Feb. 13, 1951 G. F. NADEAU ET AL 2,541,479

METHOD AND APPARATUS FOR COATING PHOTOGRAPHIC FILM

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FIG. 1.

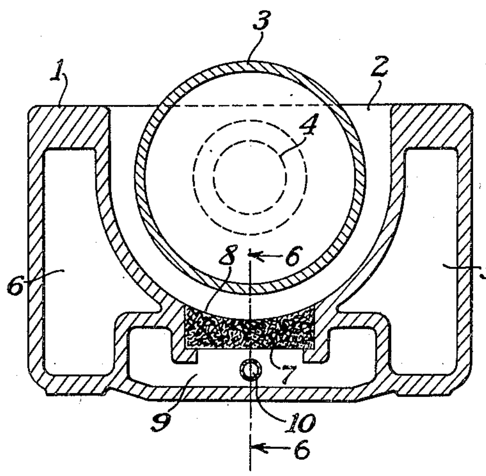



FIG. 2.

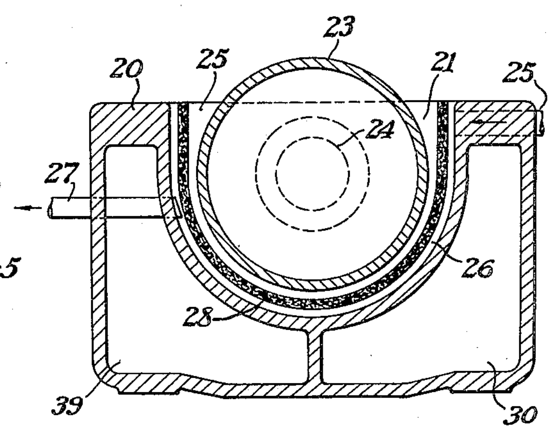



FIG. 3.

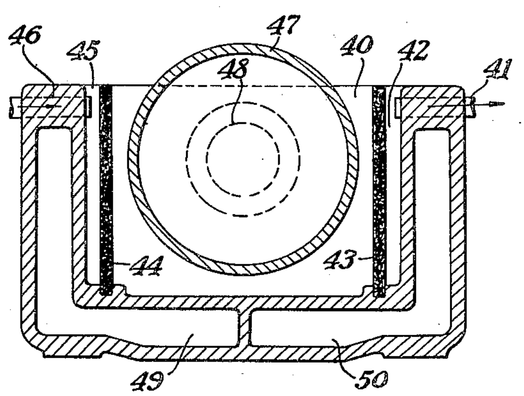



FIG. 4.

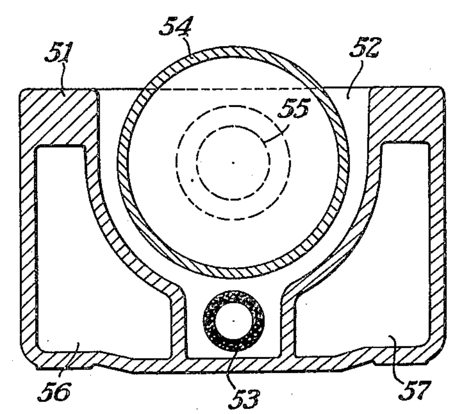



FIG. 5.

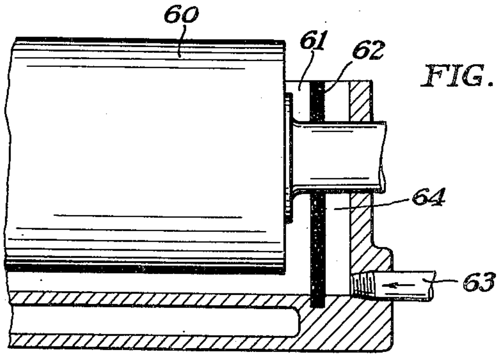
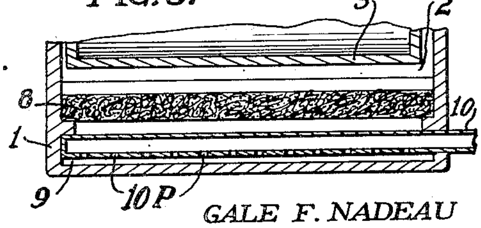



FIG. 6.

