating compositions of the nature generally used for coating paper, the ridges remain as blemishes which must be removed subsequently if the product is to be satisfactory.

It is true that in the special case where a very absorptive base-paper is used and a light application of surfacing composition containing a relatively small quantity of water is applied thereto by means of squeeze-rolls, the water may be sufficiently absorbed from the surface composition into the paper-base so that the surface composition is left in a condition sufficiently dry or "hard" to resist the tendency to form roll marks. The product so made, commonly called "semi-coated" or "filmed" paper, is excellent for many purposes, but it is easily distinguishable from what the trade recognizes as true "coated paper."

An obvious way to avoid formation of roll-marks in any weight of coating on any body-stock is to apply to the paper, by means of applicator rolls, a plastic coating composition which is so definitely non-fluid that the surface is not appreciably affected by surface tension. In practice, however, it has not proved to be easy to spread a coating of such consistency smoothly upon the applicator surface. A doctor-blade of metal or other composition will not satisfactorily smooth coating composition of the non-fluid consistency required. In the first place, it is practically impossible to avoid lumps in non-fluid coating compositions; such lumps lodging on the edge of the doctor-blade cause streaks or "drags" in the film of coating on the applicator roll, which streaks, when the coating has been transferred to the paper web, may reappear as streaks in

the final coating. If a doctor roll be used to spread the coating on the applicator, it is found that the non-fluid, tenacious coating may adhere sufficiently to the doctor-roll to cause blemishes in the film on the applicator, which blemishes may reappear in the coated surface after the coating film has been transferred to the paper web.

As far as I am aware, prior to the present invention only one successful method has been devised for providing a pair of applicator surfaces with non-fluid smooth layers of mineral coating composition suitable for transfer simultaneously to opposite sides of a paper web. The method follows an ingenious but complicated procedure in which fluid or semi-fluid coating composition is applied to the first of a series of co-operating rolls arranged side by side. Alternate rolls have soft rubber surfaces while the intervening rolls have hard surfaces. The nip between each two rolls is very carefully regulated by means of micrometer adjusting screws. Some of the rolls oscillate axially in addition to rotating. The coating composition passes over each of the rolls in turn, and, in such passage, is worked continually by the rubbing action of the rolls. As the coating mixture passes over the series of rolls it loses water by evaporation until by the time it is transferred to the final roll of the series, which is the applicator roll which transfers the coating to the paper web, the coating is definitely non-fluid. The continuous "working" of the coating composition during the dehydration of the mixture is essential to prevent sticking of the coating to the rolls as it dries out. A similar series of rolls is used on each side of the web, so that the two applicator rolls form a pressure nip through which the paper web passes and in which two layers of coating are transferred to the two sides of the web. This method is very satisfactory in many respects: it is practically independent of the weight, strength, or quality of paper base used, and it may be used at practically any speed desired—even up to 1,000 feet a minute or over. Moreover less drying obviously is required when the coating is already nearly dry when applied. A coating layer applied in a non-fluid condition is less liable to penetration by fibers from the surface of the base-paper, and so actually may be thinner than coatings applied by other methods.

It is obvious, however, that the prior art method above described is complex, and that it requires use of equipment which is cumbersome and expensive to install. Moreover, meticulous care on the part of the operator is required in making the delicate adjustment (between rolls) necessary for successful operation of the complicated apparatus.

It is an object of the present invention to provide a simple method of obtaining the same end product as results from the "distributing roll" coating method outlined above. Another object of the invention is to provide much simpler and less expensive equipment for accomplishing like results. Another object is to provide simple and reliable applicator-roll equipment for simultaneously coating both sides of a web of paper. Another object is to provide a method of applying simultaneously to each side of a traveling web a preformed layer of coating material, very uniform in thickness and substantially free from blemish.

More broadly, it is an object of the present invention to provide improved means for applying a paper coating composition to a surface of a paper web, e. g., before or after the latter has been completely dried on the paper machine. It is an object, also, to provide improved means by which a coating film may be concentrated after it has been drawn away from the main body of coating and before it is finally transferred to a surface of a web of sheet material.

