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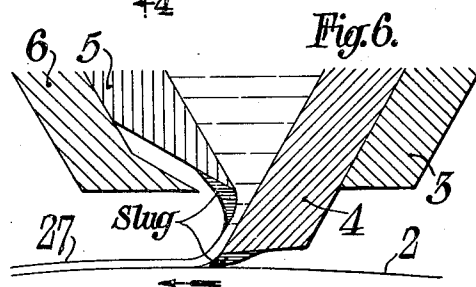
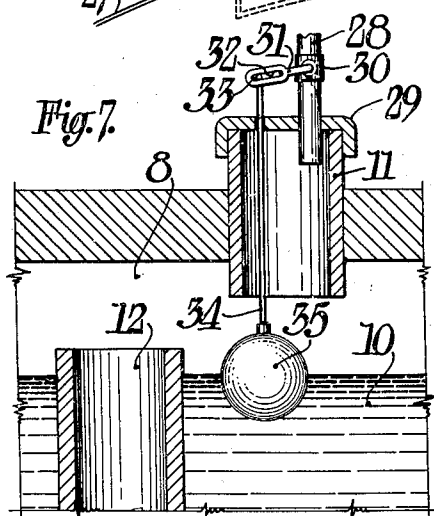
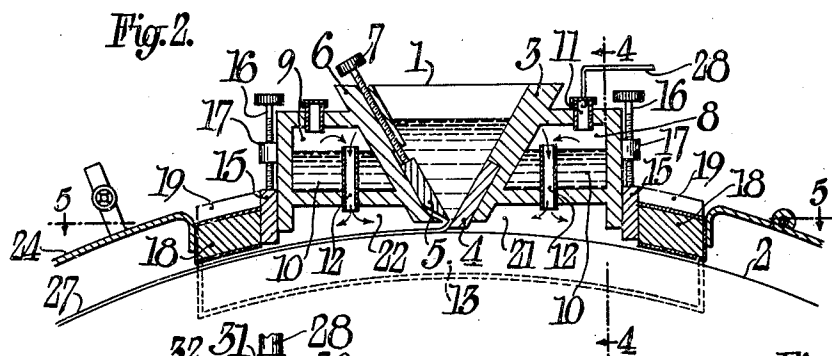
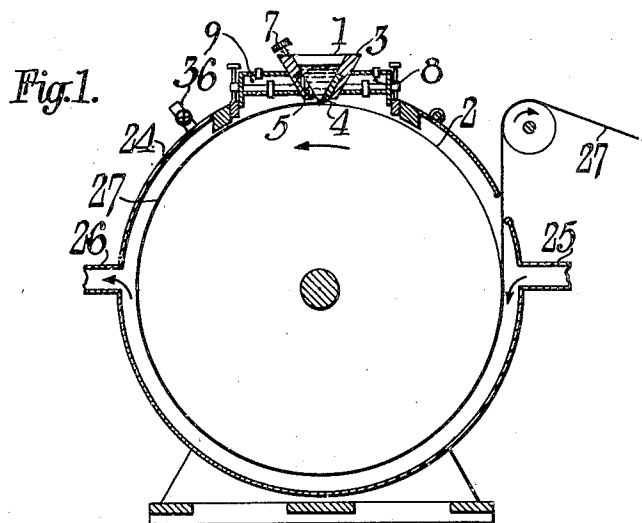
A. J. DAVIDSON

