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R. J. CHEN ETAL

3,453,138

PHOTOGRAPHIC PROCESSING APPARATUS AND METHOD

Filed July 27, 1966

Sheet 2 of 3

FIG. 2

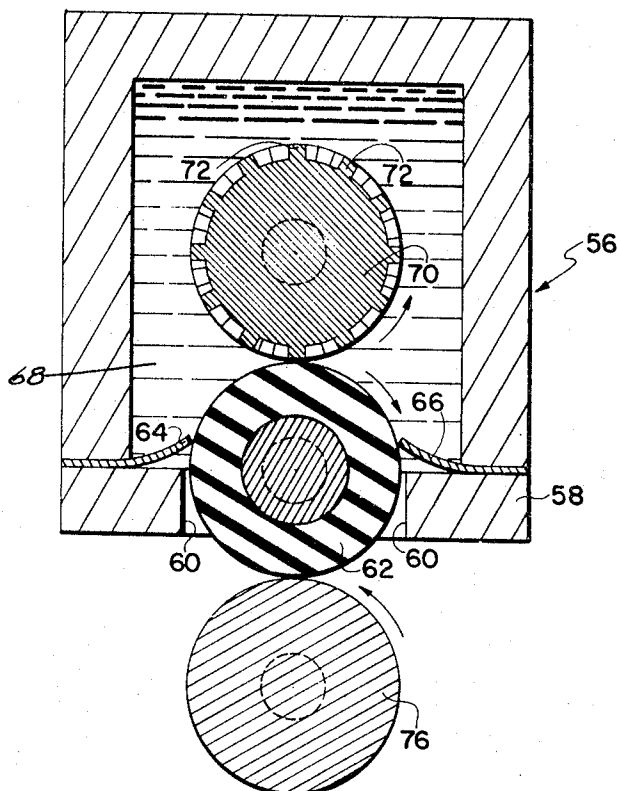
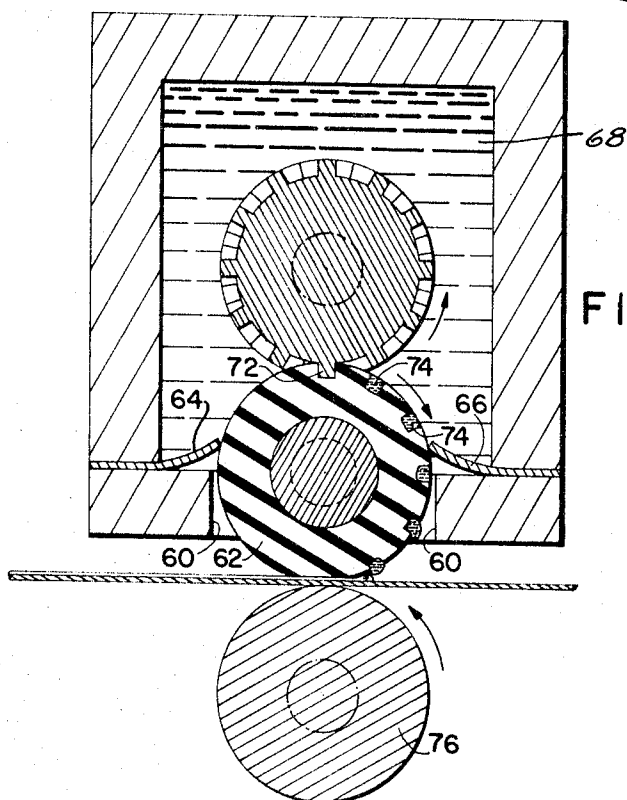


