Dec. 22, 1959 S. J. WOMMACK ET AL 2,918,393

METHOD AND APPARATUS FOR ROLL COATING WEBS

Filed June 12, 1956 3 Sheets-Sheet 1

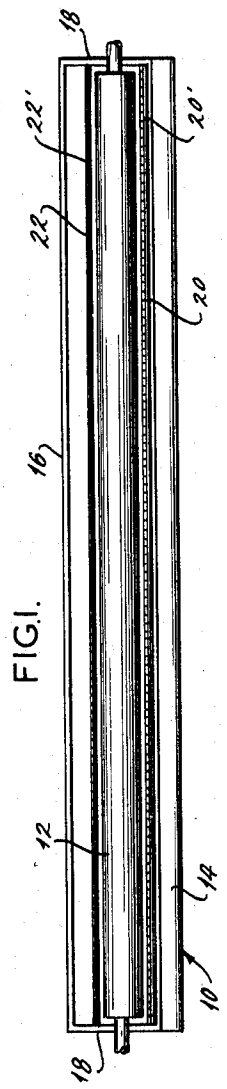


FIG. 1.

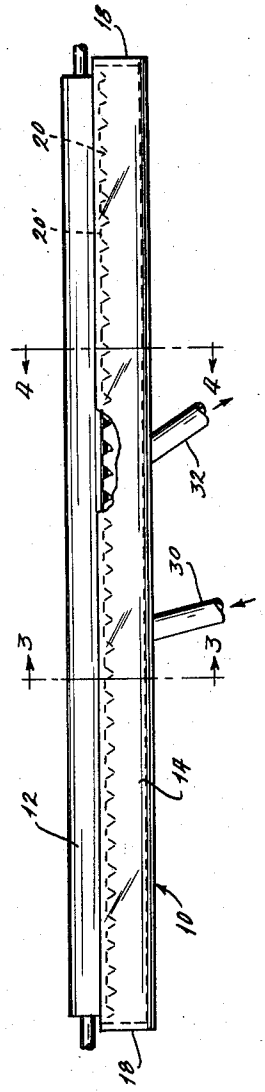


FIG. 2.

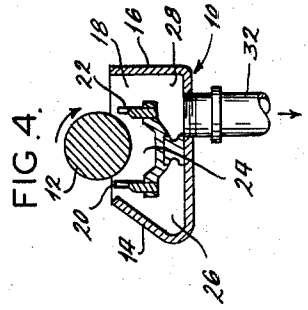


FIG. 4.

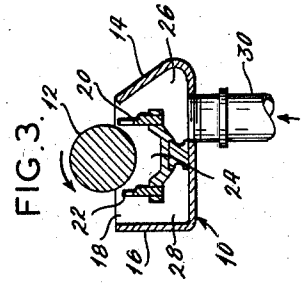


FIG. 3.

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METHOD AND APPARATUS FOR ROLL COATING WEBS

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FIG.5.