Another object is to provide simple and reliable doctoring means for redistributing, evening, and smoothing a layer of coating material on an applicator surface.

The mode of operating the present invention comprises the steps of applying a substantially continuous layer of a fluid or plastic coating composition upon a moving transfer surface capable of being wetted by said composition; directing against said layer of fluid coating composition a jet of compressed air in the form of a rectilinear sheet whose source is disposed parallel to the plane of the transfer surface, the jet being of substantial length and preferably being substantially as long as is the width of the web to be coated and usually being directed at an acute angle to the transfer surface in the direction opposite to the direction of travel of the transfer surface; and conducting a moving web of sheet material into coating-transferring relation with said transfer surface in such manner as to transfer the layer of fluid coating composition from the transfer surface to the web, these steps all being continuous. The moving transfer surface may be that of a transfer, or applicator, roll or a surface of a travelling apron or belt, which roll, apron or belt surface may be, or at least present a surface, of metal, rubber or other suitable composition wettable by the fluid to plastic coating composition employed; it should be smooth and may advantageously be polished.

The expression "fluid coating composition" is intended to include liquids or mixtures of liquids, emulsions, lacquers and varnishes; and solutions and suspensions of solid matter in water or other liquid medium, either with or without binding agents. By the expression "plastic" is here meant a consistency too stiff to permit ready flow but readily susceptible to yielding to pressure. The process and apparatus are particularly advantageous in the coating of paper with a coating composition comprising a suspension of finely divided pigment (e. g., satin white, clay or the like) in an aqueous solution of an adhesive agent (e. g., of casein, starch, glue or equivalent).

In such procedure, the sheet of compressed air, or "air doctor," may be assisted by the force of gravity and act in the same direction as the latter. It may also, however, be directed substantially horizontally or vertically upward. In any case, the impact of the obliquely directed "air brush" forces the fluid coating layer against the transfer surface, removing therefrom surplus coating to any desired degree and smoothing the remaining coating layer into a continuous uniform surface, without the formation of wavy surfaces and striae before its transfer to the paper web.

It is apparent that the conjunction of "air brush" and transfer surface avoids the necessity of the frequent grinding required to keep an applicator roll and co-acting solid doctor roll or scraper in alignment. At the same time, variations in spacing between applicator roll and mechanical doctor due to temperature changes do not occur. Moreover, blemishes in the coating

layer, such as roll marks or drags from dirt lodged on the scraper, are avoided.

The initial density of fluid coating composition which successfully may be applied by this method to a single side of the web may vary from one of the density of water to one denser than can be successfully applied by the usual brush type of coating machine, even one that is definitely non-fluid but plastic. Any desired weight of coating can be applied, varying from a film of considerably less than one pound per 24 x 38—500 ream to a weight several times as great as that used on commercial grades of coated paper.

The above described procedure has been found to be operable for the simultaneous coating of both sides of a web. For effecting the two-sided coating, the coating composition in metered quantity is smoothed by means of suitable jets of air (or their equivalent) directly upon the surfaces of two applicator rolls rotating in opposite directions and arranged to provide a pressure nip at their mutual line of contact; a web of paper is passed through the nip between the applicator rolls, traveling in the direction of travel of the roll surfaces at their line of contact; the layers of coating on the applicator rolls are simultaneously transferred to the two sides of the paper-web in the nip and the coated web is then dried. The jet used on each roll is in the form of a thin sheet of compressed air or other gas, co-extensive with the width of the paper web to be coated, and, preferably, extending substantially entirely along the length of the roll face. The edge of the sheet of air contacts the coating on the roll and has a substantially uniform thickness and velocity through its line of contact with the coating. Preferably, the source of the air-jet is so mounted that the angle between the jet and the roll surface can be varied at will to any desired value. A very suitable nozzle for use in producing the air-jet was disclosed by Killey E. Terry in U. S. Patent No. 2,139,628.