FIG. 3



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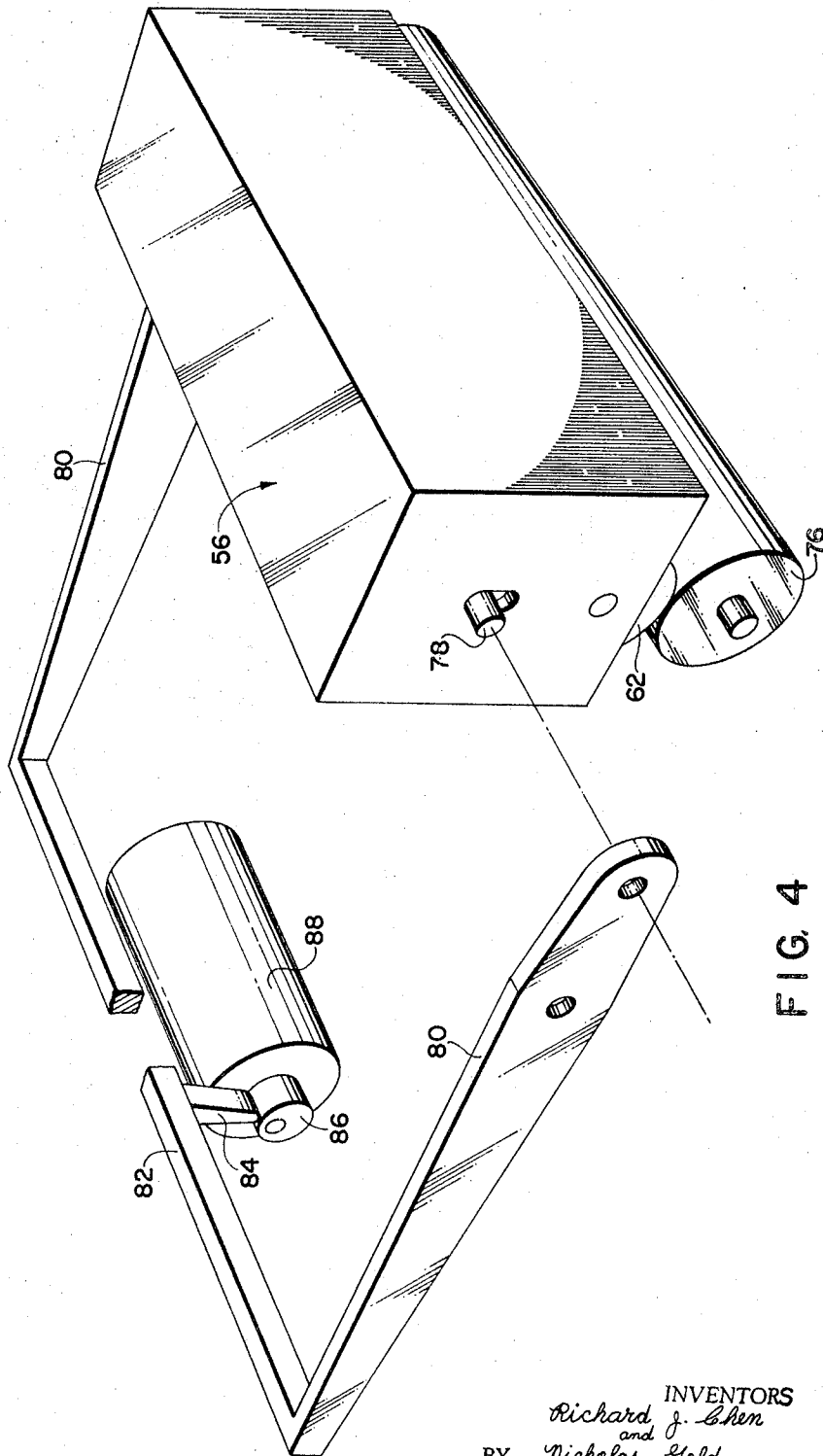
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1

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PHOTOGRAPHIC PROCESSING APPARATUS AND METHOD

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11 Claims

ABSTRACT OF THE DISCLOSURE

Photographic processing apparatus and method of applying viscous liquid photographic reagents to photographic sheet materials in a predetermined quantity to each of a succession of areas of the sheet material. The controlled amount of reagents are withdrawn from a container by depressions formed in an elastomeric surfaced applicator member by an embossing roll and transferred to the surface of a sheet or another applicator member and uniformly distributed on that surface by the elastomeric surfaced applicator member.