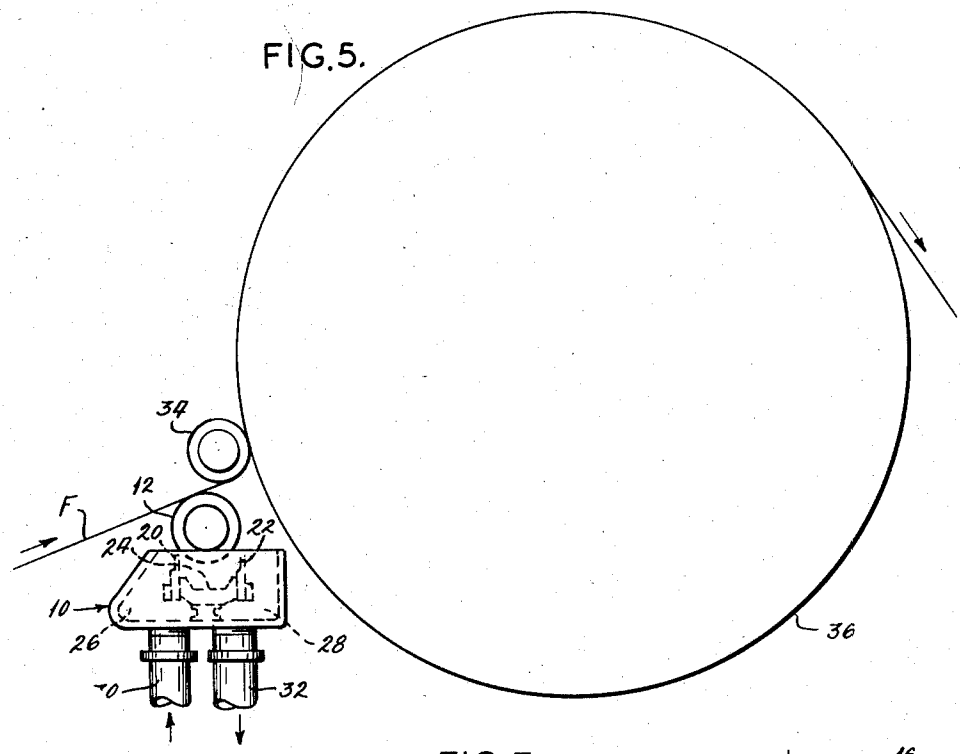


FIG. 7.

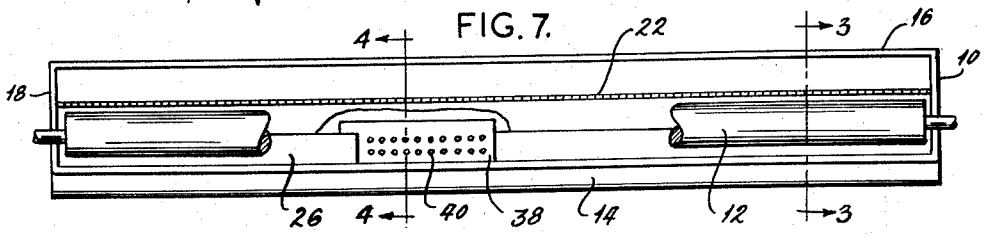


FIG.8.

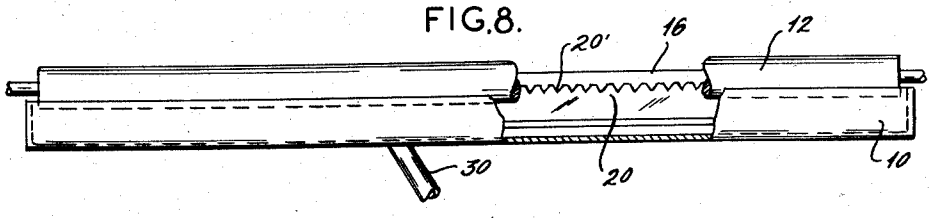


FIG. 9.

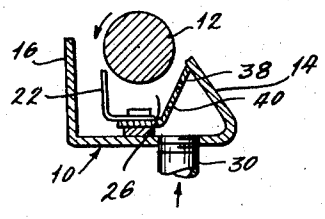
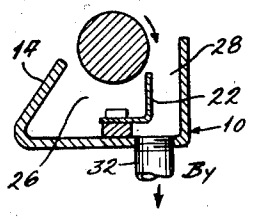


FIG.10.