2,051,201

FILM MAKING MACHINE AND METHOD

Filed April 10, 1934

2 Sheets-Sheet 1



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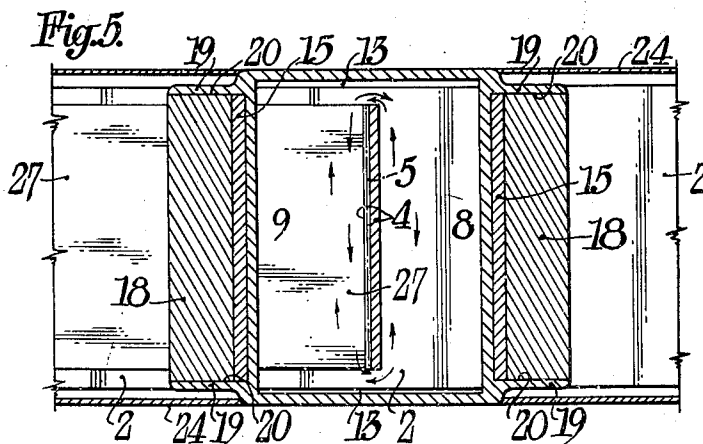
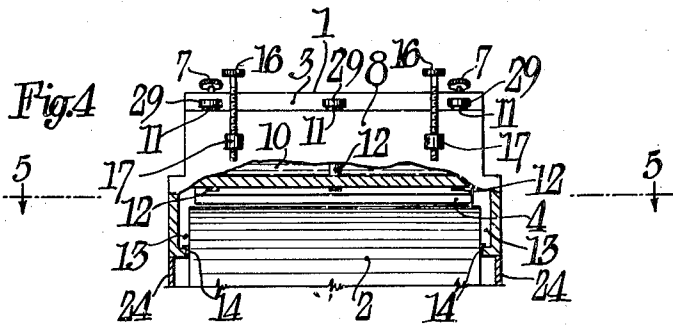
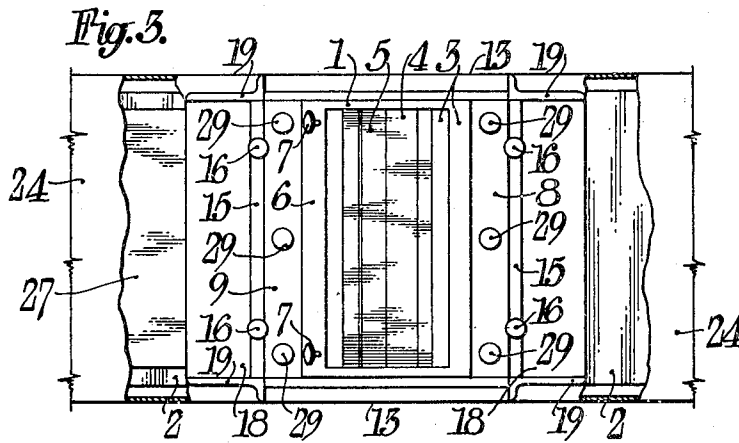
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FILM MAKING MACHINE AND METHOD

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2 Sheets-Sheet 2



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UNITED STATES PATENT OFFICE

2,051,201

FILM MAKING MACHINE AND METHOD

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Application April 10, 1934, Serial No. 719,917

7 Claims. (Cl. 18—15)

This invention relates to the art of making film base or sheeting by coating solutions of cellulosic material onto a smooth moving surface such as a belt or wheel and more particularly to an improved process for maintaining the proper conditions at the beginning of the coating operation and to an improved type of apparatus for accomplishing this result.

As is well known to the art, cellulosic film or sheeting is formed by spreading a thin coating of the desired material, generally a solution of a cellulose ester such as cellulose nitrate or cellulose acetate in suitable solvents, onto an appropriate surface and permitting or causing the solvents to evaporate therefrom. The method generally employed consists in feeding the solution or dope from an appropriate feeding device onto the polished metallic surface of a slowly rotating wheel or drum. The solvent evaporates from the film more or less progressively as the wheel turns until (in less than a complete revolution) sufficient solvent has been removed to admit of the film being removed therefrom and conveyed to a wind-up or carried over other rolls or drums for further treatment.

The device usually employed for feeding the solution to the wheel comprises a V-shaped hopper provided with blades mounted at an angle to one another at the apex of the V and at least one of which is adjustable with respect to the other so as to provide a means of controlling the thickness of the dope stream and therefore the sheet being formed. Such a device is shown in conventional form in U. S. Patent 1,900,873 issued on March 7, 1933 to Henry E. Van Derhoef.

