

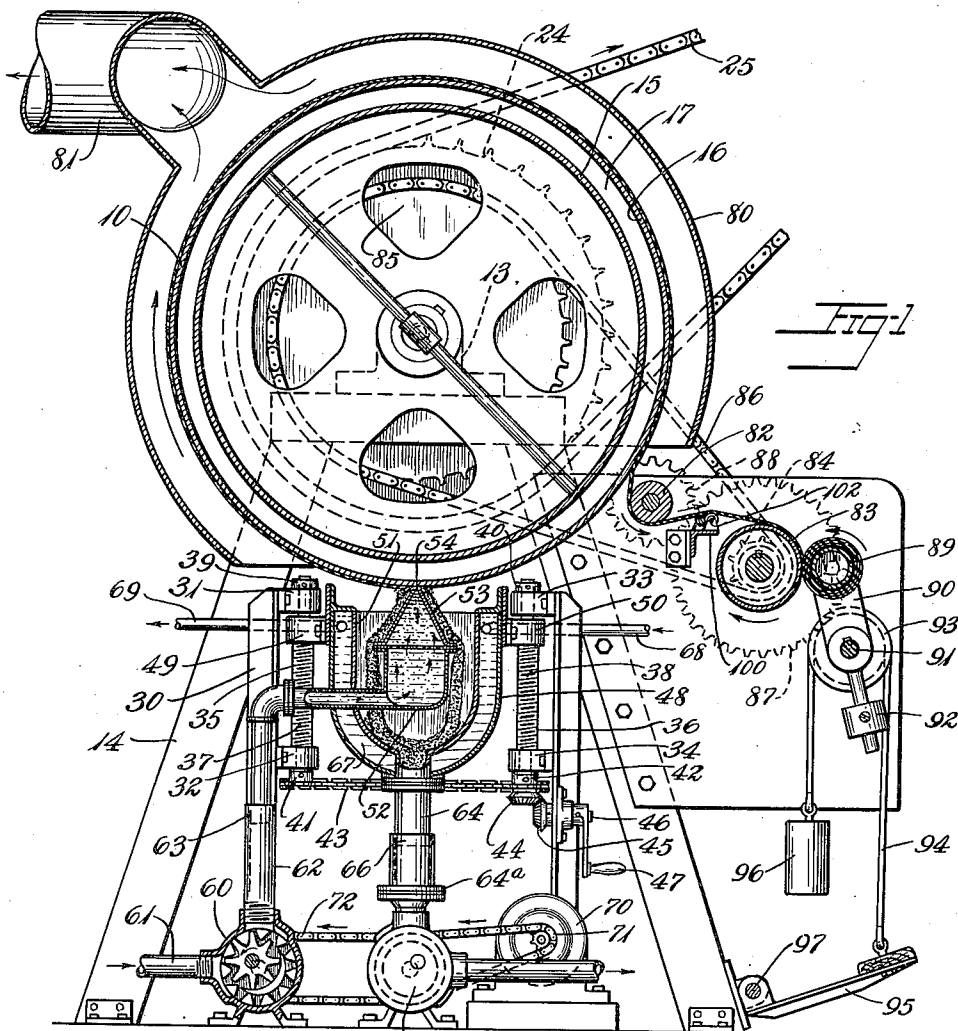
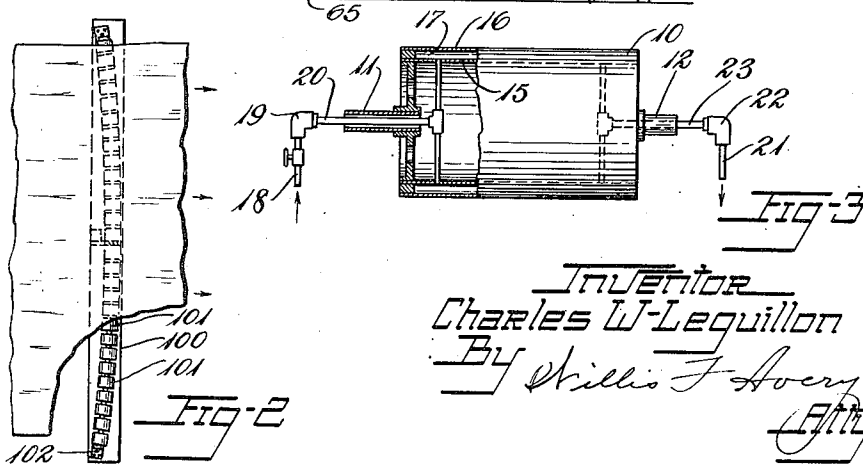
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METHOD OF AND APPARATUS FOR DEPOSITING FILMS