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METHOD AND APPARATUS FOR ROLL COATING WEBS

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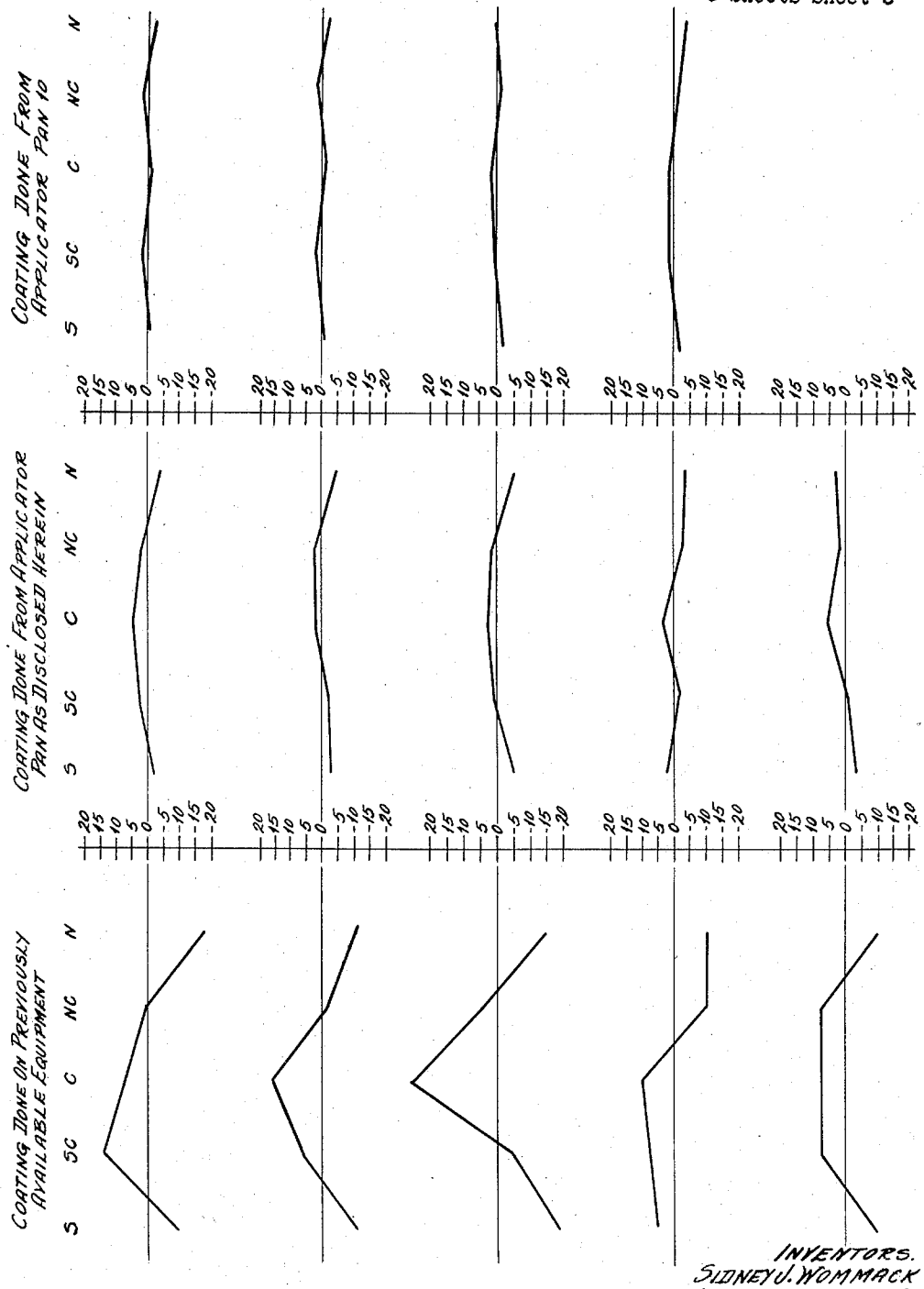


FIG. 6.

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United States Patent Office 2,918,393 Patented Dec. 22, 1959

2,918,393

METHOD AND APPARATUS FOR ROLL COATING WEBS

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Application June 12, 1956, Serial No. 590,884

7 Claims. (Cl. 117—111)

This invention relates to the coating of regenerated cellulose films and the like, and more particularly to an improved coating method and apparatus by which "crown" effects are substantially eliminated in the coatings obtained.

"Crown" is the term commonly used to describe the variation in coating thickness that normally occurs across a sheet of coated regenerated cellulose or the like as an expected result of normal coating procedures. This crown effect has always been a troublesome problem in film coating operations, as where regenerated cellulose film is provided with a moistureproof coating, and it has proved to be an especially difficult problem to deal with when aqueous dispersions are used to provide a moistureproof coating as disclosed in U.S. Patent No. 2,570,478, issued October 9, 1951. The aqueous dispersion coatings offer substantial advantages over the solvent type coatings heretofore generally employed, but they are sometimes much harder to handle and apply.

It is therefore an object of this invention to provide a method and apparatus for coating film from an aqueous dispersion of the coating material that substantially eliminate the foregoing problem. Another object of the invention is to provide an improved method and apparatus for coating regenerated cellulose film and the like with coating material of substantially uniform composition and with less crown effect than with heretofore available coating means.