This invention relates to novel photographic processing apparatus and methods and particularly, to apparatus for and methods of applying viscous liquid photographic reagents to photographic sheet materials.

A variety of photographic processes involve the application of a viscous liquid reagent to a sheet material as a continuous layer of predetermined uniform thickness on a surface of the sheet material. In typical photographic processes involving the application of the viscous liquid reagent to a sheet, the reagent may include a light-sensitive material, a sensitizer, a reagent for processing an exposed light-sensitive layer to produce a visible image, or a composition for protectively coating and/or treating a visible image.

The present invention is particularly concerned with a solution for the problems inherent in the application of precisely controlled quantities of a viscous liquid reagent to form a uniform layer as required to effectuate a photographic process. These basic problems are further compounded by the need for high application rates, intermittent operation for varying periods and at intermittent intervals, protecting the reagent against evaporation and/or exposure to the atmosphere in order to preserve the quality and stability of the reagent, preventing contamination of the reagent by residual reagent from previous application operations and handling the applying reagents that may be adhesive and/or higher corrosive.

An object of the invention is to provide novel and improved apparatus for and methods of storing the viscous liquid reagent and applying a predetermined quantity of said reagent to each of a succession of areas of photographic sheet material.

Another object of the invention is to provide apparatus and processes in which precisely controlled amounts of the viscous liquid reagent are withdrawn from a container by an applicator member and are immediately transferred from said applicator member to the surface of a sheet or another applicator member and uniformly distributed on the surface by the first-mentioned applicator member.

Other objects of the invention will in part be obvious and will in part appear hereinafter.

The invention accordingly comprises the apparatus possessing the construction, combination of elements and arrangement of parts and the process involving the several steps and the relation and order of one or more of

2

such steps with respect to each of the others which are exemplified in the following detailed disclosure, and the scope of the application of which will be indicated in the claims.

For a fuller understanding of the nature and objects of the invention, reference should be had to the following detailed description taken in connection with the accompanying drawings wherein:

FIGURE 1 is a somewhat schematic sectional view of apparatus in the form of a document copier embodying the invention;

FIGS. 2 and 3 are sectional views illustrating the construction and operation of the viscous liquid applicator of the invention; and

FIG. 4 is a perspective view of components of the apparatus of FIG. 1 including the liquid applicator.

The present invention is directed to novel apparatus and methods for applying a viscous liquid reagent to sheet materials. It should be appreciated that the nature and composition of and processes performed by the viscous liquid reagent applied by the applicator and according to the method of the invention, and the structures, functions and compositions of the photographic sheet materials treated, may vary substantially. However, for purposes of illustration, the invention will be described with reference to a document copying apparatus and process in which successive areas of a photo-sensitive image-recording sheet are treated with a liquid reagent including the ingredients necessary to produce a visible positive image. More specifically, the process and apparatus described by way of example involve the exposure of an image-recording sheet including, as light-sensitive material thereof, a silver halide emulsion and treatment of the exposed sheet with a liquid reagent including a silver halide developer, for producing a visible positive image on the sheet by a reversal process.

Reference is now made to FIG. 1 of the drawings wherein there is illustrated document copying apparatus embodying the invention. The document copier comprises means for exposing successive areas of a combined image-recording and image-receiving sheet, severing successive sections of the sheet, each containing an exposed area, from the remainder of the sheet and means for processing the successive sections of the sheet including means for applying a viscous liquid reagent to one side of each of the sections.

