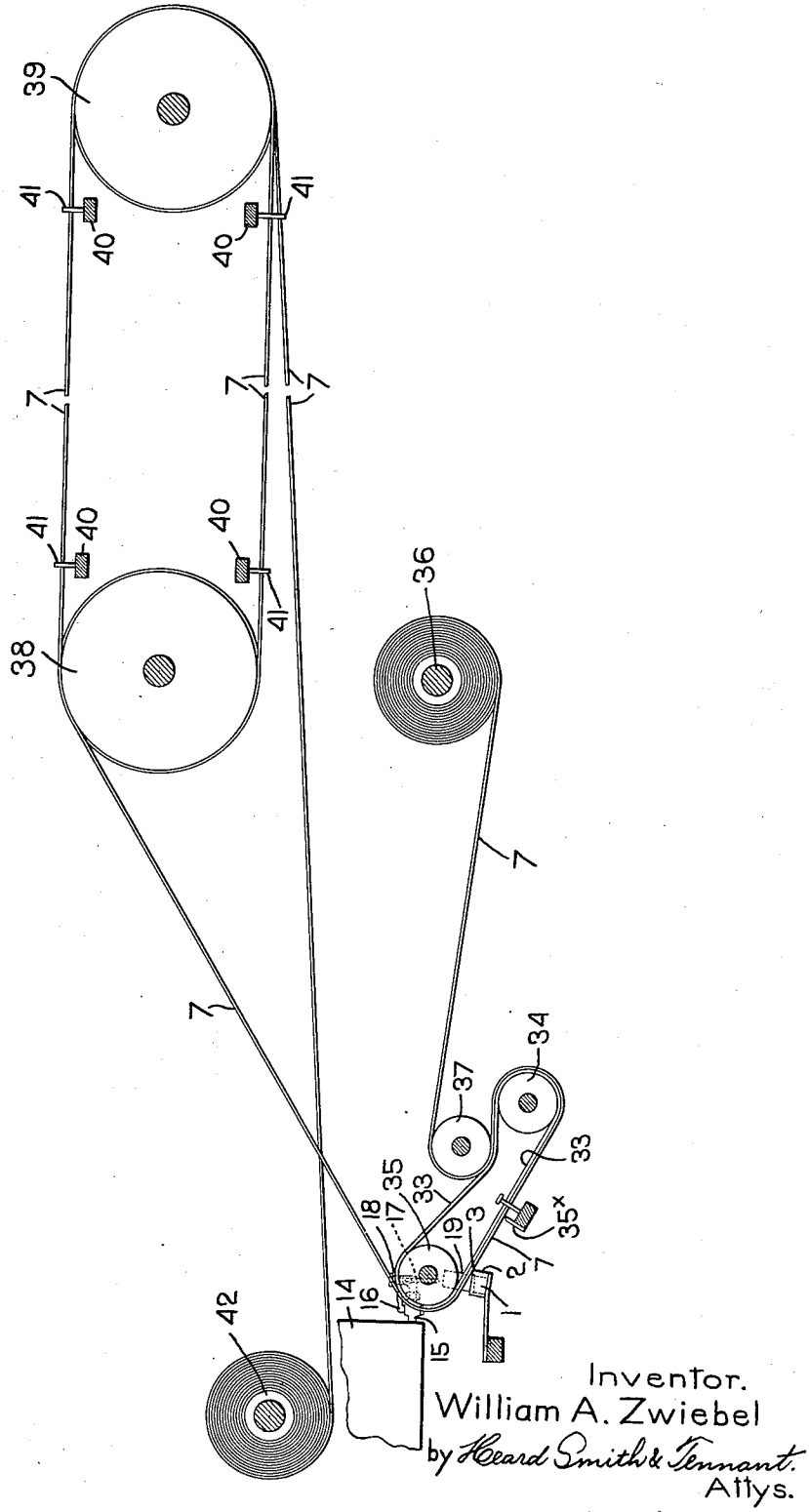
July 7, 1936. W. A. ZWIEBEL 2,046,596

APPARATUS FOR UNIFORMLY COATING FLAT SURFACES

Original Filed Jan. 13, 1932 2 Sheets-Sheet 1

Fig. 1.



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Fig. 2.