This application is a continuation-in-part of our copending application, Serial No. 310,396, filed September 19, 1952, now abandoned. As set forth in the aforesaid application, the foregoing objects are achieved in accordance with this invention by providing an apparatus and method for coating films of regenerated cellulose and the like with a coating material of substantially uniform composition and without any substantial amount of crown effects. It has been found that regenerated cellulose film and the like absorb water from an aqueous coating material that has been applied to the surface thereof and, consequently, any of the excess coating material squeezed or otherwise removed from the film during the coating process contains less water than the dispersion being used for coating the film. In the heretofore conventional coating apparatus, the amount of water and other ingredients of the coating material has varied as the coating of the film proceeds and this variation in concentration has lead to variations in coating thickness. In accordance with this invention, the coating material removed from the film is not returned to the coating bath and is not permitted to contact the film again until it has been adjusted to the correct composition, and in addition the coating material is continuously flowing through the applicator pan in order to insure uniform distribution in transverse relation to the longitudinal axis of the coating roll and to insure that the dispersion into which the coating roll is partially submerged is of substantially uniform composition. The coating apparatus provided by this invention has a compartment from which the coating material is transferred to the film and a second compartment into which the excess coating applied to the surface of the film is returned after it has been removed from the film.

The procedure and arrangement of this method and apparatus are described in further detail below in connection with the accompanying drawing in which:

Fig. 1 is a plan view of an embodiment of an applicator pan and associated applicator roll arranged in accordance with the present invention;

Fig. 2 is a side elevation corresponding to Fig. 1;

Fig. 3 is a sectional detail taken substantially on the line 3—3 in Fig. 2;

Fig. 4 is a sectional detail taken substantially on the line 4—4 in Fig. 2;

Fig. 5 is a fragmentary side elevation, largely diagrammatic, illustrating the manner in which the applicator pan of the present invention is employed in a coating operation;

Fig. 6 is a graphic illustration of the comparative data tabulated in the specification;

Fig. 7 is a plan view of another embodiment of an applicator roll associated with an applicator pan;

Fig. 8 is a side elevation of the embodiment of Fig. 7;

Fig. 9 is a sectional view taken along the line 3—3 of Fig. 7; and

Fig. 10 is a sectional view taken along the line 4—4 of Fig. 7.

Referring now in detail to the drawings, and more particularly at first to Figures 1 to 4, an applicator pan embodying the present invention is indicated generally in the drawings by the reference numeral **10** in association with an applicator roll **12**, the applicator pan **10** and roll **12** being adapted for arrangement transversely with respect to the path of travel of the film as it is coated as will appear more fully presently, and being formed as is usual in a length at least coextensive with the width of the film to be coated.

The applicator pan **10** may otherwise be provided with any external form desired so long as it is made to serve suitably as a container for presenting coating material to the applicator roll **12**. In the embodiment shown in the drawings one side wall **14** of the applicator pan **10** is slanted inwardly to allow disposition of the pan **10** and roll **12** to more convenient advantage in relation to film being coated (compare Fig. 5), but this is not essential. The other side wall **16** and end walls **18** are preferably arranged squarely, as shown.

Internally, the applicator pan **10** of Figures 1 to 4 is specially arranged with two spaced, parallel, partitions **20** and **22** fitted lengthwise therein to form a central compartment **24** with separate compartments **26** and **28** at each side. The separate side compartment **26** is employed as a supply compartment for coating material and for this purpose has a supply conduit connected thereto as at **30**.

Delivery of coating material from this supply compartment **26** to the central compartment **24** is provided for by arranging the separating partition **20** as an overflow partition, preferably by forming spaced notches along the top edge thereof as at **20'** to serve as overflow weirs. The advantage of this arrangement may be further increased by shaping the notches **20'** in the form of an inverted isosceles triangle having a 90° vertex angle, so that the overflow rate therethrough is rendered directly proportional to the overflow head of coating material maintained in the supply compartment **26** and may therefore be controlled nicely for close regulation during the coating operation.

The central compartment **24** of the applicator pan **10** is employed as the chamber from which the coating material is transferred to the film to be coated, and the

applicator roll 12 is arranged to run partially submerged in the compartment 24 (compare Figs. 3, 4 and 5) to effect this transfer from a continuous flow of coating material through the compartment 24 from the supply compartment 26. The continuous flow of coating material through the central compartment 24 is maintained by arranging the second separating partition 22, similarly to the previously noted partition 20, as an overflow partition by notches such as 22' to form overflow weirs as before, and which again may be advantageously shaped as inverted isosceles triangles with 90° vertex angles, but which should be lowered slightly in relation to the inlet notches 20' in order to provide a cascading effect on the coating material flow through the central compartment 24 and thereby insure effective functioning of the notched overflow partitions 20 and 22.