The apparatus comprises exposure means including a window 10 in the upper wall of the housing of the apparatus for supporting an original, e.g., document, in position for exposure to light from lamps 12 mounted within an enclosed chamber, separated from the remainder of the interior of the housing, by a lower wall 14 and a side wall 16. Light reflected from an original positioned on window 10 is transmitted by a conventional objective lens, part of a lens and shutter assembly 18, toward a focal plane in the apparatus at which the lens forms an image of the original. The optical system includes, in addition to the lens of assembly 18, a mirror 20 positioned beneath the lens for reflecting light toward one side of the housing and means for supporting a light-sensitive image-recording sheet at the focal plane of the lens.

A supply of light-sensitive image-recording sheet material, designated 22, is provided coiled on a spool 24 in the lower portion of the apparatus behind mirror 20. The means for positioning successive sections of the sheet in position for exposure include a support plate 26 and a juxtaposed transparent plate 28 located in a vertical plane with the surface of the transparent plate located substantially at the focal plane of the lens. Sheet 22 is withdrawn from spool 24 and moved upwardly between plates

26 and 28 by a pair of juxtaposed feed rolls 30 located beneath and adjacent the lower edges of the plates.

A rotary knife 32 and anvil 34 are mounted above and adjacent the upper edges of plates 26 and 28 for severing successive exposed sections of the image-recording sheet as each section is advanced upwardly from between the plates between the knife and anvil. In the operation of the apparatus, a section of the image-recording sheet positioned between plates 26 and 28 is advanced, following exposure, upwardly past the knife into engagement with liquid applicator means and then through a sheet conveyor system designed to deliver the sheets from the applicator to an exit opening in the housing of the apparatus and to provide a delivery period of sufficient duration to permit completion of the processing of the image-recording sheet within a dark environment. The sheet delivery system includes two sets of endless conveyor belts 36 and 38. The belts 36 are mounted on support rolls 40 and 42, and belts 38 extend from a support roll 44, juxtaposed with support roll 42, upwardly in juxtaposition with belts 36 and around an enlarged drum or discs 46 and thence back to support roll 44 by way of support rolls 48 spaced around the periphery of drum or discs 46. The conveyor belts 38 which contact the side of the sheets to which the liquid is applied are preferably quite narrow in order to limit the area of contact between the belts and the sheet, and in the preferred form, may comprise conventional O-rings.

The housing of the apparatus includes an opening 50 through which the processed sheets are delivered and a pair of guides 52 extending from the opening upwardly toward the points of tangency between belts 38 and discs 46 for guiding the sheets from between the belts and discs downwardly through opening 50.

The liquid applicator apparatus of the invention, illustrated in detail in FIGS. 2 through 4, is located in the document copier in the path of movement of the sheets between knife 32 and support rolls 42 and 44. In the form shown, the latter two rolls are located above and to one side of the knife and a curved guide plate 54 is mounted above knife 32 for engaging the leading edge of the sheet and directing it along an inclined path past the applicator means toward the nip of support rolls 40 and 42.

The apparatus illustrated is designed to be employed with a combined image-recording and image-receiving sheet such as described in the copending application of Edwin H. Land, Ser. No. 519,995, filed Jan. 11, 1966, and application of Edwin H. Land et al., Ser. No. 519,884, filed Jan. 11, 1966. This photosensitive element is designed to produce a positive black-and-white reflection print and in general comprises a paper base support for a layer including a gelatino silver halide emulsion as the light-sensitive material and a translucent material provided in the same layer with the light-sensitive material, or a layer overlying the light-sensitive material, for providing a white, opaque background for a silver transfer image and masking the negative image in the light-sensitive layer. This translucent material permits exposure of the silver halide emulsion and may comprise one of the finely divided white pigments such as titanium dioxide.