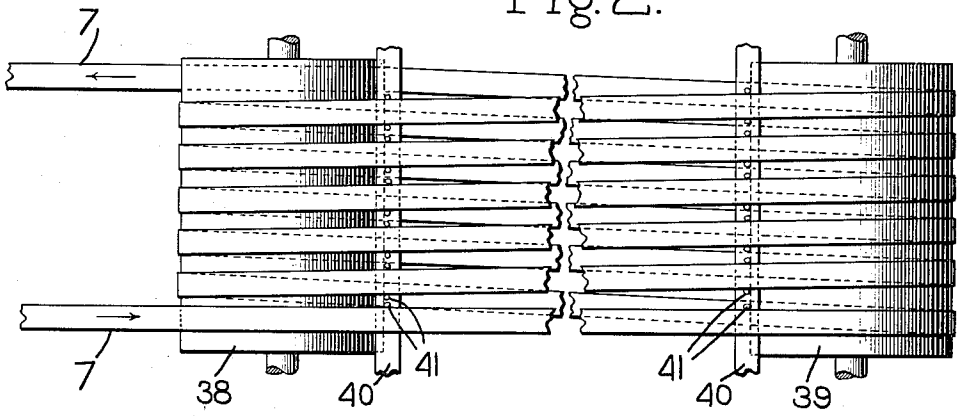


Fig. 3.

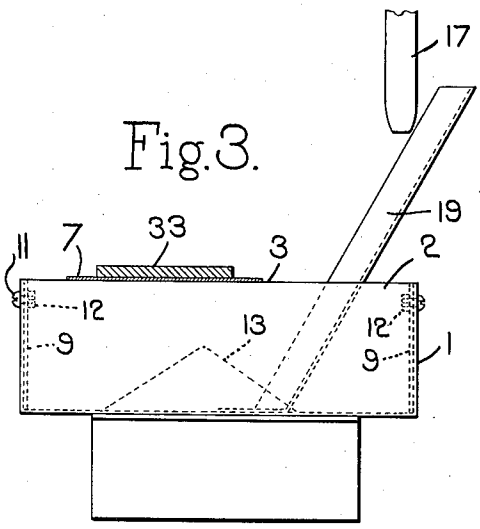


Fig. 4.

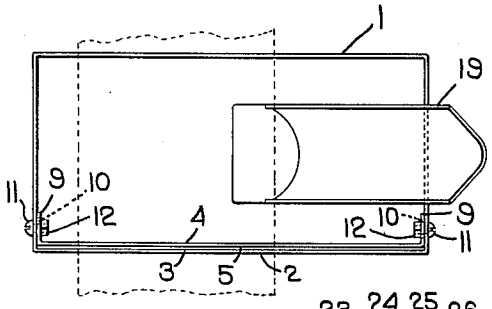


Fig. 5.

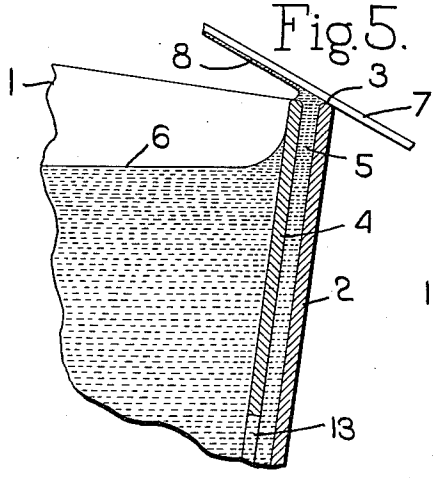
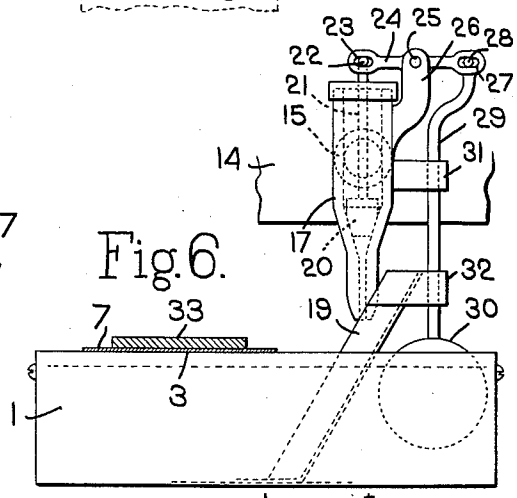


Fig. 6.



