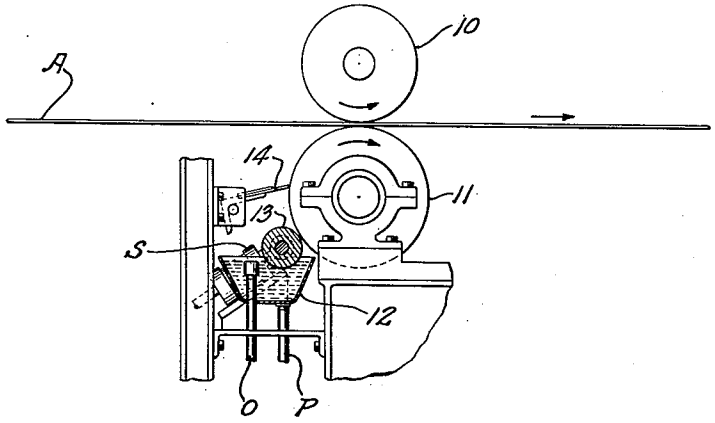
Jan. 2, 1940. P. J. MASSEY 2,185,859

METHOD OF COATING PAPER

Filed Nov. 14, 1938 2 Sheets-Sheet 1

Fig. 1



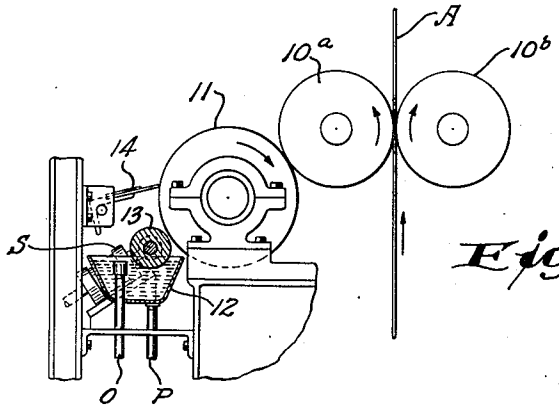


Fig. 2.

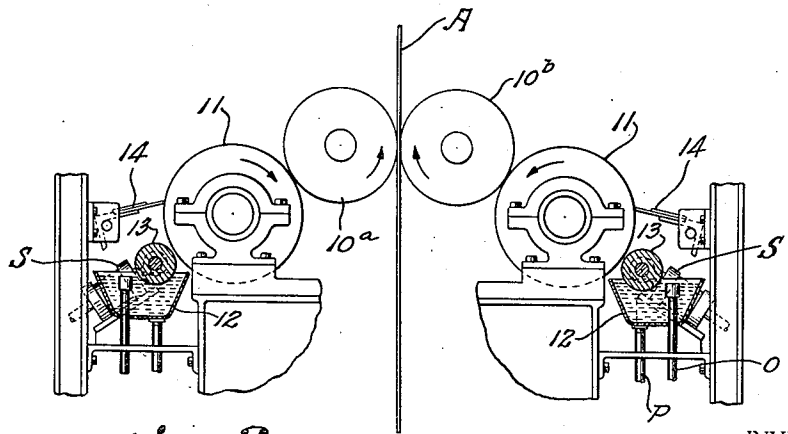


Fig. 3.

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Filed Nov. 14, 1938 2 Sheets-Sheet 2