In general, it is preferred that the paper web going into the coating nip be substantially dry. It is possible, however, to use a web that contains up to about 50% of water, as for example a web leaving the wet presses of a paper machine before the application of heat thereto. The invention is particularly applicable to use as a step in the continuous production of paper on a paper-machine, since it is not restricted to use at low speeds or on paper of considerable strength only. Obviously, however, it may be practiced, if desired, as a separate operation entirely apart from the paper machine.

The air-jets may be used merely to smooth the coating on the applicator rolls, or, if desired, they may remove excess coating while simultaneously smoothing the residue. It is preferred, however, that in any case the quantity of coating on the applicator shall previously have been at least roughly limited by some other device, such as a gate-roll or scraper, so that the excess required to be removed by the air-jet shall remain fairly constant throughout any particular run.

The use of air-jets to smooth the coating on the applicators gives this process a marked advantage over methods in which the coating is spread and smoothed on applicators by means of rollers or similar solid "doctoring" devices. When the coating is spread on an applicator by a roll there is always a tendency for roll-marks to be left in the surface of the coating; the magnitude of the marks is generally dependent upon the viscosity or body of the coating mixture—thinner mixtures usually giving more pronounced roll-marks than compositions of higher solids content. When such ridged coating-layers are applied to a paper web in a presure nip, the ridges as well as other blemishes in the coating layer tend to reappear, to some extent at least, in the final surface of the coated paper. In addition to such transferred or secondary blemishes, if the coating composition is too liquid new roll-marks may also appear as the applicator-roll itself leaves the surface of the paper. However, since all paper webs are absorptive to a greater or lesser extent, some water is absorbed from the coating layer into the web in the pressure nip, so that the coating layer on the paper is harder as it leaves the applicator-nip than before it enters. Hence in a particular case it may happen that no noticeable new roll-marks are formed in the transfer-nip, but nevertheless the coated surface of the paper may be spoiled by secondary marks which were made in the coating layer when it was spread on the applicator roll and carried through the applicator-nip to the surface of the final coated papers. This latter difficulty is of course entirely avoided by use of an air-jet to spread a perfectly smooth layer on the applicator in the first place. Therefore by use of air-jets to smooth the layers of coating on the applicators according to the invention no blemishes are ever formed in the layer on the applicator roll, and consequently coating compositions may be used satisfactorily which have lower contents of solids and are more liquid than can be used in cases where rolls are used to spread the coating upon applicators. More than this, in cases where the coating applied to the web is so liquid that roll-marks are actually formed as the web leaves the applicator-nip, there still are no secondary marks transferred to the paper by the applicator-rolls; so less smoothing action by any succeeding auxiliary smoothing device is required than is the case where rolls have been used to spread the same liquid coating upon the applicators, and both primary and secondary marks have to be eliminated.

Typical embodiments for carrying out the concepts of the invention will be described hereinafter with reference to the accompanying drawings, in which:

Fig. 1 is a schematic view representing apparatus suitable for the practice of the process of the present invention and illustrating a Fourdrinier machine of conventional type including coating mechanism of a form particularly adapted to the coating process of the invention;

Figs. 2, 3 and 4 are schematic views illustrating modifications of the coating mechanism of Fig. 1, and adjuncts thereto;

Fig. 5 is a schematic view of apparatus suitable for use in the simultaneous coating of the two sides of a paper web;

Fig. 6 is a schematic view illustrating a modification of the coating mechanism of Fig. 5, and

Fig. 7 is a sectional view, on an enlarged scale, of a preferred form of air doctor means and mounting, for carrying out the process of the invention.

With reference to Fig. 1 of the drawings, and to the coating of a single side of a paper web, in a typical instance of carrying out the invention, a web of paper 1, after having been formed on the Fourdrinier wire 2, is passed between press

rolls 3 and 4, thence between an applicator roll 5 and squeeze roll 6, after which it may be, and preferably is, passed to a bank of drying cylinders (not shown), after which it may, if desired, be calendered and reeled up. Or, the applicator roll 5, and its cooperating squeeze roll 6, may be placed at any other desired point on the machine, e. g., between sections of the driers; in such case, the coating, smoothed on applicator roll 5, is transferred to the formed and partially dried web of paper 1 after which the so-coated paper is finish dried by passage over the succeeding bank or banks of drying cylinders.