Exposed areas of the image-recording sheet are treated with a viscous processing composition preferably capable of forming a positive silver transfer image. This processing liquid includes, for example, an aqueous alkaline solution of a silver halide developing agent and a silver halide solvent, which develops exposed silver halide while forming an imagewise distribution of a soluble silver complex from unexposed silver halide and transfers this complex by diffusion to another stratum where it is reduced to silver to form a positive image. The processing composition is also quite viscous, preferable having a viscosity of the order of 5,000 to 20,000 centipoises, and includes a viscosity adding agent. A typical viscous processing composition useful in the method and apparatus of

the invention for producing silver transfer images in exposed areas of an image-recording sheet of the type described comprises the following proportions of ingredients:

5	Water -----cc--	8400.0
	Sodium carboxymethyl cellulose (medium viscosity type) -----g--	600.0
	Sodium sulfite -----g--	675.0
	Sodium hydroxide -----g--	180.0
10	Potassium thiosulfate -----g--	207.0
	4-amino-2,6-dimethylphenol -----g--	180.0
	Aqueous solution of sodium sulfide (0.0156 g. Na ₂ S/cc.) -----cc--	9.0
15	Aqueous solution of lead acetate and cadmium acetate (8.7 g. of lead acetate and 6.3 g. of cadmium acetate/300 cc.) -----cc--	192.0

The processing composition described, in addition to being quite viscous and highly corrosive, is subject to evaporation and other forms of deterioration such as oxidation due to exposure to the atmosphere and must be protected at all times from such exposure. The liquid processing composition is also subject to contamination by residue of the liquid previously exposed to the atmosphere so that provision must be made in the applicator apparatus for cleaning any applicator component employed to transfer the viscous reagent from a supply thereof to a sheet following each coating operation in which the applicator component and reagent thereon is exposed to the atmosphere. Other important features of the applicator apparatus include the ability to contain and store the processing liquid for extended periods of time and during the periods between application operations; the ability to apply the liquid rapidly, uniformly and in precisely predetermined quantities; compactness; and simplicity and inexpensiveness of construction and dependability of operation.

The applicator for the viscous liquid comprises a container 56 for holding a quantity of the viscous liquid reagent and means for withdrawing a predetermined quantity of the liquid from the container, transferring it to a sheet, and distributing the liquid uniformly in contact with the sheet. Container 56 is generally rectangular in shape and includes an elongated wall 58 formed with an opening 60 extending substantially from end to end of the container. An applicator roll 62 having a generally cylindrical periphery formed of an elastomer is mounted for rotation about its axis within the container in closing relation to opening 60 with a portion of the periphery of the roll extending through the opening beyond the outer surface of wall 58. A pair of elongated resilient doctor members 64 and 66 are mounted on wall 58 and extend from end to end of the wall inwardly into engagement with roll 62. Doctor members 64 and 66 cooperate with the roll to substantially seal opening 60 by preventing escape of the processing liquid and admission of air into the container. A mass of viscous liquid 68 is enclosed in the container with a portion of the periphery of roll 62 immersed in the liquid.

In order to withdraw a precisely predetermined quantity of liquid from the container for application to a sheet, embossing roll 70 is mounted for rotation within the container about an axis of applicator roll 62. Embossing roll 70 is substantially equal in length to roll 62, is generally cylindrical and its periphery is provided with a regular pattern of radial projections 72 adapted, when pressed against applicator roll 62 to form depressions in the applicator roll. The radial projections on embossing roll 70 are preferably pressed into the portion of the applicator roll submerged in the processing liquid so that as an embossed section of the applicator roll moves from engagement with the embossing roll, the depressions, designated 74, in the applicator roll are immediately filled with the predetermined quantities of the processing liquid. The applicator roll is embossed and the depressions filled with the

5

processing liquid during rotation of the applicator and embossing rolls against one another within the container and during rotation of the applicator roll in a clockwise direction (viewing FIGS. 2 and 3), doctor member 66 engages the outer peripheral surface of the applicator roll and removes the liquid therefrom so that only the liquid entrained in the depressions in the applicator roll is withdrawn from the container.

