Sept. 8, 1942. C. R. FORDYCE 2,295,280

COATING HOPPER

Filed May 15, 1940

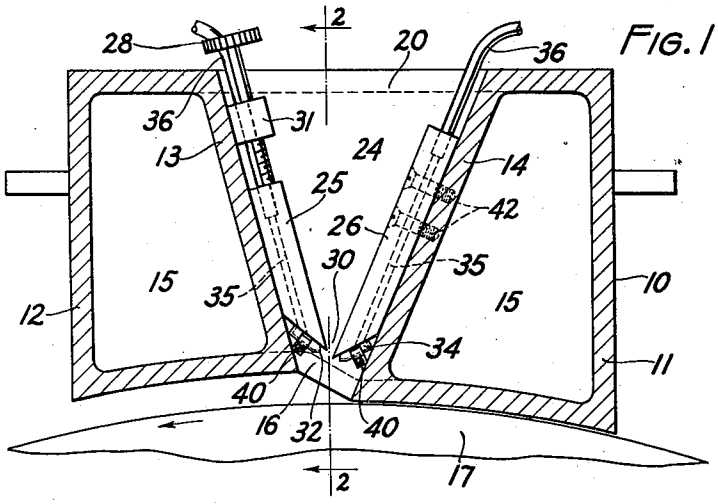


FIG. 1

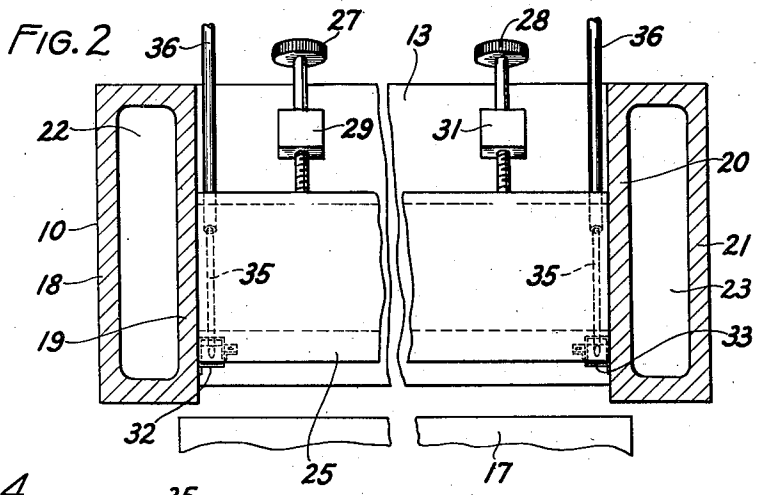


FIG. 2

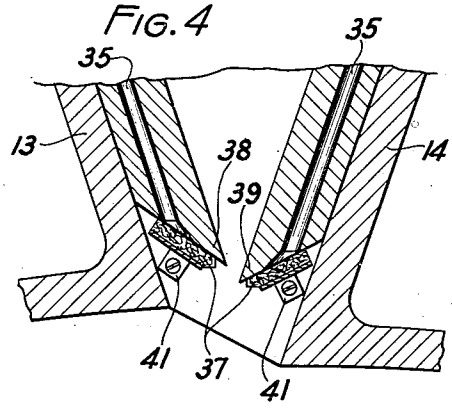


FIG. 4

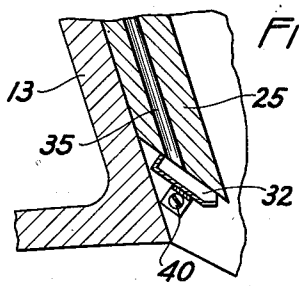


FIG. 3

CHARLES R. FORDYCE
INVENTOR

N. M. Perrins

BY Daniel J. Mayne

ATTORNEYS

Patented Sept. 8, 1942 2,295,280

UNITED STATES PATENT OFFICE

2,295,280

COATING HOPPER

Charles R. Fordyce, Rochester, N. Y., assignor to Eastman Kodak Company, Rochester, N. Y., a corporation of New Jersey

Application May 15, 1940, Serial No. 335,335

3 Claims. (Cl. 18—15)

This invention relates to coating apparatus for coating cellulosic film forming solutions into a continuous sheet, and more particularly to an improved type of apparatus especially adapted for use with gelation type coating solutions.