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Patented July 7, 1936 2,046,596

UNITED STATES PATENT OFFICE

2,046,596

APPARATUS FOR UNIFORMLY COATING FLAT SURFACES

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Application January 13, 1932, Serial No. 586,279
Renewed November 29, 1935

7 Claims. (Cl. 91—43)

This invention relates to improvements in apparatus for applying a thin uniform coating to a flat surface. The invention broadly stated comprises the utilization of the surface-tension of the coating liquid to draw the liquid from a suitable source upon a relatively moving flat surface.

More specifically the invention relates to improvements in method and apparatus for coating flat sheets or strips of flexible material. The invention will be disclosed herein with particular reference to the coating of flat narrow sheets or strips of celluloid, or the like, with a coating of liquid nitro-cellulose, pyroxylin, or like materials, in which the solvent for the coating material also has an affinity for the material being coated. It will be understood, however, that the process is also adapted to coat any suitable material, such as textiles, paper, sheet metal, and various other flat materials.

In performing the method forming the subject matter of the present invention a narrow capillary column of the liquid coating is caused to extend upwardly above the normal level of the liquid in the reservoir and the flat surface to be coated is passed transversely across this column and in communication therewith in such manner that the surface-tension of the liquid not only adheres to the moving surface to which it is applied, but by cohesion serves continuously to draw from the capillary column of liquid a thin film which progressively adheres to the surface as the movement of the sheet is continued.

Any suitable means may be employed to produce by capillarity an uninterrupted column of the liquid coating. This may be accomplished by providing two parallel plates having their adjacent surfaces in such proximity that capillary action will cause the liquid between the plates to rise above the normal level of the liquid and in proximity to the upper edge or edges of the plates. If then the surface to be coated is passed across the upper ends of said plates at a predetermined rate correlated to the viscosity of the liquid coating, after a line across the sheet has been moistened by the liquid, the continued movement of the sheet will cause the surface-tension of the liquid continuously to draw a thin film of liquid from the column produced by capillary attraction and the progressive adhesion of the liquid to the sheet will form a complete and uniform coating thereupon. By maintaining the liquid level in the reservoir at such height that the column of liquid formed by capillary attraction will extend to or in proximity to the upper edge of the plates or walls, which form the capillary outlet or nozzle, a continuous coating of the sheet moved at a uniform predetermined rate across and in communication with the column may be effected.

The process above defined may be performed manually, but preferably is performed by mechanical means adapted continuously to produce a uniformly coated product. Suitable apparatus is illustrated in the accompanying drawings for coating a sheet of flexible material by the method above described which is particularly designed for the purpose of coating a narrow sheet or strip of celluloid with a nitro-cellulose or pyroxylin pigmented coating of any desired color.

In the drawings:

Fig. 1 is a diagrammatic view of an illustrative form of coating apparatus;

Fig. 2 is an enlarged plan view illustrating a pair of guiding rollers for supporting a continuous coated sheet with guiding means for spacing the leads in such manner that the progressive leads may not overlap, the rollers being spaced apart a sufficient distance to enable complete drying of the coated surface while supported by the rollers;

Fig. 3 is an enlarged detail view in side elevation of the reservoir for the liquid coating illustrating the manner in which the liquid is delivered to the reservoir and also showing in section the sheet being coated;

Fig. 4 is an enlarged detail plan view of the reservoir shown in Fig. 3, and illustrating in dotted lines the position of the sheet which is being coated;

Fig. 5 is a detail view upon a highly magnified scale showing the manner in which the liquid coating is drawn upon the sheet from the reservoir by surface-tension including capillary attraction; and,

Fig. 6 is a detail side elevation of the reservoir and means for supplying the coating liquid thereto with a float-operated valve for controlling the supply of liquid to maintain a predetermined liquid level in the reservoir.

In the illustrative embodiment of the invention shown in the drawings the sheet to be coated, which as shown is a narrow strip of material such as celluloid, is progressively fed by an endless carrier across the straight edge of one wall of a rectangular tank. A flat plate is located in the reservoir in parallelism with the wall over the edge of which the sheet is passed and in such close proximity thereto that a capillary action is produced by the surface-tension of the liquid

upon the adjacent surfaces of the wall and plate which will cause a capillary column of coating liquid to extend well above the normal level of the liquid in the reservoir.