The coating material overflow from the central compartment 24 at the second overflow partition 22 is received in the side compartment 28 at the other side of the applicator pan 10. This side compartment 28 serves as a drain compartment and has connected thereto a drain conduit 32 by which the overflowed coating material may be continuously drained from the compartment 28 for mixture and recirculation in any convenient manner with the coating material supplied to the first compartment 26 through the supply conduit 30.

The arrangement of an applicator pan 10 as described above for use in a coating operation is illustrated in Fig. 5 of the drawings in which the fragmentary showing indicates the path of a regenerated cellulose film F or the like through coating apparatus adapted to handle the film F in continuous web form as is usual. As shown, the applicator pan 10 is arranged transversely of the path of travel of the web of film F and disposed so that the associated applicator roll 12 runs in contact with the film F, and rotates so that the adjacent travel of the rotating surface of roll 12 at the central compartment 24 is opposite to the direction of the material flow therein. Beyond the applicator roll 12 the coated film F is trained between the opposed surfaces of rolls 34 and 36 forming a squeeze nip at which excess coating is removed from the film F, and the film F then continues for a suitable distance on the surface of the roll 36 which may be arranged to serve as a casting surface for setting the coating on the film F. The excess coating may, of course, be removed by any other suitable means such as, for example, by a knife blade, scraper or the like, but the excess must fall into compartment 28.

As previously mentioned, the applicator pan 10 of this embodiment functions during this coating operation so that the roll coating of the film F is done by the applicator roll 12 from a continuous flow of coating material channeled in a uniform manner transversely with respect to the axis of the roll 12. The uniformity of this coating material flow results from several unique features of the improved applicator pan 10 together with the particular method employed in applying the coating.

In the embodiment of the invention shown in Figures 7 through 10 a partition similar to 20 of the embodiment in Figures 1 through 4 is not required. The applicator pan 10, applicator roll 12 and partition 22 may be of the same type as that of the other embodiment. Instead of partition 20, however, this embodiment is provided with a perforated baffle 38 over inlet 30 as shown to best advantage in Figure 7. This baffle is relatively short and only of sufficient length to prevent the coating material entering through inlet 30 from causing excessive turbulence in the coating bath and from squirting out of the applicator pan. As shown in Figure 10, throughout most of the length of the applicator pan 10 only two compartments are required. The coating material enters through inlet 30 and flows either through perforation 40 of baffle 38 or around the ends of the baffle. When the height of the coating material in the pan corresponds to the height of the partition 22, the coating material overflows into the drain compartment 28 and out of the applicator pan to discharge conduit 32. Roll 12 rotates in a direction opposite to the direction of flow of coating material in pan 10. Partition 22 is preferably provided with a serrated edge 20' similar to that of the embodiments of the Figures 1 through 4 in order to overcome any surface tension that would tend to make the overflow uneven along the edge of partition 22 or all toward one end of the pan. It has been found that as a result of providing an applicator pan with an overflow partition 22 and a baffle 38 the flow of solution transverse to the axis of the coating roll is such that a substantially uniform composition of coating material will be maintained in compartment 26. As in the embodiment of Figures 1 through 4, the applicator pan of Figures 7 through 10 is positioned under the nip between squeeze roll 34 and roll 36 so that the excess material removed by these rolls from the film will drop only into compartment 28. Otherwise, the composition of the coating material adjacent roll 12 would vary from time to time during the coating process.

The location of the supply and drain conduits 30 and 32 for the compartments 26 and 28 is rendered immaterial by the compartmented arrangement of the applicator pan 10 of Figure 1 or of the positioning of baffle 38 of Figures 7 through 10, and so long as these conduits 30 and 32 are provided in a size large enough to avoid any appreciable velocity head and resulting turbulence from the flow of coating material entering and leaving through them, they may be located to supply and drain the compartments 26 and 28 as is most convenient without affecting the good operating results obtainable with the applicator pan 10. Also, the compartmenting of the applicator pan 10 as shown in Figures 1 through 4 so that the coating material is supplied and drained separately from the central compartment 24, isolates the central coating compartment from the supply and drain flow of coating material and thereby allows an even distribution of the coating material to be effected through the central compartment 24 by the overflow partitions 20 and 22. In addition, the notched arrangement of the overflow partitions 20 and 22 results in channeling the coating material flow to and from the central compartment 24 in a manner that avoids any stratifying or randomness of flow.

