June 29, 1943. E. K. CARVER 2,322,827

COATING HOPPER

Filed Dec. 29, 1939

FIG. 1.

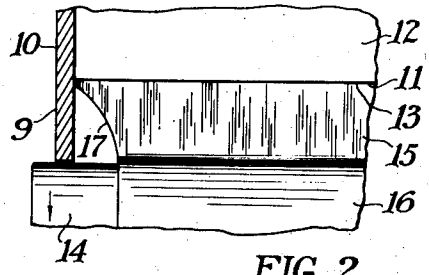


FIG. 4.

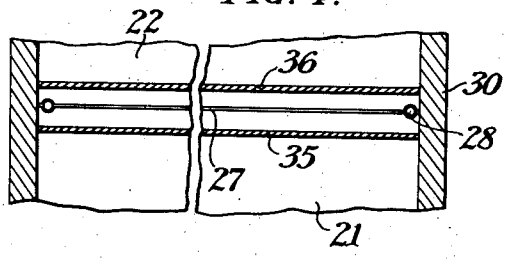


FIG. 2.

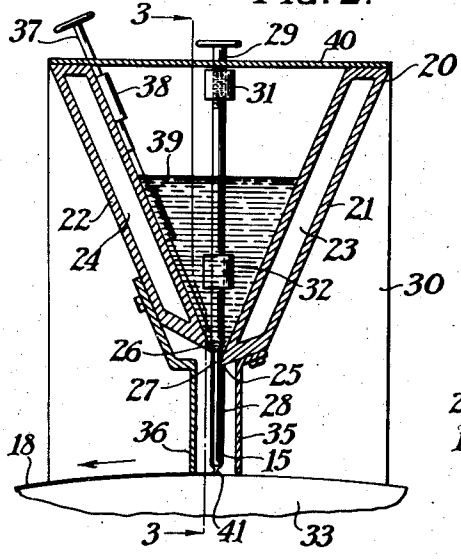


FIG. 3.

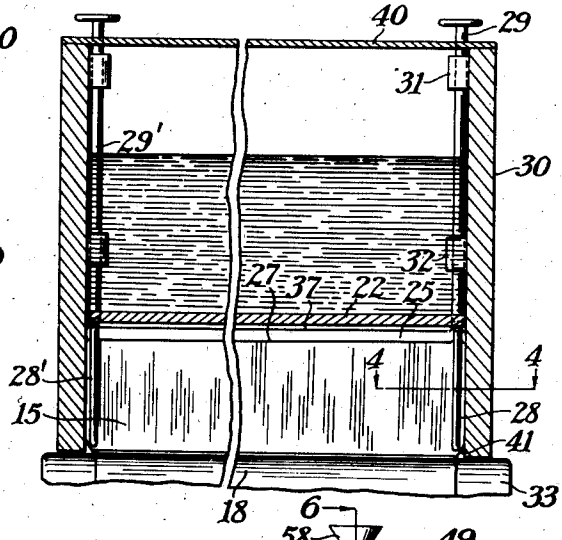


FIG. 6.

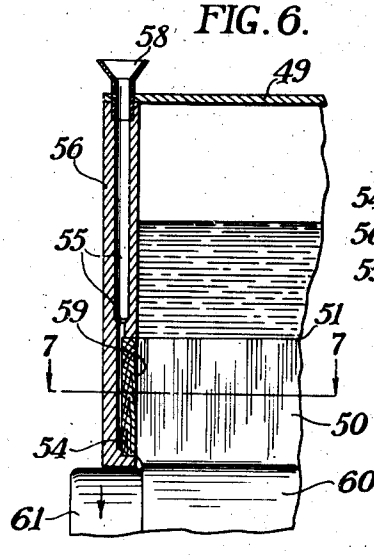
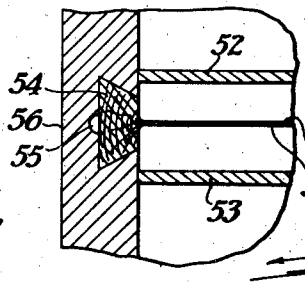


FIG. 7.



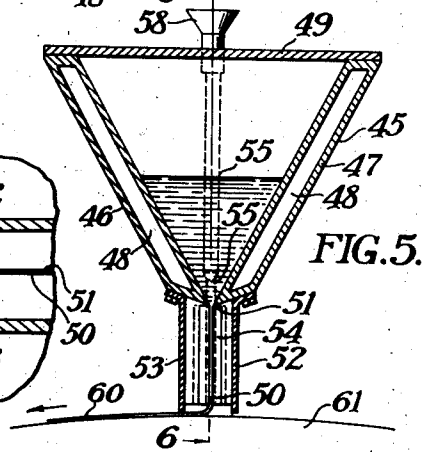


FIG. 5.

