

Nov. 20, 1962

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3,065,098

METHOD FOR COATING WEBS

Filed March 21, 1960

Fig. 1

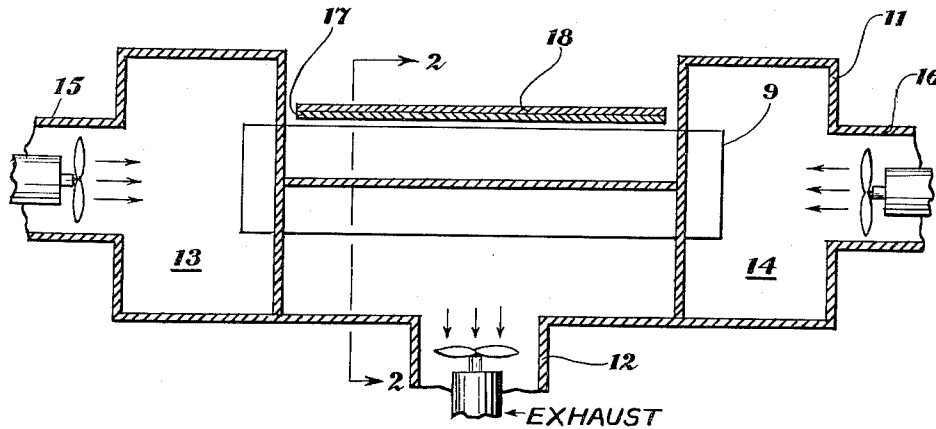
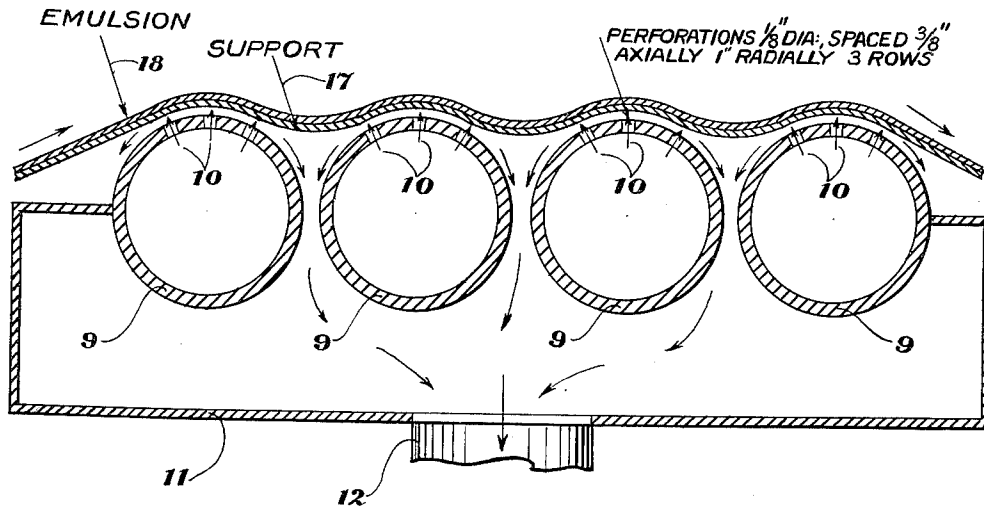


Fig. 2



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3,065,098

METHOD FOR COATING WEBS

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Filed Mar. 21, 1960, Ser. No. 16,271

5 Claims. (Cl. 117-34)

This invention relates to coating emulsion on webs or film for continuously maintaining a uniform layer of emulsion on a continuously moving, flexible photographic film support.

In the photographic emulsion coating process, a gelatin emulsion is applied to the film support and then cooled until the emulsion gels. The emulsion is, however, free to flow for an appreciable time before it gels and during this free-flow period, the film support has a tendency to wrinkle so the solution flows off the "ridges" and "puddles" in the "valleys" of the wrinkles. This, of course, results in film support having a non-uniform emulsion layer thereon and this non-uniformity introduces undesirable characteristics in the completed photographic film.

Some years ago, it was found if the path of the film support is undulated, that is, if it moderately bends up and down in a regular pattern during its progress through the emulsion coating apparatus, that wrinkles in the film support are reduced and a non-uniform flow of the liquid emulsion is lessened. The liquid emulsion flows on the thus undulating support at a rate somewhat faster than the rate of travel of the support when the support is moving downwardly and somewhat slower as the support travels upwardly. This frequent reversal in direction of emulsion flow relative to the support eventually gives a very uniform surface on the emulsion coating and it is cooled and set in this desirable condition.