The normal level of the liquid in the reservoir is maintained at such height that the capillary column of coating liquid intermediate of the end of the wall and plate will extend to or in proximity to the edge of the wall, so that after contact of the under face of the sheet or strip to be coated has been made with the capillary column, and the sheet progressively drawn over the edge of the plate, the adhesion of the liquid to the sheet or strip will cause the surface-tension of the liquid progressively to draw a thin film of the liquid from the reservoir and cause it to adhere to the sheet, so that if the sheet is continuously moved across the edge of the wall and at a uniform rate of speed, a thin and uniform coating of the liquid will be applied to the sheet throughout its entire width of contact with the edge of said wall.

Obviously other means may be employed for performing the method herein described. The mechanism particularly illustrated in the accompanying drawings comprises a rectangular reservoir 1 for the coating liquid, supported in any suitable manner, having a flat side wall 2 presenting a straight upper edge 3. A flat plate 4 is located within the reservoir in parallelism with the flat side wall 2 and in such proximity thereto that the capillarity of the liquid will cause a narrow column 5 of the liquid to extend well above the normal surface 6 of the liquid in the reservoir.

Means, hereinafter to be described, are provided for maintaining the liquid level 6 in the reservoir at such height that the capillary column 5 of the liquid will extend to or in close proximity to the upper edge 3 of the wall 2. The under surface of the sheet or strip of material 7 to be coated is first caused to contact with the capillary column 5 of liquid and then is drawn or passed progressively over the edge 3 at a uniform speed in the manner illustrated in Fig. 5, thereby causing a thin film of coating 8 to adhere to the sheet.

As the degree of capillarity of different liquids varies in accordance with the viscosity of the liquid, means are provided for adjusting the position of the plate 4 relatively to the wall 2. As illustrated in the drawings each end of the plate 4 is provided with a laterally extending flange 9 provided with one or more horizontal slots 10 which receives a bolt 11 mounted in the end wall of the reservoir and provided with a nut 12 which when set up will clamp the flange of the sheet against the end wall. By loosening the nut 12 the plate 4 can be moved toward or from the wall 2 and secured in such adjusted position that with a proper liquid level in the tank the capillarity of liquid coating of the particular viscosity will extend to or in proximity to the edge 3 of the plate, so that when the under face of the sheet or strip is brought into contact with the capillary column of liquid thus formed, the adhesion of the liquid to the surface of the sheet will, in co-operation with the surface-tension of the liquid, continuously draw a thin film of the liquid from the reservoir as the sheet is progressively moved across the edge.

In order to permit the liquid to enter the space between the plate 4 and the wall 12, the plate may be made of sufficiently narrow width to leave a space between its lower edge and the bottom of the reservoir. Preferably, however, the central portion of the plate is cut away to provide an inverted V-shaped aperture 13 extending a considerable distance upwardly from the central portion of the plate, as illustrated in Fig. 3.

Any suitable means may be provided for maintaining a proper liquid level in the tank to enable the capillary column to extend to or in proximity to the edge 3 of the wall 2 of the reservoir. One means, which is illustrated in Fig. 1, comprises a tank 14 having near its bottom an outlet pipe 15, preferably provided with a shut-off valve 16 and with a downwardly extending nozzle 17 having an adjustable needle valve 18 for accurately controlling the flow of liquid, and so positioned as to deliver the liquid upon an inclined preferably V-shaped gutter 19, the lower end of which is submerged in and preferably extends to the bottom of the tank in proximity to the opening in the aperture 13 in the plate 4.

By reason of this construction the liquid delivered from the nozzle 17 will gradually flow down the inclined trough or gutter 19 into the liquid without producing sufficient agitation to disturb the liquid level in the reservoir and, therefore, will not affect the uniformity of the capillary column.

The reservoir may be provided with a suitable cover (not shown) to reduce evaporation of the liquid in the reservoir and to prevent the escape of volatile constituents of the coating liquid.