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## METHOD AND APPARATUS FOR COATING PHOTOGRAPHIC FILM

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14 Claims. (Cl. 117—111)

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This invention relates to a method and apparatus for supplying coatings to strip material. One object of our invention is to provide a method for applying coatings which will eliminate, or which will materially lessen, undesirable streaks, uneven marks, and the like, in coating strip material and particularly photographic film. Another object of our invention is to so regulate and control the flow of coating material into coating pans, or hoppers, as to entirely eliminate, or greatly minimize, the usual lack of uniformity which occurs because of an imperfect supply of coating fluids and imperfect diffusing, or blending, of the coating fluids at the place from which they are applied to the material. A still further object of our invention is to improve the technique of applying coatings by improving the method of, and the apparatus for, introducing coating solutions into and/or withdrawing coating solutions from coating pans. Other objects will appear from the following specification, the novel features being particularly pointed out in the claims at the end thereof.

In the coating art, the requirements differ widely according to the material to be coated and the type of coating to be placed on the material. One of the most exacting is the art of applying coatings to strip material to be used for photographic film The quality requirements of coatings on film support to prepare it for emulsion coating are of such as nature that none of the ordinary accepted coating techniques produce sufficiently satisfactory results without considerable modifications and requirements in the equipment or the method of operation. One of the very serious sources of poor quality and actual waste in the tinting and subbing of photographic supports is a more or less parallel or diagonal streakedness which we have demonstrated to be caused by "flow lines" or "channeling" of the subbing solutions in the immersion pan or bead hopper. "Sub," as used in this application, refers to a sub-stratum coating which is particularly used on photographic films and is a well-known term in the photographic art. We have shown by using glass-walled equipment that it is not practically possible to introduce solutions into a hopper and withdraw the excess from the hopper without experiencing this channeling of the liquid. This phenomenon is not new and has been pointed out by many other workers in other fields of endeavor. Similar problems are experienced if one attempts extremely uniform development of sensitized products. In this case, streakedness or lininess in

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the developed image is caused by a similar flow pattern of the processing solutions across the surface of the film.

In the subbing of photographic materials, a condition exists which actually accentuates many of these troubles. This condition is a result of the solution of some of the support materials in the subbing solvents which in practically all cases are solvents capable of dissolving the support itself. This necessitates a fairly rapid flow of fresh subbing material into the pan in order to maintain the correct composition of the subbing solution. The whole operation is so sensitive insofar as movement of this sub in the pan, or hopper, is concerned that stirring is not possible. The least bit of agitation, even vibration in the subbing equipment transmitted through the machine parts, is frequently responsible for poor application and, in some cases, special precautions are required to protect the subbing mechanism from the machine.

Many attempts have been made to solve this problem since it is quite obvious that feeding sub into one end of a hopper and drawing off the excess from the opposite end implies or, in fact, practically necessitates the existence of these flow lines through the subbing solution. One attempted solution involved feeding the sub by a perforated pipe whch ran the length of the hopper. The failure of this approach was a result of the relatively small volume of fluid handled which eliminated any practical method of realizing uniform flow throughout the length of the pipe. In actual practice, practically all of the flow occurred very near the entrance point. Calculation of the size of a rectangular slot the length of the pan required to give the necessary control with a very slight fluid head gives figures of the order of .0001-inch. Such control is not practically possible. The use of a weir or dam has been proposed, and this is used to some extent, although the results are far from satisfactory. In this instance, there is a tendency for all of the incoming liquid to flow over the weir in one point or at one or the other end of the hopper. Since the amount of sub supplied to a system of this type may be in the order of one to five gallons per hour, the fluid pressure head required is so small that uniform distribution across the pan or hopper does not seem to be realizable.