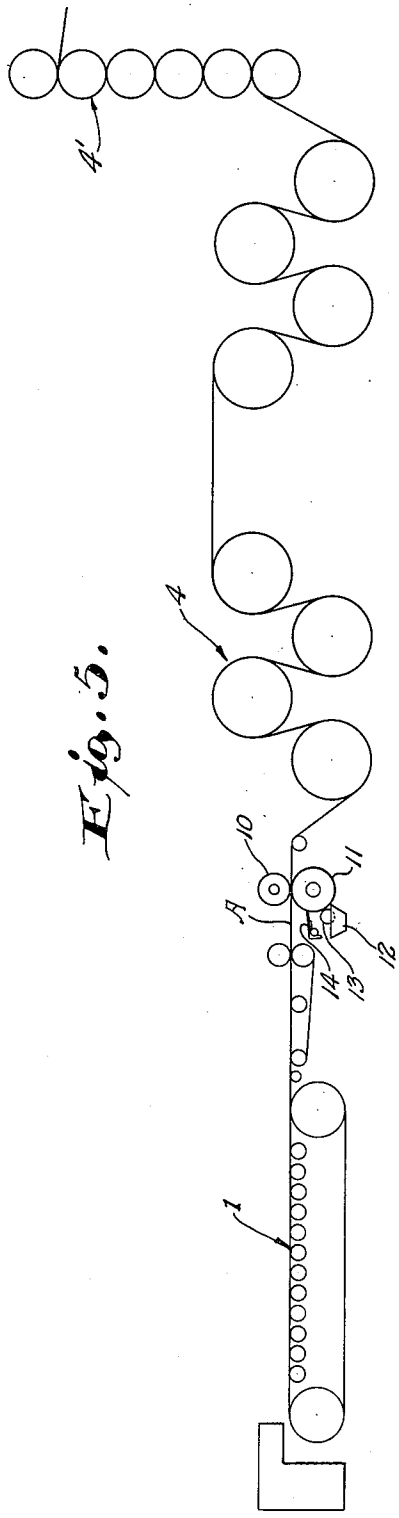


Fig. 5.

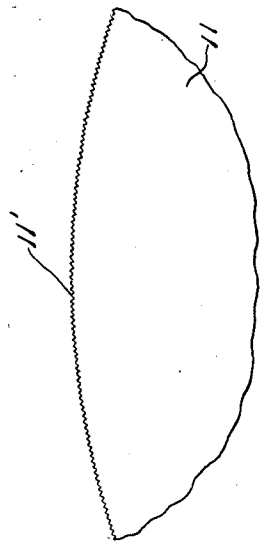


Fig. 4.

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Patented Jan. 2, 1940 2,185,859

UNITED STATES PATENT OFFICE

2,185,859

METHOD OF COATING PAPER

Peter Jay Massey, River Forest, Ill.

Application November 14, 1938, Serial No. 240,211

7 Claims. (Cl. 91—68)

This invention relates to a method of producing a sheet of paper to improve its formation and its surface and to enhance its printing properties. The method involves impregnation as well as coating of the sheet.

The present application is a continuation in part of my application for "Process and apparatus for coating paper" filed April 24, 1937, Serial No. 138,724.

The object of the invention is to produce a sheet of paper which has a smooth, plane surface, the desired opacity and color, and the other properties desirable in a sheet of paper which is used for high speed printing, and to accomplish this at comparatively slight expense and in such a way as not to impair in any degree the capacity of the paper making machine for sustained high speed production.

The present invention proposes to incorporate in the sheet as the sheet is being produced an aqueous suspension of a filler, usually a mineral such as titanium dioxide and an adhesive such as a mixture of casein and starch. This liquid suspension is applied to the sheet as a film of pre-determined thickness and consistency and is enmeshed with the fibers of the sheet and smoothed and compacted and made an integral part thereof at the time it is applied thereto. The perfect bond thus effected between the suspension and the fibers precludes subsequent lifting, flaking, blistering or dusting of the surfaces of the web or sheet.

In carrying out the present invention the film is formed by supplying an aqueous solution or suspension of a mineral and an adhesive to a transfer or film forming surface susceptible of being wet by the liquid suspension and having a multiplicity of minute, closely adjacent depressions or pits, the lower areas or valleys of which are in open communication and the peaks or high areas of which are isolated.

The transfer surface which is usually produced on the periphery of a roll is prepared by sand blasting the roll surface, although of course, the type of transfer surface employed in practicing the present method may be produced in various other ways as by knurling, etching, electrodeposition, engraving, or equivalent suitable processes.

Such a transfer surface allows the suspension freedom of flow so that the pits or depressions are instantaneously filled, when the liquid suspension is supplied to the surface, with the liquid in immediate contact with all of the surfaces of the hills and valleys of the roll surface. Moreover, the uniformly irregular formations of the pits or depressions are such that, with the liquid suspension in immediate contact therewith, the interfacial tension or molecular attraction exerted between the roll surface formations and the liquid suspension acts not only radially but also along lines extending circumferentially, transversely, and at various angles with respect to the periphery of the roll. This, together with the surface tension of the liquid suspension is believed to be the cause of the formation of the film of predetermined, uniform average or mean thickness.