While the mechanism above described for delivering the liquid from the supply tank 14 to the reservoir has been satisfactorily employed, automatic means may be provided for insuring the maintenance of the proper constant liquid level in the tank. A suitable automatic device of this character, is illustrated in Fig. 6 in which the nozzle 17 is provided with a valve 20 having an upwardly extending valve stem 21 provided at its upper end with a cylindrical offset 22 which engages a slot 23 in the end of a lever 24 which is fulcrumed upon a pintle 25 at the upper end of a bracket 26 extending laterally from the body of the nozzle 17, the opposite end of the nozzle having a slot 27 which is engaged by the offset upper end 28 of a rod 29, the lower end of which is connected to a float 30 partially immersed in the liquid in the reservoir. The rod 29 may be guided in any suitable manner as by a bracket 31 extending laterally from the nozzle 17 and a bracket 32 mounted upon the inclined trough or gutter 19. Obviously variations in the liquid level in the tank will raise or lower the float 30 and thereby close or open the valve 20 in such a manner as so to control the amount of liquid delivered from the tank 15 as to maintain a constant predetermined liquid level in the reservoir at all times.

Any suitable means may be provided for causing the sheet or strip of material to be coated to pass over the edge 3 of the wall 4 of the reservoir at a constant rate of speed and in close contact therewith throughout the width of the sheet or strip. In the preferred construction illustrated herein, which is adapted to coat a strip of celluloid, or other suitable material, and endless feeding belt 33 is utilized. The belt 33 is mounted upon rollers 34 and 35, one of which, preferably the roller 35, is driven at a uniform speed. The belt 33 is arranged at a suitable angle to the horizontal and is so positioned as to press the strip 7 firmly against the upper edge 3 of the wall 2 throughout the entire width of the strip. Preferably the belt 33 is of considerably less width than the strip and does not contact with the edge

of the wall 3, thereby avoiding the accumulation of any of the liquid coating upon the belt and consequent smearing of the belt.

The sheet or strip 7 is drawn from a roll 36 over a guide roll 37 which presses against the upper lead of the endless belt 33 in advance of the roll 34, so that the strip is maintained in proper frictional contact with the belt 33 as it passes around the rolls 34 and the rolls 35 and throughout the length of the lower lead of the belt between said rolls. Desirably a cleaner 35x is positioned to engage the face of the sheet or strip to be coated and remove therefrom any dust or foreign matter which may have accumulated upon the strip.

Any suitable means may be provided for drying the coating upon the strip after it is delivered from the roll 35. As illustrated herein the strip 7, after leaving the belt 33 at a tangent to the roll 35, is led over a roll 38, thence over a roll 39 located at a considerable distance from the roll 38. The rolls 38 and 39 may be of any desired length and the strip guided progressively over these rolls as illustrated in Fig. 2. Any suitable means may be provided for guiding the strip so that it will not contact or overlap as it passes progressively over the rolls 38 and 39. A convenient means, which is illustrated in Figs. 1 and 2, comprises bars 40 located at suitable distances from the lines of contact of the strip with its respective rolls and provided with pins 41 so positioned as to engage the edges of the strip as it progressively approaches the respective rolls and thereby so to direct the strip upon the rolls as to prevent contact of adjacent portions of the strip.

The rolls may be placed such distances apart and the strip carried around the rolls a sufficient number of times to permit complete drying of the coating. The dried coated strip 7 may then be led to and wound upon a suitable winding or storage roll 42. The winding roll 42 and the rolls 38 and 39 may be driven in any suitable manner to maintain the proper tension upon the strip 7 as will be readily understood by those skilled in the art.

The apparatus disclosed herein is one which has been employed in the coating of strips of flexible material, such as celluloid, with a pigmented pyroxylin or cellulose coating, but obviously may be and has been employed for coating other sheets or strips of flexible material including fabric, flexible steel strips, and the like. Obviously, the method may be employed to coat any flat surface with a suitable liquid adherent to the surface and of such viscosity that the surface-tension of the liquid will insure continuous delivery of the liquid from the reservoir to the surface of a sheet moved at a substantially uniform speed across the straight edge of the wall of the reservoir in communication with a capillary column of liquid of the character above described.

It will be understood that the particular mechanism disclosed herein for performing the method above described is of an illustrative character and that other suitable types of apparatus may be employed within the meaning and scope of the following claims.