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COATING HOPPER

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Application December 29, 1939, Serial No. 311,588

4 Claims. (Cl. 18—15)

This invention relates to coating hoppers for coating solutions of cellulose material onto a smooth moving surface such as a belt or wheel to form a continuous sheet or film, and more particularly to an improved coating hopper adapted to coat photographic film support and the like from the new type of solution which is coated on a relatively cold belt or wheel to congeal the solution to form a gel like film rather than coated on a hot wheel, as commonly practiced, to dry out the solvent.

As is well known to the art, cellulose film or sheeting is formed by spreading a thin coating of the desired material, generally a solution of a cellulose ester such as cellulose acetate in a suitable solvent, onto an appropriate heated surface and causing the solvent to evaporate therefrom. The method generally employed consists of 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. In less than a complete revolution sufficient solvent has been evaporated to permit the film to be removed from the wheel and conveyed to a wind up or carried over other rolls or drums for further curing treatment.

The device usually employed for feeding the solution to the coating wheel comprises a V shaped hopper provided with spaced apart blades mounted at an angle to one another at the apex of the V to form a coating slot. Usually one of these blades 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 hoppers are very staisfactory for coating many kinds of cellulosic solutions. However, when an attempt was made to coat what will be hereinafter termed a "gel dope" from such a hopper onto a cold wheel various unforeseen difficulties arose. The invention will perhaps be better understood if the characteristics and nature of a "gel dope" are explained. In short, these types of dope can be maintained as fluids at temperatures above 50° C. and when allowed to cool to or below a critical temperature between 10°–50° C., depending on the composition, they form transparent gels which remain homogeneous throughout the gelling operation. This gelation occurs within approximately 20° C. of the flowable solution point. When the gels are first formed they do not adhere strongly to the cooled wheel and although the gelled film contains relatively large amounts of solvent, i. e. an amount of solvent equal to or greater than the weight of the cellulose ester, it is sufficiently strong and resistant to deformation so that it can be continuously stripped from the coating wheel. On leaving the coating wheel, the gel like film is usually further dried to reduce the solvent content to a minimum. This can be done without employing high temperatures since the structure of the gels is such that they readily release the volatile solvent.

As above pointed out these gel dopes change from a fluid to a gel within a few degrees of tempertaure. In coating the ordinary type dopes onto a heated wheel such small variations were inconsequential. When the regular type hopper was employed in coating the gel dopes onto a cold wheel, the proximity of the hopper slot to the cold wheel caused a sufficient temperature drop in the hopper lips to permit formation of slugs on the edges of one or both of the hopper lips. These slugs project into the dope stream and give rise to uneven coating and the formation of streaks in the finished product. In forming photographic film base such imperfections are of course very undesirable.

Various expedients were tried to eliminate the slug formation due to the chilling effect of the cold roll on the hopper lips. The difficulty was finally overcome by raising the hopper lips from the normal height of one inch above the coating wheel to two inches above the wheel and surrounding the hopper lips by an enclosure from which air currents, particularly the cold air from the coating wheel, could be minimized or substantially excluded.

Although these changes in the operation and construction of the hopper eliminates the difficulty of slug formation from the chilling effect of the wheel, it was soon found that another unforeseen difficulty is introduced by these changes which is as great if not even more of a disadvantage than slug formation.

It was found that under the new operating conditions it was difficult to coat a sheet or film support of a desired width. For example, it was found that a dope hopper which will coat a sheet 50 inches wide from a slot 50 inches long would only coat a sheet of film support onto the cold wheel of about 48½ inches wide. This change in width was caused by the relatively long drop from the slot to the wheel which permitted the surface tension of the gel dope to drag in the edges of the stream before it reached the coating wheel.

It was attempted to correct this difficulty by

using a 51½ inch hopper to coat a 50 inch sheet. However, this did not solve the problem since sometimes the hopper would coat a 51½ inch sheet and spoil the operation. This was a serious matter for unless the width of the film could be controlled the efficient manufacture of gel dope film support would be greatly impaired.

An object of the present invention is an improved coating hopper which will coat gel dope to a predetermined width.