Applicator roll 5 dips into a tank 9, containing a body of fluid coating suspension of suitable fluidity, which may be prepared in known ways and is supplied from storage tank 8 by means of pump 13, any surplus therefrom returning to the tank through overflow 14. The applicator roll 5 presents a smooth and polished metal surface wettable by the fluid suspension. As the roll 5 rotates it takes up a layer of coating material which may be relatively uniform in thickness but which is in excess of the amount ultimately required. As the roll continues to rotate it carries the layer of coating through a jet of compressed air from air doctor 12. A source of compressed air is represented at 10. 11 is a conduit communicating between compressed air source 10 and air doctor 12, for supplying the latter with air under pressure.

For controlling the thickness and smoothness of the fluid coating layer on the moving transfer surface, in accordance with the present invention, there may be used any suitable air doctor capable of delivering an accurately controlled rectilinear sheet of air, preferably substantially non-divergent in character. Thus, there may be employed the Terry air doctor referred to above, or the air doctor disclosed in United States Patent No. 1,980,923 to Lebel. The air doctor is so mounted with respect to the moving transfer surface that the angle of impingement may be adjusted and also that the distance between the source of the air sheet and the fluid coating layer to be redistributed likewise may be varied. The air doctor structure preferably should be such that the width of the rectilinear slot through which the air sheet is expelled may be varied.

By suitably adjusting the thickness of the air sheet, the pressure applied upon the air, and the angle at which the air sheet strikes the fluid coating layer carried on the moving transfer surface, it is found that the superficial portion of the layer of fluid coating material is uniformly wiped back and distributed over the width of the transfer surface, leaving a free continuous coating of uniform consistency and characteristics and of the desired depth or thickness. For example, an instance of satisfactory operation of the apparatus described was obtained with a jet of air 0.027" thick, having an air pressure of four pounds per square inch and directed at an angle of 35° to the tangent of an 18 inch polished brass, or rubber, transfer roll, rotating at a speed of 300 linear feet per minute and operating on the following fluid coating composition:

	Pounds
Calcium carbonate	67
Oxidized starch	33
Water	900

the re-distributed and evened coating, in an amount to yield a coating which, when dried, weighs about 2 pounds per 25 x 38—500 ream, being transferred from said transfer roll to a paper web moving at a rate of about 300 linear feet per minute. For varying compositions and thicknesses of coating, and different types of paper, speeds of sheet travel, etc., operating conditions may be altered accordingly, within the scope of the invention.

As the applicator roll 5 rotates beyond the air brush produced by air doctor 12 the definitely limited and smoothed layer of coating is carried to the nip between rolls 5 and 6 where the coating layer is transferred to and squeezed into the surface of the fibrous web as the sheet passes between the rolls. The coated web may then pass to a series of drying cylinders (not shown), where it is dried in the customary manner.

In the embodiment of the invention shown in Fig. 2 a continuous sheet 15 of paper or fabric is taken from reel 16 over a series of guide rolls 17, thence between applicator roll 18 and squeeze roll 19, thence over guide roll 20 to suction apron 21 and to a festoon or other drier (not shown). As before, the applicator roll dips into a tank of coating mixture and rotates past an air brush produced by air doctor 12 which spreads the coating on the roll and limits the quantity to the desired degree. Fig. 2 shows the applicator roll rotating in a direction opposite to the direction of travel of sheet 15. The applicator roll may, however, if desired, rotate in the same direction as the travel of the sheet, as shown in Fig. 1. The peripheral speed of the applicator roll may be the same as or more or less than the speed of travel of the sheet as desired. The quantity of coating on the applicator roll may be roughly limited if desired, by a squeeze roll, as shown by element 22 in Fig. 3, prior to the final limiting and smoothing action of the air brush. If desired the sheet may be held against the applicator roll by its own tension between rolls 23 and 24, as shown in Fig. 3.