For many years, this undulating or sinuous path, has been provided in emulsion coating apparatus by employing closely spaced rollers with suction to hold the film support in contact with the rollers. The rollers turn by the movement of the film support thereon. There are several disadvantages in that system. The emulsion does not cool uniformly because air flowing from edge to center under the film support cools the edge more than the center. The rollers conduct a greater amount of heat from the edge of the film support than from the center. Any dirt or projection on the rollers locally deforms the support and allows the liquid emulsion to flow away from the deformity, and if this coincides with gelation, a non-uniform coating results. Also, imperfections may be introduced into the coated film support because of a roller with a defective bearing requiring more force to rotate than the friction between the film support and the roller will produce. The film support then slips on the roller, resulting in abrasion of the film support surface.

An object of the present invention is, therefore, an improved apparatus for coating and setting emulsions on a web or a film support.

Another object is an improved method for maintaining the uniformity of the surface of emulsions on film support which eliminates the disadvantages of the above-described prior art methods.

Among other objects of this invention is to provide means for moving a freshly emulsion-coated web which maintain the web out of contact with either moving rolls or a stationary surface while the emulsion is flowable.

Other objects will appear hereinafter.

In accordance with my invention, these objects are attained by providing apparatus having means for continuously supporting and continuously moving a flexible film support or a web on air, after it has been coated with

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a liquid emulsion, in an undulating path, until the emulsion is gelled by cooling.

In my novel apparatus and method, there is no contact between the film support and solid surfaces during the period when the emulsion is in flowable condition or while being cooled. This obviates damage to the coated film support or web due to projections such as dirt from solid surfaces or abrasion of the coated film support due to abrasion from poorly turning supporting rolls. My apparatus permits more uniform widthwise cooling of the coating because of the controlled air flow under the moving film support and because the air supported film support is not in contact with the rolls which remove heat therefrom.

This invention is further illustrated in the following detailed description with reference to the drawings in which:

FIG. 1 is a view in elevation, and partly in section, of coating apparatus in accordance with this invention;

FIG. 2 is an enlarged side sectional view in elevation of the apparatus taken on lines 2-2 of FIG. 1 also showing a web or film support moving through the apparatus.

Referring to FIGS. 1 and 2, the apparatus comprises a series of stationary cylindrical tubes 9 having perforations 10 therein. The tubes may be about 3 inches in diameter and of a suitable length depending on the width of the web being coated. They are closely and equally spaced and mounted in a fixed position in the upper portion of a substantially enclosed chamber 11 which is connected by conduit 12 to an exhaust fan. The ends of the tubes 9 terminate respectively in chambers 13 and 14 which are connected respectively through conduits 15 and 16 with high pressure air in-put fans.

If chamber 11 is placed under a vacuum by operation of the exhaust fan and chambers 13 and 14 under pressure by operation of the high pressure fans and a continuous flexible web 17 of any material is placed over tubes 9 and drawn through the apparatus by means, not shown, air flow and web behavior will be according to the enlarged cross-section shown in FIG. 2. Air flowing through perforations 10 will raise the web above and out of contact with the tubes 9 and the vacuum under the tubes 9 will draw air and the web downwardly into the space between adjacent tubes, thus causing the moving web to move through a sinuous path in a general horizontal direction.

If, as shown in FIG. 2, the web being drawn through the apparatus is a photographic film support 17 having a heated flowable emulsion coating 18 thereon, which is eventually set by gelation cooling, an interesting phenomenon takes place. The flowable emulsion 18 will flow somewhat faster than the rate of travel of the support when the support has passed over the top of rolls 9 and enters the valley therebetween. However, the emulsion will flow in a direction opposite to the direction of the film support as the support comes up out of the valleys and at a rate less than that of the moving support. This frequent reversal in direction of emulsion flow in respect to the travel of the film support causes the emulsion to attain a desired smooth surface before it leaves the apparatus without substantially altering the thickness of the coating. The undulating path is arranged to effect this desired leveling or smoothing before the heat loss in the emulsion is enough to cause the emulsion to gel.

As will be understood, a plurality of tubes 9 may be employed in my apparatus. In FIG. 2, only four tubes 9 are shown but the apparatus may have from 25 to 50 such tubes. The air may advantageously have a temperature of from 35° to 50° F. and be forced through the apertures at a pressure of 10 to 15 inches water gauge. The vacuum drawn between the tubes may be advantageously held at approximately 4 inches of water gauge.

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The rate at which the web is drawn over the tubes will depend somewhat on the nature of the emulsion and flexibility of the web.

If desired, cooling equipment, not shown, can be positioned adjacent the outlet side of the apparatus to assist in causing gelation of the emulsion at a desired place in the path of travel of the emulsion coated film support.

While the novel method of this invention is illustrated in connection with the apparatus shown in FIGS. 1 and 2, the apparatus may comprise other means of causing the web to take a sinuous path on an air support. The air distributor need not be tubes but a corrugated sheet with suitable means for supplying and removing air, thus the radius of the bends in the web can be greater or less, depending upon the conformation of the distributor.