We have found a satisfactory solution to this problem and one which appears to overcome all of the objections to the various prior art through the use of a baffle composed of sintered glass or some similar porous material. These materials are available in plate form of various thicknesses and have been used in the chemical industry, especially as filter media, for highly corrosive systems that would attack ordinary wool, cotton, or paper filters. These materials are adaptable to this problem since the subbing material can diffuse through them and be introduced into the main bulk of the sub in the hopper or pan in a multitude of minute streams which are so numerous and so close together that lateral diffusion blends the whole incoming stream into a uniform system. With a porous baffle having a slight resistance to flow, it is possible, by using a perforated or slotted pipe, to introduce the sub more uniformly along the length of the pan behind this baffle and build up a slight head back of it. By using a similar baffle on the opposite end of the pan, the drawoff is removed in a similar fashion, and this eliminates any end-to-end flow through the long pan, which condition would encourage the formation of flow lines or currents in the sub. In addition to plates, a tube made of the porous material can be used. Also a semicircular trough concentric with the subbing roll is usable. It is also possible to incorporate a porous section in the design of the hopper body itself and, in this case, it is possible to feed the sub directly into the pan and not remove any, since the absence of channeling with its resultant buildup of stagnant areas in the pan, renders a drawoff unnecessary.

Coming now to the drawings wherein like reference characters denote like parts throughout:

Fig. 1 is a section through a coating pan in which the coating solution may diffuse directly into the pan, this figure showing a coating solution supply constructed in accordance with and embodying one form of our invention;

Fig. 2 is a section, similar to Fig. 1, in which one wall of a pan is constructed of porous material, and in which there are inlet and outlet pipes to supply the coating solution to a space behind the wall of perforated material so that it may diffuse through the wall and into the coating position;

Fig. 3 is still another embodiment of our invention in which a supply and a take-off pass into supply and take-off chambers in a pan or hopper, these chambers being defined on one side by a wall of porous material;

Fig. 4 is a section through a pan, or hopper, constructed in accordance with still another embodiment of our invention. In this form, the coating material is introduced through a porous tube which permits it to evenly diffuse into the coating pan, and

Fig. 5 is a transverse section through a coating pan, or hopper, constructed in accordance with still another embodiment of our invention. In this form, the coating fluid is introduced through an end wall into a chamber from which it may diffuse into the coating portion of the pan or hopper. A similar drawoff may be provided at the opposite end of the pan or hopper, if desired.

Fig. 6 is a fragmentary detailed section taken on line 6—6 of Fig. 1.

Our invention comprises broadly a method of diffusing coating fluid over a relatively large area of a coating pan or hopper by supplying the coating material and introducing it in innumerable minute streams so that the lateral diffusion of these streams blend uniformly and provide a pool of coating solution from which a directional flow has been eliminated.



In the form of our invention, shown in Fig. 1, the coating pan 1 may have a coating chamber 2 in which a roller 3 is mounted on suitable trunnions 4. This chamber may be provided with a temperature control arrangement consisting of the hollow chambers 5 and 6. There is a coating solution entrance in the bottom of the chamber 2 which may consist of a plate or block 7 of porous material, preferably having an inner wall 8, arcuately shaped to conform with the shape of the coating chamber 2. There is a bottom channel 9 which may be filled with coating solution through a pipe 10 having perforations 10P, Fig. 6, so that the solution in this chamber may diffuse evenly through the plate 7. Obviously the perforations can be made anywhere desired in pipe P although they are shown in the bottom of the pipe in Fig. 6. The plate 7 may preferably consist of sintered pulverized glass so that the coating solution in the channel 9 is actually divided up into innumerable minute streams passing through the plate 7 which diffuses laterally to blend the coating solution in the chamber 2 uniformly and to prevent directional flow therein. In such a system, it is possible to supply only such coating material to the chamber 2 as is actually applied to the strip material so that no drawoff is necessary.

We might mention that a suitable form of porous material is produced by Filtros, Incorporated, East Rochester, New York, this material being known as "Filtros." We have found that at least one grade of this material is produced with the pore diameter of the porous material having an effective diameter of 0.002 inch. This is known as the "H" Grade of "Filtros." This material has proved entirely satisfactory and the effective diameter of the pores is much smaller than the usual type of porous clay plates which may have an effective pore diameter of 0.012 inch. While we prefer to use porous material in which the effective diameter of the streams is generally as small as possible and, while we have found that .002 inch is a very desirable size of pore we, nevertheless, may use somewhat larger, or smaller, pores if suitable material having pores of a smaller effective diameter can be found. For instance, we prefer pores having an effective diameter of less than .01 inch although an effective diameter of about .002 inch is preferred. It is understood that these dimensions are given only by way of illustration to better visualize the particular material which has worked satisfactorily.