In Fig. 4, the applicator roll is replaced by a travelling apron 25 supported by rolls 26, 27, 28. The apron may be a metal belt or one of rubber or other flexible material having an impervious surface capable of being wetted by the coating mixture. A roll 22 dips into a tank 9, containing a body of fluid coating suspension of suitable fluidity, and carries therefrom a layer of coating which is transferred to the travelling apron 25; the latter carries the layer of coating through a jet of compressed air from air doctor 12, by means of which jet the coating is re-distributed and smoothed, excess coating being wiped back. Thereafter, the travelling apron 25 carries the definitely limited and smoothed layer of coating into coating-transferring relation with the moving sheet 15 tensioned between rolls 17 and 19, whereby the layer of coating is transferred onto the adjacent surface of said sheet. The coated web then passes over guide roll 20 to suction apron 21, and thence to a festoon or other drier (not shown). This arrangement makes possible a thickening of the coating before its transfer to the web, by evaporation of water from the layer of coating. The extent of thickening may be influenced by the extent of travel of the apron from the point of application of the coating to the point of contact of the coating layer with the paper web. Or, the extent of thickening may be influenced by heating the apron and the layer of coating carried thereon as by application of a current of heated air to the layer in transit.

According to the embodiment shown in Fig. 5,

a web of paper 31 is delivered from a series of drying cans 32, passes over guide rolls 33, and thence between pressure applicator rolls 34 and 35 which rotate so that the surfaces contacting the paper travel with the paper. Coating composition 36, in a pasty, non-fluid condition, is fed by any conventional means (not shown) to a nip between applicator roll 34 and gate-roll or feed-roll 37. Gate-roll 37 is mounted with its axis parallel to that of roll 34 and is adjustable so that the space between the two rolls may be varied. Gate roll 37 is driven to rotate in a direction opposite to the rotation of roll 34, and the speed of rotation may be varied at will independent of the speed of roll 34. Dams (not shown) are mounted near the ends of rolls 34 and 37 to prevent the coating composition from being lost over the ends of the rolls. The quantity of coating carried by roll 34 may be varied either by varying the gap between the two rolls 34 and 37, or by varying the speed of roll 37, or by both these measures. The layer spread on roll 34 by roll 37 is not smooth, however, but contains streaks and in some instances may show that roll 37 has actually carried away part of the coating on its own surface. The rough layer of coating on roll 34 then passes by nozzle 38 which delivers a jet of air against the coating layer with sufficient velocity to press the layer firmly against roll 34 and to redistribute and level the outer surface of the coating layer.

A similar layer of coating is applied in identical fashion to applicator roll 35. A reservoir of pasty coating composition 36' is fed into the nip between roll 35 and gate-roll 39, which latter spreads a metered quantity of the composition roughly upon roll 35. The rough layer is smoothed and leveled by an air-jet from air doctor 40.

The smoothed layers of coating upon rolls 34 and 35 are simultaneously transferred to the two sides of web 31 as the latter passes through the pressure nip between the two rolls. The coated web may then advantageously pass through a hot air drier 41, over guide roll 42 and thereafter over a series of drying cans 43. Drier 41 is used as a precautionary device to guard against possible sticking of the coating against the surfaces of the succeeding guide rolls and drying cans; its use is not absolutely required, however.

As has been indicated hereinbefore, the devices 38 and 40 may be caused to deliver a jet of gas other than air, and hence the term "air doctor" is intended to apply to the device regardless of the gaseous fluid, which said device is caused to discharge. Whatever the identity of the gaseous fluid delivered by the air doctors, it is ejected from the latter as a rectilinear sheet and under a considerable pressure. Each of the devices 38 and 40 is of substantial length, preferably being as long as the web to be coated is wide. Means are provided for varying at will the thickness of the air sheet ejected by each air doctor, as are means for varying the angle at which the ejected air sheet is caused to strike the coating composition layer carried on the travelling applicator surface and for varying the distance between the discharge of each air doctor and the travelling applicator surface with which it cooperates.