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METHOD OF AND APPARATUS FOR  
DEPOSITING FILMS

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This invention relates to the deposit of liquid dispersions to provide films of material and is especially useful in forming sheet material from dispersions of organic and other compositions, and also in coating strip or sheet material.

In the manufacture of thin sheets of cellulosic compositions, gelatin, rubber and synthetic resinous materials it has been proposed to rotate a smooth faced drum through a bath of a liquid dispersion of the composition and to deposit and dry a film of the material upon the drum. Such a procedure has not been successful in producing a uniform film of material especially where the liquid dispersion has been sensitive to temperature or to humidity or other atmospheric conditions. Such liquids often have been found to scum over or coagulate in the presence of the atmosphere, so that coagulated scum particles, or foreign particles such as dust settling in the tank have been present in the deposited film.

The present invention aims to overcome or avoid the difficulties encountered and in the prior procedure to provide a novel method and apparatus for depositing uniform films or coatings upon a movable surface. The term "film" as used herein is intended to embrace both independent films and coatings or strip or sheet material, unless otherwise stated.

The principal objects of the invention are to provide uniformity of product, to avoid or eliminate waste, to provide for continuous manufacture of film material, to provide simplicity of equipment, and to provide convenience of operation.

A further object is to provide for avoiding or reducing to a large extent the depositing of objectionable particles on the film as it is formed.

Of the drawing

Fig. 1 is a cross-sectional elevation of the apparatus constructed according to and embodying the invention, parts being broken away.

Fig. 2 is a detail plan view of the spreading roll of the apparatus.

Fig. 3 is a detail view of the drum, parts being broken away.

In accordance with the invention there is provided an upwardly directed constantly flowing stream of dispersed composition and a constantly moving depositing surface moving through the flowing material so that a constantly uniform and fresh supply of clean material is always at the position of deposit, and the deposited film is free from dirt and scum particles by reason of such constant flow of fresh material.

The invention is best illustrated by referring

to the drawing which shows the apparatus as provided for the formation of a wide sheet of thin material, although, if desired, strip or sheet material may be coated, or a film may be deposited upon a narrow traveling surface such as a wire.

The numeral 10 designates a rotatable drum having hollow trunnions 11, 12 by which it is rotatably supported in bearings 13 by a suitable stationary frame 14. For convenience of controlling the temperature the drum is provided with a cylindrical wall 15 closely spaced below its outer wall 16 to provide a thin space 17 therebetween through which a heating or cooling fluid may be circulated at a relatively high rate of travel. An inlet pipe 18 communicates with the space through a swivel pipe connection 19 and a pipe 20 extending through one of the hollow trunnions. An outlet pipe 21 is similarly connected with the space through a swivel connection 22 and a pipe 23 extending through the other trunnion. By making the space 17 relatively thin, rapid circulation of fluid therethrough is accomplished and accurate heat control is therefore possible. A sprocket 24 is fixed to one of the trunnions and is driven by a chain 25 from any convenient source of power (not shown).