It has been found that serious difficulties often arise from the tendency of the cellulose ester solutions to form slugs or encrustations on the edges of either one or both of the hopper blades, since, when these slugs form, they project down into the dope stream and give rise to uneven coating and the formation of streaks in the finished product which render it unfit for use. These difficulties are more serious in the manufacture of the thinner types of sheeting and film support than in the thicker material and may even result in the production of holes or voids in the product.

Work which I have done shows that this slugging action is due to the fact that small amounts of the cellulose ester solution creep along the outer surfaces of the blades as it flows out of the hopper instead of being carried along in the dope stream on the wheel. The solvent evaporates from these small portions of dope and cause

them to solidify, thus forming slugs. These slugs tend to increase in size due to further accretions of dope and eventually become sufficiently large to project below the edges of the blades and cause the disastrous results above referred to.

My invention accordingly has as its principal object to overcome the above mentioned difficulties and to provide a method for insuring uninterrupted and even coating of the cellulose ester solutions in film and sheet making. Another object is to provide an improved type of device for accomplishing this result. Another object is to provide a method of making cellulose ester sheets or films in which the solvent vapor in the immediate vicinity of the feeding device is maintained at such a concentration as will prevent the formation of accretions of solidified material at that point. A further object is to provide a device for enclosing a portion of the feeding device and maintaining in the enclosed portion a solvent-saturated atmosphere. Other objects will appear hereinafter.

My invention will be made clear from the following specification and the accompanying drawings in which like numerals refer to like parts and in which:

Fig. 1 is an elevational view, partly in section showing the improved type of dope feeding device of my invention mounted in operative position on a film or sheet forming machine.

Fig. 2 is an enlarged sectional elevation of the feeding device of Fig. 1 showing the liquid reservoirs and vapor chambers surrounding the hopper blades.

Fig. 3 is a plan view of the device shown in Fig. 2 with part of the wheel housing broken away to more clearly illustrate the position of the hopper with respect to the wheel.

Fig. 4 is an elevational view along the line 4—4 of Fig. 2 with one of the adjustable gates or partitioning members removed and a portion of the end wall of one of the enclosing chambers broken away to show the internal construction of the chamber and its relation to the top of the film-forming wheel.

Fig. 5 is a plan view in partial section taken on the line 5—5 of Figs. 2 and 4, illustrating the circulation or movement of the solvent vapors in the vicinity of the hopper blades, the back blade being shown in full section and the position of the front blade in relation thereto being shown in a dotted line.

Fig. 6 is a fragmentary sectional view of the lower part of the hopper illustrating the manner

in which slugs tend to form on the hopper blades of devices not employing my invention.

Referring to the drawings, the numeral 1 designates a device for feeding the cellulosic solution or dope which, for example, may be a solution of cellulose nitrate or acetate in a suitable solvent, such as acetone or other liquid, to the surface of the wheel or drum 2. This feeding device may hereinafter conveniently be referred to as a "dope hopper," the cellulosic solution as "dope" and the wheel or drum as the "coating wheel," since these are the terms customarily employed in the art. The hopper may be adjustably mounted, or suspended, over the wheel by means (not shown) in such manner that it may be lowered to, or raised from, the coating surface as occasion may require.

The hopper 1 as shown comprises a V-shaped trough provided at the lower part of its rear wall 3 with a blade 4 set into a recess in the hopper wall. Cooperating with the blade 4 is a blade 5 fitting into a recess in the opposite wall 6 and provided with a plurality of adjusting screws 7 by which it may be moved toward or away from the blade 4, thereby regulating the thickness of the stream of dope which flows from the hopper onto the coating surface. It will be noted that these blades project downwardly into the space below the hopper and that even in the case of the back blade 4 there is always a small space between the edge of the blade and the wheel surface.

According to one form of the invention, the body of the hopper may be provided with internal chambers or reservoirs 8 and 9 for storing a supply of liquid solvent 10 fed thereto through pipes 11 from a source of supply. These reservoirs are provided with vapor conduits 12 which project well up into the interior thereof and through which the vapors rising from the body of solvent pass to the various chambers and passages located in the lower part of the hopper. It should be noted that under ordinary conditions of operation these reservoirs are not necessary to the proper functioning of the device, since all that is required to accomplish the above-mentioned objects of the invention is to provide a confined and segregated solvent-saturated atmosphere in the immediate vicinity of the lower portions of the hopper blades as will be more fully set forth below.