It should also be noted that the arrangement of the applicator pan 10 for continuous recirculation of the coating material by means of the supply and drain conduits 30 and 32 makes it possible to maintain the coating material uniform in consistency as well as in flow characteristics. In this connection, it will be seen by referring to Fig. 5 again that the applicator pan 10 is arranged in operation so that its drain compartment 28 is disposed below the squeeze nip formed by the opposed roll surfaces 34 and 36 and is therefore positioned to receive and collect the excess coating material removed from the film F as it drips from the squeeze nip. These drippings of excess coating material from the squeeze nip are accordingly removed with the drain flow of coating material from the compartment 28 and are not allowed to affect in any way the coating material flow presented to the applicator roll 12. In addition, when aqueous dispersion coatings are being handled, the dewatering effect of the cellophane film F is rendered unimportant by the continuously recirculating flow provided according to the present invention, which prevents this dewatering from having any appreciable effect on the consistency of the coating material supply.

As to the materials used in constructing the applicator pan 10, any convenient materials may in general be used so long as it is kept in mind that many coating materials, particularly the aqueous dispersions mentioned above, are corrosive in nature and adequate care must accordingly be taken in the selection of suitable materials to withstand this corrosion. Also, there is a par-

ticular problem when handling the aqueous dispersions in preventing them from coagulating and coating-out on the overflow partitions **20** and **22** so as to change unduly the flow characteristics through the weir notches **20** and **22**. This coating-out effect is encountered to an unsatisfactory extent, in general, when metals are used to form the partitions **20** and **22**. We have found, however, that the coating-out difficulty may be avoided by forming the partitions **20** and **22** of a suitably corrosion resistant plastic material such as Teflon which is a polytetrafluoroethylene Du Pont plastic.

In one example, a cellulose web about 49 inches wide is passed over applicator roll **12** about 2 inches in diameter and rotating faster than the lineal speed of the film. The tension on the film is from 20 to 80 pounds per square inch. An excess of coating material flowing at a rate of about 3 gallons per minute is applied to the underside of the web by roll **12** and the film is then passed between rolls **34** and **36** where the excess is squeezed therefrom. The coated film lies against roll **36** until the coating has set to the point where it is not tacky. It may then be wound into suitable rolls. The coating material removed from the web by rolls **34** and **36** falls into compartment **28** from which it is withdrawn through conduit **32**. Water may then be added to the rejected coating material to replace that absorbed by the film and the resulting composition may be pumped or otherwise returned through conduit **30** to applicator pan **10**.

In order to illustrate further the marked improvement in coating results obtainable through use of the method and means of the present invention, comparative data are set forth below as determined from actual coating operations using an aqueous dispersion coating material of exactly the same type in each case but performed on the one hand with previously available equipment incorporating an uncompartmented applicator pan, such as has commonly been used heretofore, and, on the other hand, with coating apparatus equipped with an applicator pan **10** as disclosed herein.

The comparative data tabulated below represent "crown" determinations made on regenerated cellulose film taken in each case from coated rolls selected at random from several weeks' production on each type of equipment. The films tested were each 39 inches in width and coating weight was determined at five points evenly spaced across the film sheet from the south edge to the north edge and designated as S, SC, C, NC, and N. The coating weight found from measuring the coating on a 3.9" strip of film 39" long in the machine direction is stated below in grams of coating per square meter of film. The average coating weight across the sheet is also given, and the "crown" is expressed for each point in terms of the percentage variation from the average. Also, the maximum crown percentage is given as the algebraic sum of the extreme variations.

Table I.—Coating done on previously available equipment

Test No.	Coating Weight and Crown, Percent					Average Coating Weight	Maximum Crown, Percent
	S	SC	C	NC	N		
1	5.206 −9.6%	6.639 +15.3%	6.184 +7.4%	5.816 +1.0%	4.957 −13.9%	5.760	29.2
2	3.947 −11.6%	4.780 +7.0%	5.253 +17.6%	4.380 −1.99%	3.976 −11.0%	4.467	29.2
3	4.821 −19.3%	5.696 −4.7%	7.989 +33.7%	6.323 +5.8%	5.051 −15.5%	5.976	53
4	5.947 +5.7%	6.038 +7.3%	6.207 +10.3%	4.972 −11.6%	4.965 −11.7%	5.626	22
5	5.734 −10.8%	6.879 +7.0%	6.908 +7.5%	6.909 +7.5%	5.700 −11.1%	6.426	18.6