For supplying a constant flow of the dispersed material to be deposited on the face of the drum, a stationary frame 30 is mounted below the drum and is provided with vertical bearings 31, 32, 33, 34 in which vertically disposed shafts 35, 36 are rotatably mounted. The shafts are screw threaded between their bearings, as at 37, 38. Collars 39, 40 are fixed to the upper ends of the shafts and sprockets 41, 42 to their lower ends for retaining the shafts in their bearings. Sprockets 41, 42 are connected by a chain 43 so as to operate in unison. A bevel gear 44 fixed to shaft 36 meshes with a bevel gear 45 fixed to a crank shaft 46 having a bearing in the frame 30. A crank 47 is fixed to shaft 46 for the purpose of rotating both shafts 35, 36. A jacketed sump 48 has threaded ears 49, 50 adapted to engage the threads 37, 38 of the shafts. The arrangement is such that the sump may be raised or lowered at will by means of crank 47 with relation to the drum 10.

Located within the sump 48 but spaced from its inner wall 51 is a trough shaped manifold 52. A nozzle 53 is provided therefor and terminates at its apex in an orifice 54 extending parallel to the axis of the drum.

The liquid dispersion to be deposited on the drum is drawn from a supply container (not shown) by a rotary pump 60 through a pipe 61

and is discharged through a vertical pipe 62 to the manifold 52, a slip joint 63 being formed in the pipe 62 to permit vertical adjustment of the manifold 52. Overflow from the nozzle 53 is collected by the sump 48 and after passing a filter 54a, is drawn therefrom through a drain pipe 64 by a rotary pump 65 which returns it to the supply container for further use so that the filtered dispersion is circulated over and over. A slip joint 66 is provided in the drain pipe to permit vertical adjustment of manifold 52.

For the purpose of maintaining the temperature of the dispersion at the temperature desired for reuse, the sump 48 extends closely about the manifold 52 and is jacketed, as at 67, the jacket having a supply pipe 68 and a return pipe 69 connected thereto so that water, steam, or other fluid may be circulated therethrough for heating or cooling purposes. The arrangement is such as to remove all foreign matter, to maintain the liquid and the nozzle under constant temperature conditions, and to permit use of the liquid over and over.

The pumps 60 and 65 may be driven from a motor 70 by chains 71, 72 engaging sprockets on the pump and motor shafts. The pump 65 is adapted to be driven at slightly faster speed than pump 60 to prevent any overflow of the sump 48.

As the rotating drum 10 has its surface close to the orifice 54, the dispersed material flowing from the orifice 54 is continuously flowing under a uniform head, in contact with the drum surface and is deposited thereon. The deposited material is dried as the drum rotates and for the purpose of removing all solvent vapors and of protecting the deposited film from dust and air currents, a hood 80 is provided. This hood encloses the greater part of the drum surface and has an outlet pipe 81 for carrying away the vapors. The hood assists in reducing heat radiation from the drum.

For removing the deposited film of dried material a pair of driven rolls 82, 83 are rotatably mounted in spaced apart relation on the frame 14. A sprocket 84 fixed to roll 83 is driven from a sprocket 85 fixed to the drum 10 through a chain 86, and roll 83 drives roll 82 through gears 87, 88 fixed to the rolls respectively. The arrangement is such that rolls 82 and 83 are driven at the same surface speed as drum 10. A wind-up roll 89 is rotatably mounted on a swing frame 90 pivoted on the frame 14, as at 91, in a position to contact with roll 83. As the leading end of the film is wrapped about roll 89 it builds up by accumulation of film and its arm 90 swings away from roll 83. The pivotal axis 91 is to the left of a vertical plane through the axis of roll 89 in Fig. 1 so that the weight of the roll causes it to bear against roll 83. A counter-balance 92 is provided to adjust the pressure of the rolls against each other. The shaft 91 which acts as a pivot for arm 90, to which it is fixed, has a grooved pulley 93 fixed thereto. A rope 94 extends through the groove and has a swing treadle 95 fixed thereto at one end and a weight 96 fixed to the other end. The treadle is pivotally mounted on the frame 14 as at 97. The arrangement is such that the weight counterbalances the treadle and that depressing the treadle lifts roll 89 from roll 83. By using a heavy weight tension on roll 89 may be increased.