The action is facilitated by supplying a controlled excess of the liquid suspension to the transfer surface and then removing the excess by means of a doctor.

As soon as the film is formed it may be readily applied to the web of paper, as the web advances through the machine, either by direct contact of the film on the transfer surface with a surface of the web or by means of one or more transfer rolls.

A film of this character is very effectively bonded to and incorporated in the structure of a sheet under the influence of rolling contact pressure and becomes an integral part of the sheet, interlocking with the fibers thereof. The result is a very much improved sheet of paper, one which has a flat, smooth, plane surface, has the desired opacity, color, and other properties, which render it ideally fit for printing.

The thickness of the film on the finished sheet or web, or in other words the weight of the coating, may be controlled by varying the consistency of the suspension. By increasing the amount of water in the suspension the film may be made thinner, since the water is evaporated out of the sheet during its progress through the machine. It may also be controlled by varying the depth of the pits or depressions.

With the present method one or both sides of the sheet may be surfaced and where both sides are surfaced, this may be accomplished successively or simultaneously. In the drawings there is illustrated diagrammatically several machines which the present invention contemplates for carrying out or practicing the method.

In the drawings,

Figure 1 is a diagrammatic view in elevation illustrating one type of apparatus that may be employed;

Figure 2 is a similar view showing another type of apparatus;

Figure 3 is a view similar to Figures 1 and 2 but showing the apparatus adapted for simultaneously coating both sides of a web of paper;

Figure 4 is a detail diagrammatic view illustrating generally the intaglio surface of a film forming roll; and

Figure 5 is a diagrammatic view in elevation illustrating one way in which the apparatus may be embodied in a paper making machine.

For the purpose of example and as illustrating the general type of apparatus which will func-

tion satisfactorily in carrying out the present invention, a conventional Fourdrinier forming part is illustrated, but any other suitable web forming mechanism may be used. In Figure 5 the web forming means is designated generally at 1. The web of paper is designated at A, and after traveling over the couch rolls is passed through the first press.

The apparatus for carrying out the method constituting the present invention may be built into the machine at any point. In Figure 5 it is shown as being positioned to take the web as it leaves the first press or breaker stack. It may however, be advantageously located in the dryer section. If located after eight or ten dryers, economies are effected in cutting down the percentage of adhesive in the coating suspension. Any of the instrumentalities illustrated in Figures 1, 2 and 3 for applying the coating material may be built into the paper making machine at the selected point.

In the apparatus shown in Figures 1 and 5, the web of paper is conducted through the nip of a pair of rolls designated at 10 and 11. The roll 10 is elastic or resilient, preferably soft rubber. It is essential that the surface portion at least of the roll 10 have the requisite elasticity. Of course, the material used may be varied. It may not only be rubber but also paper, leather, or some suitable composition.

The roll 11 is rigid and its essential and characteristic feature is an intaglio surface formed with a multiplicity of closely adjacent, minute depressions or pits of such character that the liquid suspension when supplied to the surface will form a film of pre-determined thickness which may be applied as such and bonded with the sheet or web of paper. The multiplicity of closely adjacent, minute pits or depressions on the surface of the roll 11 are of such character that the low points or valleys thereof are in open communication whereas the high points or peaks are isolated. Such a surface formation allows the liquid suspension freedom of flow, provides a surface which the liquid suspension will wet and one on which it will form a definite film of uniform average or mean thickness, and also allows the surface tension of the liquid suspension to act to best advantage not only in the formation of the film but also during its application to and incorporation in the web of paper. Under the influence of its surface tension the film is self-levelling both on the transfer roll and on the web when it is applied thereto. It has been found that rolls or bronze or gun metal, chromium plated and sand blasted may be advantageously employed. Blasting a phosphorus bronze roll with a No. 50 steel grit at eighty pounds pressure will produce on the surface of the roll an intaglio design of proper mesh or character and of a uniform depth of pit of .003".

Of course, a roll with the desired type of intaglio surface may be produced in other ways. It may be knurled, etched, or produced by the electro deposition process or by engraving, or in any other suitable way. However, sand blasting is simple, economical, and a very satisfactory method and may be controlled to get the character of surface desired and the depth of pit desired, and furthermore, produce a surface of uniform character. While the formations making up the individual pits are irregular, the pits are similar to each other so that the surface as a whole is uniform in character.