Referring to Figs. 4 and 5 the hopper frame, which may be in the form of a single casting or other convenient construction is so formed as to provide side chambers 13 which form passages for the solvent vapors to circulate or at least pass freely between the chambers 8 and 9. The lower walls of these chambers or passages 13 are provided with sealing strips 14 which serve the double purpose of preventing escape of solvent from the interior of the device and providing antifrictional contacts between the hopper and the sides of the rotating wheel.

Numerals 15, Figs. 2 and 3, designate gate or partitioning members adapted to be raised or lowered by means of thumb-screws 16 operating in internally threaded bosses 17 on the hopper frame. Rigidly, but removably attached to the members 15 are members 18, preferably of wood, and provided with a covering of suitable textile fabric or other soft material. The numerals 19 indicate guide members projecting from and integral with the hopper providing vertical guiding channels 20 within which the gate members 75 move.

Numerals 24 designates a casing for the wheel 2 provided with inlet 25 and outlet 26 for the ingress and egress of air or any other suitable evaporative medium. It will be noted that the internal chambers 21 and 22 of the hopper have no communication with the wheel casing except what is provided by regulation of the gate members 18 as will be further indicated hereinafter. A valve-controlled port 28 may be provided for breaking or controlling the degree of vacuum which may exist at the upper part of the casing 24.

The operation of the device and the method of producing film or sheeting in accordance with the invention will now be described.

The hopper 1 is supplied with dope, preferably in a continuous manner, and the hopper blades 4 and 5 are adjusted to give the desired thickness of film. The solution flows out upon the surface of the wheel which rotates slowly in the direction indicated by the arrow. Evaporation of solvent takes place immediately and continues more or less progressively as the film is carried around by the wheel through less than a complete revolution until at some predetermined point the film thus formed, which may be designated by numeral 27, can be removed therefrom and conveyed to other apparatus for further treatment or to a wind-up.

The reservoirs 8 and 9 are filled with a suitable solvent selected according to the particular cellulosic material employed in the dope. Assuming for purposes of illustration that a cellulose acetate dope is employed, the solvent may be acetone, the level of the liquid being brought to just below the tops of the vapor conduits 12. If desired, any form of constant level devices connected to a suitable source of supply may be employed for automatically maintaining the solvent level at the desired point in the reservoirs. One suitable form of such a device is illustrated in Fig. 7 and comprises a feed line 29 connected to a suitable source of supply (not shown) passes through cap 29 and is provided with valve 30. This valve is controlled by lever 31 and provided with slot 32 in which cam 33 attached to rod 34 is adapted to move. Rod 34 is attached at its lower end to float 35 which rises and falls with the level of liquid in the reservoir, and admitting more solvent by opening valve 30 when the liquid level drops below a predetermined point. Optionally, heating means such as coils in which warm water or other liquid circulates may also be provided for increasing the rate of evaporation of the solvent.

The vapors of solvent pass through the conduits 12 and down into the chambers 21 and 22 where they are confined within the space formed by the wheel surface, the walls of the chambers 21 and 22 and by gate members 18. As indicated by the arrows in Fig. 5, the solvent vapor circulates or moves from one chamber to the other through the passages 13 thus insuring at all times a concentrated solvent atmosphere for both the front and back hopper blades. The atmosphere surrounding the blades is thus automatically kept as nearly saturated at the temperature prevailing in the apparatus, as is possible.

As indicated above, the level of solvent in the reservoirs should never rise above the tops of the conduits 12 as otherwise drops of liquid solvent would drop down upon either the wheel surface or the forming film and cause spots or other defects in the product. In other words, in accordance with the principles of my invention, there 75

should always be a sufficient amount of solvent present at the blades to keep them free from slugs or encrustations of dope, but the solvent should always be present in the form of vapor rather than liquid.