Fig. 2 shows a second embodiment of our invention in which the coating pan, or hopper, 20 is provided with a chamber 21 for the coating solution surrounding a roller 23 mounted on suitable trunnions 24 in the end walls 25 of the coating pan. In this instance, coating fluid may be supplied through a supply pipe 25 to a chamber 26 and excess coating fluid may be withdrawn from the take-off pipe 27. Between the coating pan chamber 21 and the supply chamber 26, we provide a wall 28 of porous material to divide up the incoming coating solution into an innumerable number of minute streams as the solution diffuses through the wall 28. In this instance, there is a circulation of coating solution in the chamber 26 but this circulation, or flow, is definitely controlled, or eliminated, in the chamber 21 which supplies the coating to the material which may either pass around the roller 23 or may be bead-coated therefrom. By a bead coating we mean coating by means of a bead of solution between an applying roller and the strip material, the strip material lying out of contact with the roll, such as is well known in the art. Here again, the temperature of the solutions may be controlled by the chambers 39 and 30.

Fig. 3 shows still another embodiment of our invention in which the coating pan or hopper chamber 40 is supplied with coating solution through an inlet pipe 46 feeding the supply chamber 45 so that the incoming solution may diffuse through the plate 44 and into the pan or hopper 40. From this pan or hopper the excess coating may diffuse through the plate 43 into the take-off chamber 42 from which it may pass through a pipe 41. A roller 47 carried by suitable trunnions 48 may turn in the chamber 40 and temperature may be controlled by suitable fluids passing through the chambers 49 and 50. In this form of our invention, like the form shown in Fig. 2, the coating solution may both be flowed to and from the coating pan. On the other hand, in the embodiment of our invention shown in Fig. 4, as in the embodiment shown in Fig. 1, we only supply an amount of coating solution to a coating pan or hopper which is sufficient to coat the material and no drawoff is used. In the embodiment shown in Fig. 4, the coating pan or hopper 51 is provided with a coating chamber 52 which is supplied with coating solution through a porous pipe 53. This divides the coating solution passing through the inside of the pipe into innumerable small streams diffusing through the walls of the pipe and into the chamber 52 in such a manner that directional flow is eliminated. The strip material may be coated by either passing around or may be bead-coated by solution from the roller 54 which turns on suitable trunnions 55. Temperature may be controlled by flowing suitable fluid through chambers 56 and 57.

In the embodiment of our invention, shown in Fig. 5, the roller 60 may be immersed in a coating chamber 61 which is supplied with coating fluid passing through a porous plate 62 so that solution entering a pipe 63 and passing in a chamber 64 may diffuse through the plate 62 and provide a suitable body of solution in the chamber 61 for coating. In this form of our invention we may supply only the amount of material which is to be used through the pipe 63, or, we may have an exactly similar structure to the supply end of the chamber 61 at the opposite end thereof so that such a structure may serve as a take-off if we desire to have a constantly moving body of solution in the chamber 61.

It will be noticed with all of the embodiments of our invention that there is a similar and important coating feature in that in all of the apparatus the coating solution is actually divided up into innumerable minute streams over a relatively large area of the coating area of the pan or hopper, so that these streams, by lateral diffusion, blend into a body of solution which is very suitable for our purpose. We may, as in Figs. 1 and 4, only supply the quantity of solution necessary to be taken up by the coating operation, or we may, as in Figs. 2 and 3, provide both a supply and a take-off so that the coating solution actually flows through the coating pans but does not produce any flow, or current, or directional markings, due to this movement of the solution because of the relatively large area of the porous walls which produce the innumerable minute streams which blend into a non-directional body of coating solution.



We realize that our invention may take many forms and we have illustrated quite a number of different embodiments of preferred forms of our invention. We believe that our method of dividing the incoming coating solution into innumerable minute streams which, through lateral diffusion, blend together, either entirely eliminates, or substantially eliminates, the customary difficulties of coating film supports with the required coatings to prepare such supports for emulsion coating satisfactorily. It is the preparatory coatings which are ordinarily the most difficult to properly apply so that it will be possible to apply an even coating of emulsion which, of course, must also be applied with great care.