The dimensions and distribution of radial projection 72 and depressions 74 formed thereby are subject to control within close tolerances with the result that the quantity and distribution of the processing liquid withdrawn from the container is also subject to substantially precise control. The liquid filled depressions are arranged in a regular pattern with the spacing between depressions and the capacity of the depressions so related as to provide for a layer of predetermined thickness when the liquid entrained in the depressions is distributed in contact with a surface as a continuous layer thereon. The depressions formed in the applicator roll, since it is in the elastomer, disappear as the elastomer recovers and the roll returns to its original cylindrical configuration so that by relating the speed of rotation of the applicator roll to the rate of recovery of the elastomer it is possible to utilize the applicator roll for both withdrawing metered quantities of the liquid from the container and distributing the liquid thus withdrawn as a uniform continuous layer on a surface.

For example, an applicator device was constructed in accordance with the invention designed to apply a 0.001 inch thick layer of the viscous liquid reagent to the surface of a sheet. The device included a one-inch diameter applicator roll formed of 30 to 70 durometer, polyurethane having a 0.1 to 0.3 second recovery time. The embossing roll was one inch in diameter and included cylindrical projections one-sixteenth inch diameter and height and covering approximately 30 percent of the area of the periphery of the roll. The paper being coated was pressed against and moved tangentially to a section of the applicator roll diametrically opposed to the embossing roll at a linear speed of one and one half inches per second to transfer the liquid from the depressions in the applicator roll and distribute the liquid as a uniform continuous layer in contact with the paper surface.

In the apparatus shown by way of example, the paper to be treated with the liquid is supported against the applicator roll by a backing roll 76 mounted in juxtaposition with the applicator roll for rotation about an axis parallel with the axis of the applicator roll. Backing roll 76 is biased toward the applicator roll with sufficient force to at least effectuate the spreading of the discrete masses of processing liquid entrained in the depressions in the applicator roll. The backing roll also functions to aid in the recovery of the elastomer and the provision of a smooth cylindrical surface on the applicator roll which insures spreading of the liquid as a layer of uniform thickness.

Embossing roll 70 is mounted for movement toward and away from applicator roll 62 to permit rotation of the applicator roll without the formation of depressions therein and withdrawal of the liquid from the container. Embossing roll 70 is normally so located with respect to the applicator roll as not to emboss the applicator roll and at the commencement of an application operation, the embossing roll is moved toward the applicator roll so as to emboss and form depressions in the cylindrical peripheral surface of the applicator roll. A liquid application operation is terminated simply by moving the embossing roll away from the applicator roll so that it no longer embosses the applicator roll and by virtue of this construction it is possible to control very accurately the commencement and termination of liquid application operations.

In the apparatus shown in the drawings, and particularly FIG. 4, embossing roll 70 is provided on its ends with shafts 78 which project through openings in the end walls of container 56 and are rotatably engaged in the ends of

6

levers 80 pivotally mounted immediate their ends and coupled at their ends opposite shaft 78 by a connecting member 82 mounting a cam follower 84 which coacts with a cam 86 rotated by suitable drive means such as a rotary solenoid 88 for pivoting levers 80 to move the embossing roll into and from embossing engagement with applicator roll 62. Suitable means are provided for rotating backing roll 76 and either or both the applicator roll and embossing rolls.

A number of modifications of the applicator apparatus are possible. Such modifications include, without being limited to changing the configuration of the radial projections on the embossing roll, for example, cubes or pyramids instead of cylinders. An endless belt or web, together with a supporting roll, may be employed in place of the elastomer covered applicator roll shown; and instead of applying the liquid to the sheet directly from the applicator roll, the liquid may be transferred from the applicator roll to the surface of an applicator member and distributed as a layer thereon for subsequent transfer to the sheets. In other words, backing roll 76 may perform the function of transferring the liquid as a layer from applicator roll 62 to the surface of a sheet supported against and moved tangentially to roll 76.