Having thus described the invention, what is claimed as new, and desired to be secured by Letters Patent, is:

1. Apparatus for coating a flat surface of material with liquid which comprises a reservoir having a flat wall presenting a straight edge, a flat plate located within said reservoir in parallelism with said flat wall and in such proximity thereto as to produce by capillarity a column of liquid therebetween, means for maintaining the liquid in the reservoir at such level that said capillary column will extend approximately to the upper edge of the flat wall of the reservoir, means for moving the surface of the sheet in contact with said edge and thence in communication with said liquid column only, whereby a thin uniform film of said liquid will be drawn from said reservoir upon said surface by the surface tension of the liquid, and means for adjusting the flat plate relatively to said flat wall in correlation to variations in the capillary characteristics of different liquids.

2. Apparatus for coating a sheet of flexible material with liquid comprising a reservoir having a flat wall presenting a straight edge, a flat plate located within said reservoir in parallelism with said flat wall and in such proximity thereto as to produce by capillarity a column of liquid therebetween, means for maintaining the liquid in the reservoir at such level that said capillary column will extend approximately to the upper edge of the flat wall of the reservoir, and means for continuously moving the lower surface of said sheet across the upper edge of said flat wall in an upwardly inclined plane and thence in communication with said liquid column only, whereby a thin uniform film of said liquid will be drawn from said reservoir upon said surface by the surface tension of the liquid.

3. Apparatus for coating a sheet of flexible material with liquid comprising a reservoir having a flat wall presenting a straight edge, a flat plate located within said reservoir in parallelism with said flat wall and in such proximity thereto as to produce by capillarity a column of liquid therebetween, means for maintaining the liquid in the reservoir at such level that said capillary column will extend approximately to the upper edge of the flat wall of the reservoir, and means for feeding the sheet of flexible material comprising an upwardly inclined flexible endless belt of narrower width than the width of said sheet positioned to maintain the lower surface of the sheet in uniform contact with the straight edge of said flat wall and thence in communication with the capillary column of said liquid.

4. Apparatus for coating a narrow sheet of flexible material with liquid comprising a reservoir having a flat wall presenting a straight edge, a flat plate located within said reservoir in parallelism with said flat wall and in such proximity thereto as to produce by capillarity a column of liquid therebetween, means for feeding said narrow sheet comprising an inclined endless belt having its lower lead engaging the upper flat edge of said reservoir, means for guiding the narrow sheet in frictional engagement with said endless belt, whereby said endless belt will maintain the surface of the sheet in close contact with the upper edge of the reservoir and thence in communication with the capillary column of said liquid, and means for supporting the traveling coated sheet a sufficient time to permit the drying of the coating thereof.

5. Apparatus for coating a narrow sheet of flexible material with liquid comprising a reservoir having a flat wall presenting a straight edge, a flat plate located within said reservoir in parallelism with said flat wall and in such proximity thereto as to produce by capillarity a column of liquid therebetween, means for feeding said nar-

row sheet comprising an inclined endless belt having its lower lead engaging the upper flat edge of said reservoir, means for guiding the narrow sheet in frictional engagement with said endless belt, whereby said endless belt will maintain the surface of the sheet in close contact with the upper edge of the reservoir and thence in communication with the capillary column of said liquid, and means for supporting the traveling coated sheet a sufficient time to permit the drying of the coating thereof, comprising supporting rollers spaced apart a sufficient distance to permit complete drying of the coating during its passage over them, and guiding means for preventing overlapping of successive leads of the sheets around said rollers.

6. Apparatus for coating a flat surface of material with liquid which comprises a reservoir for liquid, means for producing from the liquid by capillary attraction a narrow straight column of said liquid, means for moving the surface to be coated transversely across and in continuous communication with said column, and means for feeding liquid to said reservoir including an inclined gutter extending into the liquid of said reservoir, and means for delivering liquid upon said gutter at a sufficient rate to maintain the liquid level in the reservoir at such height that the capillary column of liquid will extend into proximity to the edge of said flat wall and in communication with the surface of said material.

7. Apparatus for coating a flat surface of material with liquid which comprises a reservoir for liquid, means for producing from the liquid by capillary attraction a narrow straight column of said liquid, means for moving the surface to be coated transversely across and in continuous communication with said column, means for feeding liquid to said reservoir including an inclined gutter extending into the liquid of said reservoir, a source of supply of liquid, a conduit leading from said source to said gutter, a valve in said conduit and a float carried by the liquid of said reservoir connected to said valve operable to cause such actuation of the valve as to maintain such liquid level in the reservoir at such height that the capillary column of liquid will extend into proximity to the edge of said flat wall and in communication with the surface of said material.

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