By keeping the blades surrounded by solvent vapor I have found that the slug formation above referred to and further illustrated in Fig. 6 is entirely eliminated. This is apparently accounted for by the fact that as soon as any of the dope commences to creep and solidify along the outer surface of either blade, it meets an atmosphere of solvent of such concentration as immediately to redissolve it. What actually happens is probably that the solvent in the vapor-laden atmosphere in the immediate vicinity of the edge of the blade acts to keep the dope at that point at all times in solution so that it never even has an opportunity to start a slug or solid encrustation. Whatever the explanation, I have found that by employing the above device and maintaining a saturated or nearly saturated solvent atmosphere in the immediate vicinity of the hopper blades, slug formation is entirely obviated and the film forming operation is thereby rendered much more efficient and economical than otherwise possible due to elimination of streaking and the consequent wastage of material. It might be supposed from the fact that solvents are constantly evaporating from the stream of dope at the hopper that sufficient solvent would be present at that point to prevent the formation of slugs, but experience has shown this is not the case and slugging has always been one of the most exasperating difficulties of film making. As will be evident from Fig. 6, the back blade 4 is more susceptible of slug formation than the front blade 5 because of the fact that it generally lies closer to the coating surface and thus permits only a minor quantity of solvent vapor emanating from the dope stream to pass back of the blade, and even this small amount of vapor, were it not for the provision of the enclosing means herein described, would be quickly dissipated. Although there is normally a much greater quantity of solvent vapor in the vicinity of the front blade, since it is in closer proximity to the dope stream, yet it has been found that this is insufficient to prevent accretions at the edge or on the back surface of this blade.

If for any reason it is desirable to have an amount of solvent corresponding to less than a saturated atmosphere, the gate member 15 may be raised sufficiently to permit the escape of a portion of the solvent. It should be noted in this connection that the forward gate members 15 must always be adjusted upwardly or downwardly to correspond with the thickness of film or sheeting being produced. These members are, of course, never positioned so close to the wheel surface as to contact with it or with the surface of the forming film, although they are maintained as closely thereto as is consistent with safety.

It will be seen that I have provided a means of completely enclosing or segregating that portion of the dope hopper which is in the immediate vicinity of the blades and of maintaining therein and in contact with the blades an atmosphere substantially saturated with or at least containing a high concentration of solvent vapor which completely eliminates any form of encrustation or slugging.

It will of course be apparent that many changes may be made in the above described

structure and in its specific mode of operation within the scope of my invention. It may, for example, be desirable to employ only one solvent reservoir and this may be located adjacent to either the front or back hopper blades, since the side passages 13 will serve to convey the solvent vapor from one chamber or blade surface to the other. It may also be desirable, when two reservoirs are employed, to connect them by means of a conduit or to provide any other type of connection between them in order that both may be filled through a single port.

Although I have described my invention with reference to the manufacture of cellulose acetate or nitrate films or sheeting, it is equally applicable to the production of such products from any type of cellulosic solutions such as those of the higher single organic esters of cellulose including cellulose propionate, cellulose butyrate and the mixed organic esters such as cellulose acetate propionate, cellulose acetate butyrate, cellulose acetate stearate, and others, the solvent employed for producing the vapor-laden atmosphere in any given case being selected upon the basis of its solvent power with respect to the particular ester dealt with. The solvent employed need not be the same solvent as that used in compounding the dope, so long as it is of such a nature as to exert a solvent action on the particular cellulose ester material dealt with.

As previously indicated, while I have found it convenient to describe my invention by reference to a type of device in which an auxiliary or independent supply of solvent vapor is provided in the form of solvent chambers in the hopper frame, which device may be especially desirable in producing the thinner types of film or sheeting due to the higher coating speeds employed, my invention resides broadly in providing a confined, solvent-saturated atmosphere in the immediate vicinity of the lower ends of the hopper blades, regardless of whether the solvent vapor is merely accumulated in this confined space from evaporation from the dope stream itself or derived from an independent source.