Table II.—Coating done from applicator pan 10 of Figures 1 through 4

Test No.	Coating Weight and Crown, Percent					Average Coating Weight	Maximum Crown, Percent
	S	SC	C	NC	N		
1	4.790 −2.5%	4.999 +1.8%	5.119 +4.2%	4.970 +1.2%	4.677 −4.8%	4.911	9
2	3.931 −2.1%	3.968 −1.1%	4.127 +2.8%	4.145 +3.3%	3.897 −2.9%	4.014	6.2
3	5.155 −4.4%	5.443 +1.0%	5.609 +4.1%	5.577 +3.5%	5.166 −4.2%	5.390	8.5
4	5.162 +1.0%	5.092 −0.4%	5.321 +4.1%	5.047 −1.2%	4.929 −3.5%	5.110	7.6
5	4.829 −4.8%	5.009 −1.2%	5.306 +4.6%	5.078 +0.1%	5.141 +1.34%	5.073	9.4

Table III.—Coating with applicator pan of Figures 7 through 10

Test No.	Coating Weight and Crown, Percent					Average Coating Weight	Maximum Crown, Percent
	S	SC	C	NC	N		
1	5.04 −1.27	5.19 +1.67	5.06 −0.88	5.22 +2.26	5.00 −2.06	5.105	4.3
2	5.14 −0.81	5.23 +0.82	5.25 +1.31	5.24 +1.12	5.05 −2.55	5.182	3.8
3	5.01 −2.53	5.18 +0.78	5.25 +2.14	5.07 −1.36	5.19 +0.78	5.14	4.7
4	4.53 −4.32	4.83 +2.1	4.82 +2.0	4.83 +2.1	4.56 −3.7	4.734	6.4

The data tabulated above are plotted for further comparison in Figure 6 of the drawing, and the significance of what is shown can be readily demonstrated by noting that the maximum allowable crown percentage for satisfactory commercial use of a given coating film is 20%. Beyond this percentage undue variation is encountered between the hard and soft edges of slit rolls obtained from the coated cast rolls, which leads to endless difficulties with puckering, uneven tensioning and guiding, poor printability, varying moisture resistance, and the like is subsequent converting operations.

From the tests tabulated in Table I above, it will be seen that the aqueous dispersion coating operations carried out on the previously available equipment produced just one instance in which the 20% limitation was met, and in this case the maximum crown was 18.6% or just below the limitation. When the new applicator pan **10** was used, according to the method described in Example I above, the results in Tables II and III show that in most instances the maximum crown percentage was less than half the limitation allowed (i.e. less than 10%), and in several cases was substantially less than half the limitation. The improved applicator pan **10** of the present invention together with the improved method illustrated in the example above accordingly represent the difference between unacceptable coating results with dispersion and results that are consistent and dependable as well as entirely within acceptable standards of commercial use.

The present invention has been described in detail above for purposes of illustration only and is not intended to be limited by this description or otherwise except as set forth in the claims. Although specific reference has been made to regenerated cellulose film in describing the invention, the process and apparatus are suitable for coating other webs such as, for example, polyethylene, chlorinated rubber, paper and the like.

What is claimed and desired to be secured by Letters Patent is:

1. In the process of coating a moving cellophane film and the like with an aqueous dispersion composition, the improved combination of steps to substantially eliminate crown effects which comprises, providing a continuous flow of said aqueous dispersion of substantially uniform composition substantially parallel to the movement of said film to a coating region, continuously withdrawing said composition as a stream from the surface of the region at uniformly spaced points to minimize differential rate of flow of said composition through said coating region, continuously removing a portion of said flowing composition from said stream in a direction opposite to the direction of flow by roll coating to transfer said removed coating continuously to said film.