The intaglio surface of the film forming roll produced in the manner described is to be distinguished from those commonly used in heliograving, rotograving, and the like, and which are characterized by a plurality of microscopic lines of capillary dimensions intersecting one another, usually at right angles, and defining isolated pits of regular form, usually rectangular. In such a screen the high points or boundaries of the pits are continuous in character but the pits are isolated. The intaglio surface of the film forming roll 11, on the other hand, has isolated peaks and freely communicating and continuous low areas or valleys and there is continuously varying irregularity in the communicating paths between the pits, although the pits are of uniform depth and the pits in any unit area of the roll surface are uniform and similar in general character. In Figure 4, the intaglio surface of the film forming roll 11 is illustrated diagrammatically and is designated at 11'.

The rolls 10 and 11 are in rolling pressure contact and when the paper web 2 is passed between them, have similar contact with it. The rolls used are not crowned. The pressure used is only contact pressure with set screws to maintain uniform contact constant.

The roll 11 is supplied with a liquid suspension of the coating material in some suitable way. One way in which this may be accomplished is illustrated in Figure 1 and the means there shown comprise a trough or pan 12 in which a constant level of the liquid suspension is maintained in any suitable way, as for example, by means of a supply pipe P and an overflow pipe O. An applicator roll 13 is partially submerged in the liquid suspension in the pan or trough and its peripheral surface is closely adjacent the lower peripheral surface of the transfer or intaglio roll 11. The rotating roll 13 picks up the liquid suspension and supplies it to the surface of the intaglio roll. The applicator roll is not in actual contact with the transfer roll but is slightly spaced therefrom. The setting of the applicator roll, under the regulation of suitable setting means S, determines the space between the two rolls and the amount of coating suspension supplied by the applicator roll to the intaglio transfer roll.

The applicator roll supplies a controlled excess of liquid suspension to the transfer roll. A doctor 14 coacts with the ascending side of the intaglio roll 11 and functions to remove the excess coating material supplied to the roll by the applicator roll. The doctor is preferably oscillated to preclude accumulation of coating material on its lip, to improve its smoothing action, and to aid the trickling of the excess back to the trough.

The coating material supplied to the surface of the intaglio roll flows through the communicating valleys of their surface and around its peaks by virtue of the mutual molecular attraction between the roll surface and the liquid suspension in contact therewith and under the influence of its own surface tension. The intaglio surface of the roll 11 is water receptive, that is, is wet by the aqueous liquid suspension. This wetting of the roll surface by the liquid suspension brings the two into such intimate contact that their mutual molecular attraction can act to best advantage. After the doctor has acted on the film it is of the desired and correct thickness and is uniformly average in character so that it may be directly transferred to and bonded with the surface of a wet web of paper.

The application of the film to the surface of the web is under the influence of rolling contact pressure and as the film is transferred to the web of paper its surface tension is a factor in effecting its uniform application to the sheet of paper. In one operation the film is transferred to the web, is incorporated therein, and is smoothed out.

After leaving the rolls 10 and 11, the web is run through a battery of dryers 4 and calender stack 4' and is finished up in the usual way.

Various coating materials may be utilized in practicing the method of the present invention. As indicated, the coating material comprises generally a liquid suspension of a mineral and an adhesive. Examples of mineral pigments that have been employed successfully are titanium dioxide, Georgia kaolin coating clay, and Edgar Bros. "No-Karb." Examples of adhesives that have been successfully used are starch, casein and soy bean flour. Also glue, linseed oil, gum arabic, resin, rosin, and glucose may be employed. Borax is employed to peptize the pigment. Some of the best results have been secured with an adhesive consisting of one-third casein and two-thirds starch. The invention contemplates coating compounds soluble in water or in oil, or in water with oil as the inner phase with either vegetable or mineral binders.

The following are some of the formulas of coating contemplated, the numbers signifying the parts by weight of the various ingredients. The proportions are representative however, rather than limiting.