For preventing the wrinkling of the film a spreader roll 100 comprising a series of short rolls 101 freely rotatable about a bowed shaft 102

is provided between rolls 84 and 89 and located above a plane drawn tangent to the rolls with the convex side of the spreader facing toward roll 89. The arrangement is such that a slight centering of the film occurs.

The operation of the apparatus is as follows: The liquid material is forced by pump 60 to the orifice 54 where it is forced up in a projected flow normally taking a convex meniscus form extending substantially tangent to the curved surface of the drum when not disturbed by the drum. By manipulating the crank 47 the orifice may be raised with respect to the drum so that the drum surface intersects the crest of the flow. The drum is rotated and material is deposited on the face thereof.

The superior results of the invention apparently are explained, at least in part, by the action wherein the liquid copiously flowing from the orifice and overflowing it both forwardly and rearwardly, as shown in Fig. 1, is in uniform and constant contact with the surface of the drum, the surface tension of the liquid is never broken and the new material is supplied beneath the tension surface which extends over the material previously deposited and downwardly along the overflow stream thereby avoiding any breaking of surface tension. The material is therefore deposited in the direction of its natural flow with the least tendency for eddy currents or waves to form, and any scum or deposit is naturally carried by the overflow away from the drum. At the same time the travel of the deposited material is in a generally upward direction so that no flow wrinkles are formed in the sheet. By use of the invention the use of a static liquid surface is eliminated and deposit from a flowing liquid is provided.

The deposited film rotates around the drum and its solvent evaporates and passes from the hood while the dried material is wound from the drum onto the roller 89. The apparatus may be adjusted by means of crank 47 so as to cause the convex surface of the drum to contact with the liquid over a greater or lesser arc to change the time and area of contact with the liquid at the slot providing adjustment of the deposit.

Due to excessive flow from pump 60, the liquid flows from the orifice and into the sump, providing a constant supply of fresh liquid and preventing deposit of dried material or of dust particles. The jacketed sump prevents cooling of the liquid and by its close confinement of the orifice prevents cooling of the nozzle and rapid evaporation of solvents, so that the material is always ready for further use.

The flow of the pumps 60, 65 may be regulated to means of a well known variable speed drive, such as the "Reeves" between the motor 70 and the pumps, or by use of a variable speed motor.

The apparatus is particularly useful in forming films of material such as polymerized vinyl halides from solutions or dispersions thereof or of other materials which are particularly sensitive to atmospheric conditions or change of temperature in the liquid state.

While the apparatus is shown as depositing the material directly on the surface of the drum, the same apparatus may be used for depositing a film upon a suitably fed sheet or strip of material which may if desired be fed over the surface of the drum, and while the drum is shown as having a plain surface for forming a smooth film, the drum surface may be engraved to form a film having a design. While the drum as shown is for

providing a flat wide sheet or film, by passing a wire or other strip about the drum surface a thread of material may be formed thereon. Where it is desired to provide a film on a sheet of fabric or other material by the deposit of a plurality of coats, the sheet of fabric or other material may be passed through the apparatus a number of times.

Variations may be made without departing from the scope of the invention as it is defined by the following claims.

I claim:

1. Apparatus for progressively depositing a continuous film of material from a liquid dispersion thereof upon a surface, said apparatus comprising means for moving the surface progressively past a station, an upwardly directed nozzle located at said station below the path of said surface and in spaced relation and normal thereto for accommodating a copious flow of the dispersion against said surface and overflow both forwardly and rearwardly of the nozzle with respect to the direction of surface movement, and means for projecting a copious continuous flow of said dispersion through said nozzle in continuous contact with said surface and in an excess to provide said overflow.