It has been the common practice for some time in the art of forming thin sheeting and film base to spread a thin coating of the desired material, generally a solution of a cellulose ester such as cellulose acetate in a suitable solvent, onto a heated surface and cause the solvent to evaporate therefrom. The method usually 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 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 apex of the V to form a coating slot. Usually one or both 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 satisfactory for coating many kinds of cellulosic solutions. However, when an attempt was made to coat what is herein termed a "gel dope" from such a hopper onto a cold wheel, i. e. one which is maintained below the gelation temperature of the dope, in place of a hot wheel various unforeseen difficulties arose. The present invention will perhaps be better understood if the characteristics and nature of a "gel dope" are explained. The "gel dope" which the present hopper is adapted to coat may be formed by dissolving at elevated or moderately elevated temperatures certain cellulose organic acid esters such as cellulose acetate propionates and cellulose acetate butyrates and the like in a solvent mixture, consisting of propylene chloride and ethylene chloride or propylene chloride and a lower aliphatic alcohol such as methyl alcohol to give solutions or dopes which are susceptible of gelation by a rapid lowering of temperature. The sheet or film resulting from such gelation may be stripped from the casting surface almost immediately after casting while containing nearly all or at least a large proportion of the original solvent. In short, dopes of this type can be maintained fluid at temperatures above 40° C. and when allowed to cool to or below a critical temperature between 10° C.–40° 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 temperature. In coating the ordinary type dope, heretofore employed in the art, onto a heated wheel such small temperature variations do not produce a physical change in the dope. 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 partial gelation of the dope stream and 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.

The object of the invention is an improved coating hopper which is particularly adapted for coating heated solutions onto casting surfaces which are maintained at distinctly lower temperatures.

In accordance with the invention there is employed a coating hopper provided with means to distribute a thin liquid layer on the outside of the coating slot blades adjacent the slot during the coating operation. This liquid will flow in the direction of the coating composition and at the knife like edges of the blades will contact the outflowing film forming composition. The liquid is preferably one which is miscible with the film forming composition being coated. Therefore, there will be no tendency for the solution to harden at the edges of the blades since this solvent will tend to redissolve or keep in solution

particles of the coating solution base which otherwise might collect on the blades. The solvent also prevents the accumulation of the dope on nuclear particles by either insulating them with a liquid film or removing them from the proximity of the coating slot. I have found that a slow seepage of the solvent over the blades is sufficient to prevent slug formation in the dope stream. While the solvent may be spread over the total length of the blade I have found that no difficulty is experienced if the solvent flow is restricted to a small area at the ends of the blades and on the back or outer side of the coating blades.

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

Fig. 1 is a sectional view in elevation of the preferred type of coating hopper showing the devices attached to the back of the coating blades for distributing solvent thereto.

Fig. 2 is a sectional view in elevation taken on the lines 2—2 of Fig. 1.

Fig. 3 is a broken away enlarged sectional view of one of the coating blades showing the chamber for containing the solvent.

Fig. 4 is a broken away enlarged sectional view of two of the coating blades having felt strips for conducting solvent to the blades instead of a hollow chamber.

Referring to Fig. 1 there is shown a double walled coating hopper **10** having outside walls **11** and **12** and inside slanting walls **13** and **14**. The space **15** between the double walls may be employed as a heating chamber, if desired. At the apex of slanting walls **13** and **14** there is a slot **16** thru which the coating solution flows to the coating wheel **17**. The ends of the hopper are shown in Fig. 2 and comprise similar double walls **18** and **19** and **20** and **21** forming heating chambers **22** and **23** respectively. As will be understood the space **24** is filled with coating solution during operation of the coating hopper.

To regulate the thickness of the sheet or film being coated, blades **25** and **26** are positioned on walls **13** and **14** respectively. As shown in Fig. 1 blade **26** is fixedly attached to wall **14** by screws **42**, while as shown more clearly in Fig. 2, blade **25** is movably mounted on wall **13** and can be moved toward or away from blade **26** by means of turn screws **27** and **28** which engage members **29** and **31** mounted on wall **13**. By moving blade **25** up or down the width of the coating slot **30** may be adjusted to give a flow of solution from hopper **24** as desired.

Mounted beneath the coating edge of the blades and attached to the blades near the ends of the coating slot are liquid distributing chambers. As shown in Fig. 1 at **32** and **34** and in the magnified view in Fig. 3 these liquid distributing chambers comprise small boat like members having one end wall lower than the other. They are fastened to the lower portion of the knife blades by a suitable strap **40** with the open end of the boat toward the coating slot. The boats will permit the solvent contained therein to flow on the outside of the coating blades and toward the coating slot **30**. By regulating the flow of solvent the blades can be maintained wet with solvent during the coating operation. Therefore, there will be no slugging on the edges of the blades since the solvent will keep the coating solution in a liquid form. The wetting solvent may be introduced into the boats in any suitable manner. One way as shown in the drawing is to provide conduits **35** in the knife blades thru which solvent can be introduced from connecting tubes **36** attached to a supply.

Instead of a hollow boat as the distributing means I may employ a permeable applicator, for example, felt or similar porous materials. The porous materials will act as a wick and permit the solvent to seep continuously over the blades. This modification is shown in Fig. 4 in which the felt applicators are shown at **37** held against the knife blades **38** and **39** by supporting strap members **41**.

The following is an example of the operation of the coating hopper.