As illustrated in the drawings, the path of the web is substantially horizontal, but the device may be operated at any angle between the horizontal and the vertical. As the position of the web varies toward the vertical, the mechanism of the flow of the coating may be somewhat modified.

If desired, instead of employing circular apertures in the tubes, slots may be employed. Slots having dimensions approximately $\frac{1}{8}$ inch wide and spaced $\frac{3}{8}$ inch apart extending on the tube for the width of the web to be supported are suitable for use.

The tubes 9 may be spaced approximately $\frac{1}{16}$ inch to 1 inch apart and be of a diameter from 3 to 6 inches. The tubes 9 may also be made of sintered metal through which air under pressure will pass.

The following is an example of coating a light-sensitive emulsion onto a continuously moving film support when employing the coating method and apparatus of my invention.

Example 1

A gelatinous silver halide emulsion having known modifiers such as dispersing agents, hardeners and sensitizers of a viscosity of approximately 50 centipoises and a temperature of approximately 90° F. is spread at a desired thickness upon a moving cellulose acetate film support. The film support preferably will have a gelatin or other layer thereon which will facilitate the adherence of the emulsion to the support. The initial emulsion coating device may be a pan containing an emulsion and having a rotating roll which picks up a layer of the emulsion and deposits it upon the surface of the film support.

The emulsion coated film support then passes continuously through the device of the instant invention in order to regulate the uniformity of the still flowable emulsion coating. For coating photographic emulsions, the device preferably comprises fifty air tubes 9 of a diameter of three inches and a length of 30 feet. Air of a temperature of approximately 35° to 50° F. at an air pressure of 10 inches water gauge, is supplied to the interior of the tubes 9. The vacuum applied between the tubes is approximately 4 inches of water gauge. A tension of $\frac{1}{2}$ pound per inch of width of film support is advantageous in maintaining a suitable degree of undulation in the film support and providing good contact with the drive rolls, not shown, before and following the undulating movement.

Under these operating conditions, the up and down flow of the emulsion due to the undulating path of the film support will cause the emulsion to assume a very smooth surface before any given section of the film support completes the path through the apparatus. The gelatin emulsion is then cooled to set it at this desired thickness after which it is continuously dried by conventional operation and wound on a suitable core from which it may be subdivided into sizes suitable for sale.

Example 2

My device may also be employed to dry tacky coatings onto a continuously moving web. In this instance, a heat hardenable tacky coating is continuously coated onto the

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moving web and is then introduced into my novel apparatus. The air from tubes 9 supports the web so that the tacky surface does not contact any other surface. The temperature of the air is maintained sufficiently high to dry the tacky coating before the coated web leaves the apparatus.

I claim:

1. The method of maintaining the uniformity of a flowable light-sensitive emulsion coating on the upper surface of a horizontally moving, flexible film support which comprises blowing air against the underside of the film support having said emulsion coating thereon at several spaced apart positions along said moving film support to flex the support outwardly at said positions and withdrawing air from beneath the underside of said moving support at other spaced apart positions between adjacent air blowing positions to flex said support inwardly as it passes said other positions.

2. The method of controlling the uniformity of the thickness of a flowable light-sensitive emulsion coating on the upper surface of a horizontally moving film support which comprises blowing air against the underside of the film support having said flowable emulsion coating thereon at several spaced apart positions along said moving film support to flex the support outwardly at said positions, permitting the flowable emulsion to flow downwardly of the outwardly flexed film support, whereby the thickness of the emulsion coating is reduced, and withdrawing air from beneath the underside of said moving film support at other spaced apart positions between adjacent air-blowing positions to flex said support inwardly as it passes said other positions, whereby the thickness of the flowable emulsion coating is increased.

3. A method for providing a smooth and substantially uniform thickness light-sensitive emulsion coating on a film support comprising the steps of applying an emulsion coating to the upper surface of a film support, and supporting said support on a cushion of air while moving said support along a continuously undulating path.

4. A method for providing a smooth and substantially uniform thickness light-sensitive emulsion coating on a film support comprising the steps of applying an emulsion coating to the upper surface of a film support, and supporting said support on a cushion of air while moving said support along a continuously undulating path, said air cushion being at a lower temperature than said coating to cause the same to set.

5. In a continuous flexible web coating apparatus which causes the web to follow a sinuous, undulating path, a plurality of parallel tubes spaced apart to provide a plurality of suction passage means therebetween, each of said tubes having a bore and an arcuate upper wall, aperture means in said upper walls, means for providing pressurized air to the bores of said tubes to provide an air cushion adjacent the outer surfaces of the upper walls thereof, and means for connecting said suction passage means to a source of low pressure to cause air ejected through said aperture means to flow through said suction passage means and create low pressure areas intermediate adjacent ones of said tubes.

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