We consider as within the scope of our invention all such forms of our invention as may come within the scope of the appended claims.

We claim:

1. A method of preventing "flow lines" in coating photographic materials with a solution comprising supplying coating liquid to a coating pan which consists in introducing innumerable constant sized minute streams of coating liquid over a relatively large area of the coating pan and merging the innumerable minute streams together whereby the lateral diffusion of the streams blends the incoming stream uniformly and reduces agitation to a minimum to prevent flow lines from occurring when coating strip material from said coating pan.

2. The method defined in claim 1 characterized by the size of the innumerable minute streams being of less than .01" effective diameter.

3. The method defined in claim 1 characterized by the size of the innumerable minute streams being in the order of .002" effective diameter.

4. A method of preventing "flow lines" in coating photographic materials with a solution comprising supplying an even flow of coating solution to a coating pan to produce a uniform body of solution therein comprising dividing a supply of coating solution into innumerable, constant minute streams in passing into and in leaving the coating pan, the incoming streams merging into a uniform body of solution and the outgoing innumerable, constant, minute streams maintaining the uniform body of coating solution substantially free from agitation in the pan while carrying out coating solution in excess to the quantity of such solution utilized in the pan.

5. The method of coating defined in claim 4 characterized by the size of innumerable streams into which the coating solution is divided being of less than .01" in effective diameter.

6. The method of coating defined in claim 4 characterized by the size of innumerable streams into which the coating solution is divided being in the order of .002" in effective diameter.

7. A fluid supply for coating pans comprising, in combination, a coating pan, means in the pan for applying coating from the pan to strip material, a conduit for conducting coating solution to the pan, rigid means adjacent the pan and between the supply of coating solution and the pan for dividing the supply of coating solution into innumerable minute streams which are close together whereby the lateral diffusion of the merging streams may provide a uniform body of coating solution substantially free from agitation in the pan.

8. The fluid supply for coating pans defined in claim 7 characterized by a drawoff for the pan also including a rigid means for dividing the coat-

ing fluid drawn from the pan into innumerable minute streams as the coating fluid leaves the pan to maintain the coating solution in tne pan uniform and substantially free from agitation to prevent directional effects in the coating solution in the pan.

9. The fluid supply for coating pans defined in claim 7 characterized by the means for dividing the coating solution into innumerable streams consisting of a block of rigid, porous material having innumerable pores therein of not more than an effective diameter of .01''.

10. The fluid supply for coating pans defined in claim 7 characterized by the means for dividing the coating solution into innumerable streams consisting of a block of rigid, porous material having innumerable pores therein in the order of .002'' effective diameter.

11. A fluid supply for coating pans comprising, in combination, a coating pan, means for applying coating solution to strip material dipping in the pan, a solution inlet and a solution outlet for the pan, a block of rigid, porous material between the inlet and outlet of the pan and an area of the pan adapted to contain a quantity of coating solution to be applied to strip material, the pores of the rigid, porous material being of less than .01'' in effective diameter, to maintain coating solution substantially free from agitation in the pan to prevent flow lines on the material coated by the means for applying coating solution to strip material dipping in the pan.

12. A fluid supply for coating pans comprising, in combination, a coating pan, means for applying coating solution to strip material, a solution



inlet and a solution outlet for the pan, a block of rigid, porous material between the inlet and outlet of the pan and an area of the pan adapted to contain a quantity of coating solution to be applied to strip material, the pores of the rigid, porous material being in the order of .002'' effective diameter.

13. The fluid supply for coating pans defined in claim 12 characterized by the supply of coating solution in the supply side of the means for dividing the coating solution into innumerable minute streams having a pressure head whereby the coating solution may be forced through the dividing means under pressure.

14. The fluid supply for coating pans defined in claim 12 characterized by means for establishing a pressure head on the coating solution at the supply and drawoff to force the coating solution into and out of the coating pan and through the means for dividing the coating solution into innumerable minute streams.

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