According to the modification shown in Fig. 6, a paper web 44 from a source indicated generally at 45, which may be either a reel or some part of a paper machine (such, for instance, as the wet presses, or the drying cans) is led into the nip between pressure applicator-rolls 46 and 47. These applicator rolls rotate in the direction of travel of the paper web and at a peripheral speed which is substantially the same as the linear speed of the paper web. Roll 49 turning in a reservoir 48 of the coating composition is rotated opposite to the direction of rotation of roll 46. The coating composition is applied to roll 46 by roll 49 in an amount slightly in excess of the final desired weight. As the rough layer of coating on roll 46 is carried past air doctor 50 the latter delivers against the coating a jet of air which removes the excess coating and redistributes and smooths the desired remainder upon the surface of roll 46. In exactly the same way coating from reservoir 51 is spread by roll 52 upon roll 47 where it is limited, redistributed and smoothed by an air jet from air doctor 53. The layers of smoothed coating on rolls 46 and 47 are simultaneously transferred to the two sides of paper web 44 at the moment the latter is pressed in the nip between rolls 46 and 47. The coated web is then carried to any suitable drying means indicated generally at 54.

If necessary, auxiliary smoothers may be employed after the web has passed out of the nip between the applicator rolls.

It is to be noted, finally, that the angularity of the jet or ribbon of air from the air doctor to be selected in any particular case is dependent in part upon whether the air jet is to function merely to redistribute, flatten and smooth an already roughly limited layer of coating or whether in addition to these functions it must also remove excess coating from the transfer surface. Thus, where excess coating is to be removed I prefer so to adjust the direction of the air doctor that the air jet is projected at an acute angle with respect to the transfer surface and in a direction opposite to the direction of travel of the latter. This is illustrated in Figs. 1 to 4 inclusive of the drawings. But where the coating layer already has been limited in amount, I may, as is illustrated in Figs. 5 and 6, direct the air jet perpendicularly with respect to the transfer surface.

In Fig. 7 the construction and mounting of a preferred form of air doctor 12 are shown in greater detail. According thereto, the air doctor includes a plenum chamber formed by a casing 61, provided at each end with a tubular sleeve or extension 62 each of which serves as a trunnion upon which the casing may be adjustably carried in complemental arms 63 pivoted, at 64 in similar slides 65 which may be suitably mounted upon the frame of the coating machine. One or both of these tubular extensions 62 may function also as means for introduction of air into the plenum chamber, and for that purpose may be connected with conduit 11 carrying compressed air from source 10 (shown in Fig. 1).

Angular adjustment of the nozzle with respect to the periphery of applicator roll 5 may be accomplished by means of adjusting screws 66 carried by the arms 63 and bearing against stops 67 carried by slides 65, and by adjusting screws 68 which provide for relative rotative movement between collars 69 clamped to trunnion extension 62 and collars 70 forming parts of the arms 63, these adjusting screws 68 cooperating with swivel members 71 and 72, carried by ears 7 and 74 extending radially from collars 69 and 70, respectively.

The nozzle itself is defined by plate members 75 and 76 secured to casing 61 and providing between their outer extremities a slit opening 77. For varying the thickness of the air sheet delivered through opening 77, there may be pro-

vided one or more warping means 78, as shown, which may be adjusted at will to hold the extremities of plate members 75 and 76 at any desired spacing.

This application contains subject matter in common with, and is a continuation-in-part of my copending application Serial No. 77,848, filed May 4, 1936, entitled "Paper coating apparatus."