Clay	100	Clay	100	Clay	100
Starch	25	Glue	20	Casein	13
Glucose	30	Turkey red oil	8	Glucose	30
Glycerine	8	Glucose	10	H_2O	112
H_2O	140	H_2O	115		
Clay	90	Clay	75	Clay	37.5
Titanium oxide	10	Satin white	25	Lithopone	12.5
Starch	25	Hercules gum	31	Glucose	6.5
Glycerine	10	Turkey red oil	8	Starch	13.5
H_2O	130	H_2O	116	H_2O	80
Calcium carb	85	Clay	50	Clay	90
Clay	15	Titanium oxide	50	Satin white	90
Starch	25	Starch	25	Mahogany soap	25
Glucose	20	Mahogany soap	20	Glue	20
Glycerine	10	H_2O	175	H_2O	240
H_2O	135				
		Clay	65		
		Barium sul	20		
		Titanium dioxide	15		
		Mahogany soap	20		
		Linseed oil	15		
		Rosin	5		
		H_2O	163		

The weight of the coating incorporated in the sheet of paper in practicing the method of the present invention is in direct ratio to the depth of the pits or depressions and the consistency of the liquid suspension. With a standard depth of pit maintained, variation of the consistency of the liquid suspension will vary the coating weight. On the other hand, with a standard consistency maintained, variation of the depth of the pit will vary the coating weight. Usually, control over the coating weight will be effected by variation of the consistency since it is easier to change the consistency than to change the transfer rolls.

With a phosphorous bronze roll blasted with a No. 50 steel grit at eighty pounds pressure to produce pits or depressions having a depth of .003" the weight of the coating will vary as the water content of the liquid suspension as follows: 10% mineral content=1# per ream per side; 20% mineral content=2½# per ream per side; 40% mineral content=6# per ream per side; and 45% mineral content=8¼# per ream per side, ream being the normal trade custom ream for book papers, i. e. 25" x 38" x 500 sheets.

In producing papers requiring 10# or more per ream per side the roll is given an additional operation, as coating beyond 60% solid is, at present, impractical as same would be too high in viscosity and not have sufficient flow. Therefore, when 10# or more are required, the roll, after being sand blasted as above to .003" is topped by rolling up with a resist and etched with iron chloride or other acid etch combinations to a depth of .005". The etched roll will produce a film of 12# per ream with 37.5% mineral content and 15# per ream with 45% mineral content coating.

In the type of apparatus illustrated in Figure 2 the film forming roll 11, applicator roll 13, trough 12, and doctor 14 and associated instrumentalities are employed as before. In addition, the apparatus in Figure 2 employs an elastic or rubber roll 10a which is disposed to one side of the roll 11 in pressure contact therewith and in cooperative relation, that is, in rolling pressure contact with a similar elastic or rubber roll 10b. In this type of structure the paper web A is conducted through the nip of the rolls 10a and 10b. The roll 10a transfers the film or coating from the roll 11 to one surface of the paper web, the roll 10b supplying the pressure contact to complete this transfer and cause the film applied to the web to be bonded therewith and incorporated therein.

The type of apparatus shown in Figure 3 is designed to simultaneously apply coating material to both sides of the sheet or web. It is similar to the structure shown in Figures 1 and 2 save that the roll 10b also has associated therewith a film forming roll 11, an applicator roll 13, trough 12, and doctor 14, and their associated instrumentalities.

It is to be understood that the horizontal position of the rolls shown in Figure 3 is not essential. The resilient rollers which effect the transfer of the film of coating material to the surfaces of the sheet or web and the film forming rolls themselves may be vertically alined or disposed in a vertical stack and the troughs appropriately associated therewith.

It is to be understood that the particular examples indicated above are illustrative rather than restrictive and that various changes may be made without departing from the spirit of the invention or the scope of the subjoined claims.

The invention claimed is:

1. The herein described method of producing paper suitable for printing which comprises advancing a wet web of paper, force flowing a controlled excess of a liquid suspension of surfacing material comprising a pigment and an adhesive onto a rotating film forming transfer surface

susceptible of being wet thereby and dimensionally pitted for substantially uniform volumetric measurement and for free flowing of the suspension from pit to pit about the periphery of said surface, varying the consistency of the suspension to control the weight of the surfacing finally incorporated in the web, doctoring away the excess of surfacing material, forming a continuous film of predetermined uniform average thickness on said surface by the mutual action of the molecular forces of said suspension and said surface, bringing a surface of the web as it is advanced into contact with a surface of said film after it has been formed, subjecting the portion of the web in contact with the film to rolling contact pressure to cause the film to enmesh with the fibers of the web and be smoothed and compacted and made an integral part thereof as it is applied thereto, and drying the web.