In accordance with the invention these and other objects are attained by employing a hopper which has thin metal rods, needles or blades adjacent the ends of the hopper slot and extending therethru which guide the edges of the gel dope straight down and prevent its "necking in" due to surface tension. These guide rods may be spaced from and extend down through the slot in the hopper, or they may be fastened to the ends of the hopper. When using gel dopes which change within a particularly small temperature range from a fluid to a solid, slugging may occur on the guides. In such cases I may substitute for metal guides, guides made from a porous material such as balsa wood. A solvent for the gel dope is caused to flow from a reservoir through the porous balsa wood toward the stream of gel dope so as to form a continuous layer of solvent over the surface of the balsa wood guides. The dope will adhere to this continuous layer of solvent which, in turn, adheres to the guides, and flows down evenly upon the coating surface. The continuous flow of the solvent will overcome any tendency for slugs to form on the guides.

The invention will be more clearly understood by reference to the following detailed description and associated drawing in which:

Fig. 1 is a front sectional view in elevation of a portion of an ordinary coating hopper positioned above a coating wheel and having a gel dope solution flowing from the hopper slot onto the coating wheel. The purpose of the drawing is to show the "necking in" of the gel dope solution;

Fig. 2 is a broken end elevational view in section of one type of a hopper constructed in accordance with the invention showing a guide rod extending through and out of contact with the hopper slot.

Fig. 3 is a broken front elevational view taken on the line 3—3 of Fig. 2;

Fig. 4 is a bottom view of a portion of the hopper taken on the lines 4—4 of Fig. 3 showing the relative position of the guide rods and the hopper slot;

Fig. 5 is an end elevational view in section of the second type of my improved coating hopper in which a strip of porous balsa wood is employed as the guide for the gel dope guide;

Fig. 6 is a portion of a front elevational view in section of the second type of my improved coating hopper taken on the line 6—6 in Fig. 5.

Fig. 7 is a bottom view of a portion of the hopper taken on the lines 7—7 of Fig. 6 showing more clearly the balsa wood guide in relation to the coating slot.

Referring to Fig. 1 there is shown a portion of an ordinary type of hopper 9 heretofore used in coating film support. The side of the hopper is represented at 10, and the coating slot 11 is positioned between the walls of the hopper 12 and 13. The hopper 9 is positioned above a rotating coating wheel 14 and the coating solution 15 flowing from the slot 11 will contact the rotating wheel and form a sheet 16 thereon. As shown at 17 when employing this type of hopper to coat gel dope the solution tends to neck in as it leaves the coating slot. It therefore is impossible to coat a sheet from such a hopper which will be of a predetermined and desired width.

Referring to Fig. 2 there is shown an improved coating hopper from which a film support from gel dope of a predetermined width can be made. As shown in this drawing the improved hopper is represented at 20 and comprises slanting side walls 21 and 22 having a heating jacket 23 and 24 positioned therein. The lower projections or lips 25 and 26 of these walls are suitably spaced apart to form a coating slot 27. A solution guide member 28 is removably positioned near the end of coating slot 27. The guide member 28 is suitably attached to rod 29 and can be raised or lowered by raising or lowering rod 29 which is slidably mounted on the end wall 30 of the hopper by members 31 and 32. As is indicated in this drawing the solution 15 tends to adhere to the guide 28 and flow downward to the rotating coating wheel 33 positioned therebelow. Baffles 35 and 36 attached respectively to walls 21 and 22 serve to shield the stream of dope from undesirable air currents between the slot 27 and the coating wheel 33. A sliding member 37 slidably mounted on the inside of the hopper by members 38 and 39 operates to regulate the flow of the solution down the guide 28. A cover 40 is suitably placed on the hopper to prevent foreign materials from falling in the coating solution.

It will be understood that a guide rod is positioned at each end of the coating slot as shown more clearly in Fig. 3. The solution 15 is shown flowing from slot 27 and following the guides 28 on either end of the slot downward to contact the coating wheel 33 and form a sheet 18. A slight tendency to neck in after the solution leaves the end of the guide rods 28 may occur as shown at 41. This, however, is negligible and the hopper slot can be adjusted to a length which will produce a sheet of a desired width within small limits of error.