Furthermore, while I have illustrated my invention as applied to a circular type of coating surface, namely a wheel surface, it will be apparent that the invention is equally adaptable (with slight modifications well within the province of one skilled in the art) to a flat coating or film forming surface such as that of a metal belt passing continuously underneath the hopper in a horizontal direction as shown in U. S. Patent to Stevens et al. No. 573,928.

It will be apparent that I have provided a novel method and means of preventing the formation of slugs or encrustations of solidified material on or in the vicinity of the blades of a dope hopper, thereby precluding the possibility of streak formation, tearing or voids in the film or sheeting during its manufacture and eliminating one of the most prolific sources of shut-downs and waste of time and materials.

What I claim as my invention is:

1. In a film or sheet-forming device comprising means for feeding a flowable cellulosic solution to a moving film-forming element adjacent thereto, the combination of means forming an enclosing chamber for the feeding portion of the feeding means and means for supplying said chamber with solvent vapor.

2. In a film or sheet-forming device, the combination with a hopper provided with cooperating blades positioned in and projecting through

an orifice therein adapted to regulate the flow of a cellulosic solution from said hopper to a film-forming element moving below and in close proximity thereto, of means for enclosing a portion of the coating surface and that portion of the hopper from which said blades normally project, and means for supplying solvent vapor to the space formed by said enclosing means.

3. In a film or sheet-forming device, a film-forming wheel, a hopper mounted on the upper part of and in close proximity to the wheel surface and provided at its lower portion with cooperating blades set at an angle to one another in recesses in the corresponding walls of the hopper and spaced apart so as to provide for egress of a stream of cellulosic solution of predetermined thickness, walls continuous with said hopper projecting there-below and forming substantially vapor-tight chambers around a portion of the wheel surface, said walls being provided with internal reservoirs for containing a supply of liquid solvent, conduits for conveying solvent vapor from said reservoirs to the vapor chambers, and adjustable partitioning means operating in vertical recess in the hopper walls for controlling the concentration of solvent vapor in said chambers.

4. In the process of making film or sheeting by feeding a flowable cellulose derivative solution from a container through a restricted orifice therein onto a film-forming surface located within an enclosed space containing an atmosphere of solvent vapor, the step which comprises keeping the edges of the orifice free from encrustations of solidified cellulose derivative material by enclosing and segregating a portion of the atmosphere of the enclosed space in the immediate vicinity of and surrounding the point of feed of the solution, and maintaining in said segregated portion a higher concentration of solvent vapor than in the remainder of the enclosed space.

5. In the process of making film or sheeting by feeding a flowable cellulose derivative solution

from a container through a restricted orifice therein onto a film-forming surface located within an enclosed space containing an atmosphere of solvent vapor, the step which comprises keeping the edges of the orifice free from encrustations of solidified cellulose derivative material by enclosing and segregating a portion of the atmosphere of the enclosed space in the immediate vicinity of and surrounding the point of feed of the solution, and maintaining in said segregated portion a substantially saturated atmosphere of solvent vapor.

6. In the process of making film or sheeting by feeding a flowable cellulose derivative solution between, and in contact with, thickness-regulating means through which the solution is conveyed onto a film-forming surface located within an enclosed space containing an atmosphere of solvent vapor, the step which comprises keeping the edges of the regulating means free from encrustations of solidified cellulose derivative material by enclosing and segregating a portion of the enclosed space in the immediate vicinity of the regulating means, and maintaining in said segregated portion and in contact with the regulating means, a substantially saturated atmosphere of solvent vapor.

7. The process of making film or sheeting by feeding a flowable cellulose derivative solution from a container provided with blades between which the solution flows onto a film-forming surface located within an enclosed space containing an atmosphere of solvent vapor, the step which comprises keeping the blades free from encrustations of solidified cellulose derivative material by enclosing and segregating a portion of the enclosed space in the immediate vicinity of the blades, and maintaining in said segregated portion and in contact with those portions of the surface of the blades which are adjacent to, but out of direct contact with, the dope stream, a substantially saturated atmosphere of solvent vapor.

ARTHUR J. DAVIDSON.