I claim:

1. In an apparatus for coating a web of paper and similar fibrous sheet material with a fluid coating composition of the class including an impervious travelling transfer surface, means for depositing onto said travelling transfer surface a layer of the fluid coating composition, a doctor means for smoothing and re-distributing the coating composition layer on said travelling transfer surface, and means beyond the doctor means for moving the web of fibrous sheet material into and out of coating-trasferring relation with said transfer surface, the combination wherein the doctor means is an air doctor adapted to deliver therefrom a sheet of air under pressure, said air doctor being substantially as long as the web to be coated is wide, being disposed substantially parallel to the plane of the transfer surface and transversely of and adjacent to the latter, and means in co-operation with said air doctor for delivering compressed air thereto, said air doctor being so disposed as to deliver a sheet of air obliquely with respect to the transfer surface.

2. In an apparatus for coating a web of paper and similar fibrous sheet material with a fluid coating composition of the class including a smooth travelling transfer surface, means for depositing onto said travelling transfer surface a layer of the fluid coating composition, a doctor means for smoothing and re-distributing the coating composition layer on said travelling transfer surface, and means beyond the doctor means for moving the web of fibrous sheet material into and out of coating-transferring relation with said transfer surface, the combination wherein the doctor means is an air doctor adapted to deliver therefrom a sheet of air under pressure, said air doctor being substantially as long as the transfer surface is wide, being disposed substantially parallel to the plane of the transfer surface and transversely of and adjacent to the latter, and being provided with means for varying the thickness of the air sheet delivered thereby, with means for varying the angle at which such air sheet strikes the coating composition layer carried on the travelling transfer surface, and with means for varying the distance between the air doctor and the travelling transfer surface, and means in co-operation with said air doctor for delivering compressed air thereto, said air doctor being so disposed as to deliver a sheet of air obliquely with respect to the transfer surface.

3. In an apparatus for simultaneously coating both sides of a moving web of the class including a co-operating pair of pressure applicator rolls rotatable in opposite directions, means for depositing onto the applicator rolls layers of coating composition, plural doctor means for smoothing and redistributing said layers, and means for advancing the moving web through the nip between the applicator rolls in the direction of rotation of the applicator rolls, the combination wherein each of the doctor means is an air doctor adapted to deliver therefrom a continuous sheet of air under pressure, each of said air doctors being substantially as long as the web to be coated is wide and being disposed substantially parallel to the plane of the surface of its co-operating applicator roll and transversely of and adjacent to the latter, each of said air doctors being provided with means for delivering compressed air thereto and being so disposed as to deliver a sheet of air obliquely with respect to its cooperating applicator roll.

4. In the continuous process of coating both surfaces of a web of paper, cloth or similar fibrous sheet material with a mineral coating composition involving the steps of applying substantially continuous layers of the coating composition upon a pair of opposed smooth travelling transfer surfaces providing a pressure nip, smoothing, evening and redistributing the layers of coating composition on said surfaces, and conducting a moving web of the fibrous sheet material to be coated through said nip in such manner as to effect transfer of the smoothed layers of coating composition from the opposed travelling transfer surfaces to the opposite sides of the web, the improvement which consists in smoothing, evening and redistributing the layers of coating compositions while supported on the transfer surfaces by directing obliquely against each of them a jet of compressed gaseous fluid in the form of a continuous rectilinear substantially non-divergent sheet, said jet being substantially as long as the web is wide.

5. In the continuous process of coating both surfaces of a web of paper, cloth or similar fibrous sheet material with mineral coating composition involving the steps of applying substantially continuous layers of the coating composition upon a pair of opposed smooth travelling transfer surfaces providing a pressure nip, smoothing, evening and redistributing the layers of coating composition on said surfaces, and conducting a moving web of the fibrous sheet material to be coated through said nip in such manner as to effect transfer of the smoothed layers of coating composition from the opposed travelling transfer surfaces to the opposite sides of the web, the improvement which consists in causing each of the transfer surfaces to dip into a body of the coating composition and to remove therefrom coating composition in excess of that amount which is to be transferred to the web, roughly limiting the amounts of composition retained on the transfer surfaces, and smoothing, evening and redistributing the layers of coating composition while supported on the transfer surfaces by directing obliquely against each of them a jet of compressed gaseous fluid in the form of a continuous rectilinear substantially non-divergent sheet, said jet being substantially as long as the web is wide.

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