2. In apparatus for coating a continuous web of cellophane and the like, the improvement which comprises an applicator pan arranged transversely with respect to the path of the web to be coated in said apparatus and formed in a length at least coextensive with the width of said web, said pan being fitted with lengthwise partitions forming a central compartment and supply and drain compartments, respectively, at either side of said pan, said supply and drain compartments being provided with supply and drain conduits respectively, the partition adjacent the side of the drain compartment being disposed slightly lower than the partition adjacent the supply compartment to enable a cascading flow of coating material from the supply to the drain compartment and both being formed with spaced notches along the top edges thereof providing overflow weirs from said supply compartment to said centrtal compartment and from said central compartment to said drain compartment, and an applicator roll mounted longitudinally of said central compartment to run partially submerged therein for transferring coating material therefrom to said web.

3. In apparatus for coating a continuous web of cellophane and the like, the improvement defined in claim 2 and further characterized in that said weirs are notched in the form of an inverted isosceles triangle having a 90° vertex angle whereby the overflow therethrough is rendered directly proportional to the overflow head in said compartments.

4. Apparatus for continuously coating a moving web of cellophane and the like which comprises an applicator roll for applying coating material to said web, an applicator pan for supplying coating material to said applicator roll for application to said web, said applicator pan being fitted with two spaced, parallel, partitions forming a central compartment between a supply compartment at one side of said pan and a drain compartment at the other side of said pan, the partition adjacent the drain compartment being slightly lower than the partition adjacent the supply compartment to allow a cassading flow of coating material from the supply to the drain compartment, said partitions being formed with spaced notches along the top edges thereof to form overflow weirs, a supply conduit connected to said supply compartment and a drain conduit connected to said drain compartment, said applicator roll being disposed to run partially submerged in said central compartment, a pair of opposed roll surfaces forming a squeeze nip for removing excess coating material from the coated web, said pan being disposed below said opposed roll surfaces to receive excess coating material removed by said opposed rolls in said drain compartment.

5. An apparatus for continuously coating a moving web which comprises an applicator pan arranged transversely with respect to the path of said web, a longitudinally disposed partition positioned to divide said pan along its length into a supply compartment and a discharge compartment, said compartments having connected thereto supply and drain conduits respectively, said partition being serrated along its entire upper edge to provide an overflow weir adapted to provide an overflow of fluid uniformly from along the full length of said supply compartment, an applicator roll disposed longitudinally in said supply compartment and partially submerged in said coating material, said roll being adapted to rotate in a direction opposite to the direction of flow of coating material to transfer coating material continuously from said supply compartment to said web.

6. An apparatus for continuously coating a moving web which comprises an applicator pan arranged transversely with respect to the path of the web, a longitudinally disposed partition disposed to divide said pan along its length into a supply compartment and a discharge compartment, said compartments having connected thereto supply and drain conduits respectively, a baffle element over the supply conduit opening to the supply compartment, said partition being serrated along its entire upper edge to provide an overflow weir adapted to provide an overflow of fluid uniformly from along the full length of said supply compartment, an applicator roll disposed longitudinally in said supply compartment and partially submerged in said coating material, said roll being adapted to rotate in a direction opposite to the direction of flow of coating material to transfer coating material continuously from said supply compartment to said web, and squeeze rolls for removing excess coating from said web positioned above said discharge compartment to return removed coating directly to said discharge compartment.

7. In an apparatus for coating a continuous web of cellophane and the like, the improvement which comprises an applicator pan arranged transversely with respect to the path of the web to be coated in said apparatus and formed in a length at least coextensive with the width of said web, said pan being fitted with lengthwise partitions forming a central compartment, and supply and drain compartments, respectively, at either side of said pan, said supply and drain compartments being pro-

vided with supply and drain conduits respectively, the partition adajcent the side of the drain compartment being disposed slightly lower than the partition adjacent the supply compartment to enable a cascading flow of material from the supply to the drain compartment, each of said partitions being provided with a serrated upper edge and an applicator roll mounted longitudinally of said central compartment to run partially submerged therein for transferring coating material therefrom to said web.

References Cited in the file of this patent

UNITED STATES PATENTS

1,399,160	Sevigne	Dec. 6, 1921
2,016,085	Fawkes	Oct. 1, 1935
2,168,997	Lankes et al.	Aug. 8, 1939
2,253,060	Clearman	Aug. 19, 1941
2,541,479	Nadeau et al.	Feb. 13, 1951
2,570,478	Pitzl	Oct. 9, 1951

FOREIGN PATENTS

115,247	Sweden	Oct. 23, 1945

OTHER REFERENCES

Perry: "Chemical Engineers Handbook," 3rd Ed., McGraw-Hill.