Referring to Fig. 5 there is shown a side elevational view in section of a modification of my improved coating hopper 45 in which a strip of porous balsa wood is employed as the guide for the gel dope. As shown in this drawing, the hopper 45 comprises walls 46 and 47 having heating jackets 48 therein. Cover plate 49 is placed on the hopper. A coating slot 51 is formed between the lower extremities of walls 46 and 47 through which the solution flows downward toward coating wheel 61. Baffles 52 and 53 extend along the length of the slot and extend downward toward the coating wheel 61 and serve to restrict air currents from contacting the dope stream. In place of the metal guides 28 shown in Figs. 2, 3 and 4, in the present modification, there is substituted a strip of porous balsa wood 54. This strip of balsa wood is countersunk in the end wall of the hopper and is flush therewith as shown more clearly in Figs. 6 and 7. Under the optimum operating conditions, hereinafter described, the gel dope will flow out of slot 51 as shown more clearly in Fig. 7 and follow the balsa wood guide down to the coating wheel 61 as shown in Figs. 5 and 6. To assure the adherence of the gel dope to the balsa wood guide as well as to prevent slugs from forming thereon, it is desirable to keep the surface of the balsa wood covered with a thin layer of a solvent 59 for the gel

dope. This will wet the surface of the balsa wood and gel dope will tend to adhere to the solvent and therefore follow the balsa wood guide downward toward the coating wheel and form a sheet 60. The solvent employed to wet the balsa wood guide is conducted to the side away from the dope stream 50 in sufficient quantities to flow through the porous wood by a conduit 55 contained in the end wall 56 as shown particularly in Figs. 6 and 7. A funnel 58 may be employed to introduce the solvent into the conduit 55.

To form a film support by the apparatus shown in Figs. 2, 3 and 4 an appropriate gel dope solution, for example 100 parts of cellulose acetate butyrate containing 33.2% acetyl and 11.9% butyryl in 700 parts by weight of a solvent mixture composed of 60% by weight of propylene chloride and 40% of ethylene chloride is added to the hopper and by means of the heating jacket is maintained above approximately 60° C. as a fluid. The coating wheel 33, by means not shown, is maintained at a cool temperature of approximately 14° C. The coating wheel 33 is caused to slowly rotate and a thin stream of hot dope 15 is permitted to flow from slot 27. The gel dope solution would normally neck in as shown in Fig. 1 were the guides 28 not employed. Because of the guides the dope will travel straight downward to contact the coating wheel 33 in a stream of the desired width as indicated most clearly in Fig. 3. When the dope stream reaches the cold wheel it will gel under the influence of the lower temperature and form a transparent sheet.

This gel dope solution may be coated from the apparatus described in connection with Figs. 5, 6 and 7 by maintaining the solution in the hopper at 60° C. and permitting it to flow out of the slot and down the balsa wood guides to contact the cold revolving wheel 61 in a stream of the desired width. The balsa wood guides are wetted by adding a 60–40 propylene chloride-ethylene chloride solvent mixture to the conduit 55 from which it will soak through to the face of the balsa wood as shown in Fig. 6 at 59. On reaching the cold wheel 52 the solution will change to a gel and form a transparent sheet having the desired width.

Usually on leaving the coating wheel the transparent gel like film is conducted to suitable drying apparatus, not shown, to further reduce the solvent content to a minimum. This is possible without employing high temperatures for the structure of the gel like film is such that it will readily release the volatile solvent.

Other gel dope solutions such as are disclosed in the copending applications Serial Nos. 245,020; 245,021; 245,022; 245,023 filed Dec. 10, 1938; and Serial No. 275,712 filed May 25, 1939 may be employed in my improved coating hopper for forming film support of a predetermined width.

What I claim is:

1. In a film or sheet forming device, a hopper having a slot therein for feeding a film forming solution to a moving film forming surface positioned thereunder, solution guide members positioned near the ends of the slot extending from within the slot downward toward but out of contact with the film forming surface for guiding the solution to the film forming surface in a stream width substantially equal to the length of the slot.

2. In a film or sheet forming device, a hopper having a slot therein for feeding a film forming solution to a moving film forming surface positioned thereunder, solution guide members positioned near the ends of the slot extending from within the slot downward toward but out of contact with the film forming surface for guiding the solution to the film forming surface in a stream width substantially equal to the length of the slot, and means forming an enclosing chamber around the slot and guides extending from the vicinity of the hopper slot toward the film forming surface.

3. In a film or sheet forming device, a hopper having a slot therein for feeding a film forming solution to a moving film forming surface positioned thereunder, solution guide members positioned near the ends of the slot and out of contact therewith extending from within the slot downward toward but out of contact with the film forming surface for guiding the solution to the film forming surface in a stream width substantially equal to the length of the slot, and means forming an enclosing chamber around the slot and guides extending from the vicinity of the hopper slot toward the film forming surface.

4. In a film or sheet forming device, a hopper having a slot therein for feeding a film forming solution to a moving film forming surface positioned thereunder, solution guide members positioned adjacent the ends of the slot extending from within the slot downward toward, but out of contact with, the film forming surface for guiding the solution to the film forming surface in a stream width substantially equal to the length of the slot, and means for adjusting the position of said guide members toward and away from said film forming surface.

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