Example I

A solution of 100 parts by weight of a cellulose acetate butyrate containing 25% acetyl and 20.7% butyryl in a solvent mixture composed of 420 parts of toluene and 180 parts of n-propyl alcohol was prepared by mixing the ingredients with continued stirring at 70° C. The solution was then filtered to remove incompletely dissolved particles. The dope was admitted to the hopper where its temperature was maintained at about 50° C. The blades of the hopper were so adjusted as to feed a stream of the warm dope to the wheel surface of such thickness as to give an eventual film thickness of .005 inch, the wheel being maintained at a constant temperature of about 15° C. During the flow of the coating solutions thru the coating slot butyl acetate was caused to flow at a slow rate from a source not shown thru tube **36** into conduits **35** to boats **32** and **34**. The solvent flows slowly out of the mouth of the boat and spreads over the outside of the coating blades adjacent the ends of the blades where slugging usually occurs and no slugging was experienced. The wheel was rotated at such a speed that the film remained on the film forming surface for about six minutes. On coming in contact with the wheel the coating solution was transformed into a non fluid gel; and after completing somewhat more than ¾ of a revolution on the wheel the film was stripped off the wheel and further treated by other apparatus, not shown, to remove solvent.

Example II

A similar coating operation was conducted with a filtered solution of 100 parts by weight of a cellulose acetate propionate containing 30% acetyl and 14.5% propionyl content in 600 parts by weight of a solvent mixture composed of 53% by weight of propylene chloride and 47% test amyl alcohol and containing 10% triphenyl phosphate based on the weight of the cellulose ester. During the coating operation ethylene chloride was permitted to flow from the boat like solvent distributor chambers over the hopper blades. Owing to the presence of the solvent on the blades, no slugging of the coating solution occurred. Other solvents such as ethyl and methyl acetate may be employed instead of ethylene chloride when coating this solution.

Example III

A filtered solution of 100 parts by weight of a cellulose acetate of 40.5% acetyl content in 500 parts by weight of a solvent mixture composed of 70% by weight of propylene chloride and 30% iso-propyl alcohol was coated from my improved hopper and a lubricating solvent of methyl acetate was employed on the blades to keep the

solution from slugging and no slugging of the solution was experienced.

Depending somewhat on the type of solution the following solvents may be spread on the coating blades to prevent slugging of the coating solution: ethylene chloride, propylene chloride, methyl and ethyl acetate. In general these solvents are compatible with the solutions but are not active enough to blend rapidly with them. I have also found that more active solvents may be employed provided they are highly volatile such as, for example, methylene chloride.

It will be understood that my invention can be applied to various types of coating devices and is not restricted to the V type of coating hopper disclosed in the drawing.

My coating apparatus may be used with various coating solutions, particularly in cases where it is desirable to coat a solution onto a relatively cold sheet or film forming surface.

It will be also understood that while I have shown the solvent distributors positioned on both of the coating slot blades with some solutions it may be necessary to employ only one or the other of the distributors to achieve satisfactory sheets or films. It is, therefore, within the scope of the invention to employ a distributor on only one of the coating slot blades. Furthermore while the solvent distributors are shown in the drawings mounted on the back of the blades it will be understood that they may, within the scope of the invention, be suitably positioned at the ends of the blades whereby they will also distribute the solvent over the portions of the blades where slugging most generally occurs.

By employing my apparatus I have successfully overcome slugging of coating solutions and am able to form uniform sheets and films from solutions which change to solids and gels within a relatively small temperature range.

I have also found that my improved apparatus may be advantageously employed with coating solutions which coagulate to form a gel upon the wheel when subjected to moisture vapors. Such solutions are described in the copending application Serial Number 143,302 filed May 18, 1937.

The apparatus may also be advantageously employed in coating solutions which form gels by loss by evaporation of one or more of the component solvents of the coating solution.

If desired the apparatus may even be used for coating solutions which do not gel but set by simple progressive evaporation of the solvents in the solution.

In these instances the wetting of the edges of the coating slot by a suitable solvent will prevent slug formation.

I claim:

1. In a coating hopper for coating film support, a pair of thin edged blades disposed to form a V and spaced apart to form an open coating slot between the blades at the apex of the V through which coating solution may flow, and means mounted on the back side of each blade near the end of each blade and near the apex of the V, for spreading another liquid on the edges of the blades at their end portions during the coating operation.

2. In a coating hopper for coating film support, a pair of thin edged blades disposed to form a V and spaced apart to form an open coating slot between the blades at the apex of the V through which coating solution may flow, and liquid distributing members mounted on the back side of each blade near the end of each blade and near the apex of the V, for spreading another liquid on the edges of the blades at their end portions during the coating operation.

3. In a coating hopper for coating film support, a pair of thin edged blades disposed to form a V and spaced apart to form an open coating slot between the blades at the apex of the V through which coating solution may flow, and permeable liquid distributing members mounted on the back side of each blade near the end of each blade and near the apex of the V, for spreading another liquid on the edges of the blades at their end portions during the coating operation.

CHARLES R. FORDYCE.