2. The herein described method of producing paper suitable for printing which comprises advancing a wet web of paper, force flowing a controlled excess of a liquid suspension of surfacing material comprising a pigment and an adhesive onto a rotating film forming transfer surface susceptible of being wet thereby and dimensionally pitted for substantially uniform volumetric measurement and for free flowing of the suspension from pit to pit about the periphery of said surface, doctoring away the excess of surfacing material, forming a continuous film of pre-determined uniform average thickness on said surface by the mutual action of the molecular forces of said suspension and said surface, bringing a surface of the web as it is advanced into contact with a surface of said film after it has been formed, subjecting the portion of the web in contact with the film to rolling contact pressure to cause the film to enmesh with the fibers of the web and be smoothed and compacted and made an integral part thereof as it is applied thereto, and drying the web.

3. The herein described method of producing paper suitable for printing which comprises advancing a wet web of paper, flowing a liquid suspension of surfacing material comprising a pigment and an adhesive onto a rotating film forming transfer surface susceptible of being wet thereby and dimensionally pitted for substantially uniform volumetric measurement and for free flowing of the suspension from pit to pit about the periphery of said surface, forming a continuous film of predetermined uniform average thickness on said surface by the mutual action of the molecular forces of said suspension and said surface, bringing a surface of the web as it is advanced into contact with a wet surface of said film after it has been formed, subjecting the portion of web in contact with the film to rolling contact pressure to cause the film to enmesh with the fibers of the web and be smoothed and compacted and made an integral part thereof as it is applied thereto, and drying the web.

4. The herein described method of producing paper suitable for printing which comprises advancing a web of paper, flowing a liquid suspension of surfacing material comprising a pigment and an adhesive onto a film forming transfer surface susceptible of being wet thereby and dimensionally pitted for volumetric measurement and for free flowing of the suspension from pit to pit, forming a continuous film of surfacing material of pre-determined uniform average thickness on said pitted surface by the mutual action of the molecular forces of said suspension and said transfer surface, and transferring continuously the film, as finally formed, to a surface of the web as it is being advanced.

5. The herein described method of producing paper suitable for printing which comprises advancing a web of paper, force flowing a controlled excess of a liquid suspension of surfacing material comprising a pigment and an adhesive onto a rotating film forming transfer surface susceptible of being wet thereby and dimensionally pitted for substantially uniform volumetric measurement and for free flowing of the suspension from pit to pit about the periphery of the surface, doctoring away the excess of surfacing material, forming a continuous film of predetermined uniform average thickness on said surface by the mutual action of the molecular forces of said suspension and said surface, bringing a surface of the web into contact with a surface of said film after it has been formed, and subjecting the portion of the web in contact with the film to rolling contact pressure to cause the film to enmesh with the fibers of the web and be smoothed and compacted and made an integral part thereof as it is applied thereto.

6. The herein described method of producing paper suitable for printing which comprises advancing a wet web of paper, applying a liquid suspension of surfacing material comprising a pigment and an adhesive onto a moving film forming transfer surface susceptible of being wet thereby and dimensionally pitted for substantially uniform volumetric measurement and for free flowing of the suspension from pit to pit about the periphery of the surface, forming a continuous film of surfacing material of pre-determined uniform average thickness on said pitted surface by the mutual action of the molecular forces of said suspension and said transfer surface, bringing a surface of the advancing web into contact with a surface of said film after it has been formed, subjecting the portion of the web in contact with the film to contact pressure to cause the film to enmesh with the fibers of the web and be smoothed and compacted and made an integral part thereof as it is applied thereto, and drying the web.

7. The herein described method of producing paper suitable for printing which comprises advancing a web of paper, applying a liquid suspension of surfacing material comprising a pigment and an adhesive onto a moving film forming transfer surface susceptible of being wet thereby and dimensionally pitted for substantially uniform volumetric measurement and for free flowing of the suspension from pit to pit about the periphery of the surface, varying the consistency of the suspension to control the weight of the surfacing finally incorporated in the web, forming a continuous film of surfacing material of pre-determined uniform average thickness on said pitted surface by the mutual action of the molecular forces of said suspension and said transfer surface, and transferring continuously the film, as finally formed, to a surface of the web as it is being advanced.

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