2. Apparatus for progressively depositing a continuous film of material from a liquid dispersion thereof upon a surface, said apparatus comprising means for moving the surface progressively in a curved path past a station to present the surface in a downwardly facing convex position at the station, an upwardly directed nozzle at said station below the path of said surface and in spaced relation and normal thereto for accommodating a copious flow of the dispersion against said surface and overflow both forwardly and rearwardly of the nozzle with respect to the direction of surface movement, and means for projecting a copious continuous flow of said dispersion through said nozzle in continuous contact with said surface and in an excess to provide said overflow.

3. Apparatus for progressively depositing a continuous film of material from a liquid dispersion thereof upon a surface, said apparatus comprising means for moving the surface progressively past a station, an upwardly directed nozzle located at said station below the path of said surface, said nozzle having an orifice extending across the path of said surface and in spaced relation and normal thereto for accommodating a copious flow of the dispersion against said surface and overflow both forwardly and rearwardly of the nozzle with respect to the direction of surface movement, means for providing a copious unbroken flow of said dispersion through said orifice and outwardly and downwardly over said nozzle in both said directions to maintain the nozzle at the temperature of the liquid and prevent solidification of material at the nozzle, and means for adjusting the relation of said surface and said nozzle to immerse said surface at said station in the crest of said flow.

4. Apparatus for progressively depositing a continuous film of material from a liquid dispersion thereof upon a surface, said apparatus comprising means for moving the surface progressively past a station, an upwardly directed nozzle lo-

cated at said station below the path of said surface and in spaced relation and normal thereto for accommodating a copious flow of the dispersion against said surface and overflow both forwardly and rearwardly of the nozzle with respect to the direction of surface movement, said nozzle having an orifice extending across the path of said surface, means for providing a copious unbroken flow of said dispersion through said orifice and outwardly and downwardly over said nozzle in both said directions to maintain the nozzle at the temperature of the liquid and prevent solidification of material at the nozzle, means for adjusting the relation of said surface and said nozzle to immerse said surface at said station in the crest of said flow, and means substantially enclosing the space surrounding the depositing area of said surface and said nozzle to minimize loss by evaporation of solvent from said flow of liquid.

5. Apparatus for progressively depositing a continuous film of material from a liquid dispersion thereof upon a surface, said apparatus comprising means for moving the surface progressively past a station, an upwardly directed nozzle located at said station below the path of said surface and in spaced relation and normal thereto for accommodating a copious flow of the dispersion against said surface and overflow both forwardly and rearwardly of the nozzle with respect to the direction of surface movement, said nozzle having an orifice extending across the path of said surface, means for providing a copious unbroken flow of said dispersion through said orifice and outwardly and downwardly over said nozzle in both said directions to maintain the nozzle at the temperature of the liquid and prevent solidification of material at the nozzle, means for adjusting the relation of said surface and said nozzle to immerse said surface at said station in the crest of said flow, and means for heating said surface.

6. Apparatus for progressively depositing a continuous film of material from a liquid dispersion thereof upon a surface, said apparatus comprising an upwardly directed nozzle normal to said surface having an orifice for directing a flow of said liquid dispersion, means for providing a copious unbroken flow of said liquid through said orifice and outwardly and downwardly over said nozzle both forwardly and rearwardly of the nozzle with respect to the direction of surface movement to maintain the nozzle at the temperature of the liquid and to prevent solidification of material at the nozzle, a deposit-receiving surface, and means for feeding said surface progressively past said nozzle through the crest of the liquid dispersion flowing therefrom.

7. The method of progressively depositing a continuous film of material from a liquid dispersion thereof which comprises providing an upwardly directed flow of said liquid dispersion from a nozzle in sufficient volume to overflow said nozzle both forwardly and rearwardly with respect to the direction of surface movement, continuously maintaining such overflow to provide a laterally unsupported flowing pool thereover, and progressively feeding a deposit-receiving surface through said pool to progressively form a deposit of dispersion thereon.

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