In the overall operation of the document copying apparatus shown, a section of image-recording sheet 22 is advanced upwardly to exposure position between plates 26 and 28 and movement of the sheet is arrested at this point. An exposure is made by actuating the shutter of assembly 18 whereupon rolls 30, 42, and 44, discs 46, and the applicator and backing rolls are rotated to move the exposed section of the sheet upwardly between the knife and anvil into engagement with guide plate 54 and into the nip of the applicator and backing rolls. Simultaneously with movement of the leading end of the sheet into the nip of the applicator and backing rolls, the embossing roll is pressed against the applicator roll to form impressions therein and entrain the processing liquid in the impressions. Advancement of the sheet is continued as the liquid is applied to one surface thereon so that the sheet moves into the nip of rolls 42 and 44 and is carried by belts 36 and 38 of the delivery system upwardly and around discs 46 while an image is being formed in the exposed section of the sheet. As the trailing end of the exposed section of the sheet reaches the anvil and knife, knife 32 is rotated severing the exposed and processed section of the sheet from the next succeeding section of the sheet positioned for exposure between plates 26 and 28 and, simultaneously, rotation of feed rolls 30 is discontinued.

In accordance with the enumerated objects of the invention, the applicant has described a novel and improved apparatus suitable for incorporation in a photographic system in which successive areas of photographic sheet material are to be treated with a viscous liquid reagent distributed in contact with one side of each area as a continuous layer of predetermined uniform thickness. The apparatus disclosed achieves the objects of providing a rapid, reliable, compact and inexpensive applicator suitable for use with corrosive liquids and capable of preserving the liquid for prolonged periods and during and between intermittent application operations.

What is claimed is:

1. Photographic processing apparatus for applying a predetermined quantity of a viscous liquid reagent to each of a succession of areas of photographic sheet material comprising, in combination:

a container for holding a quantity of a viscous liquid reagent;

an elastomeric member mounted with a portion of its surface within said container in contact with said liquid for movement of said portion from said container;

embossing means within said container for engaging and forming a pattern of depressions in said portion of said surface of said elastomeric member;

means for doctoring said viscous liquid into said depressions during movement of said portion from said container; and

means for transferring said liquid from said depressions to an area of a photographic sheet and distributing said liquid as a continuous layer on said area; the last-mentioned means for transferring and distributing said liquid including means for pressing a surface against said portion of said surface of said elastomeric member exterior of said container.

2. Photographic apparatus as defined in claim 1 wherein said embossing means include an embossing roll having a pattern of radial projections on its periphery, mounted for rotation within said container and means for pressing said embossing roll against said elastomeric member to form said depressions in said surface thereof during movement of said member through and from said container.

3. Photographic apparatus as defined in claim 1 wherein said elastomeric member comprises a roll mounted for rotation partially within said container with a portion of its peripheral surface in contact with said liquid within said container.

4. Photographic apparatus as defined in claim 3 wherein said means for transferring said liquid from said depressions include a second roll mounted in juxtaposition with the first-mentioned roll exterior of said container and means for urging said second roll toward said first-mentioned roll.

5. Photographic apparatus as defined in claim 4 including means for moving said sheet material between said first-mentioned roll and said second roll for applying said liquid reagent directly to said sheet.

6. Photographic apparatus as defined in claim 3 wherein said embossing means include an embossing roll having a pattern of radial projections on its periphery mounted for rotation within said container in juxtaposition with the first-mentioned roll and means for pressing said embossing roll against said first-mentioned roll to form said depressions in said peripheral surface.

7. Photographic apparatus as defined in claim 6 including means for moving said embossing roll into and from embossing engagement with said first mentioned roll.

8. Photographic apparatus as defined in claim 3 wherein said container includes an opening through which said roll extends and means within said opening for engaging said roll to prevent admission of air into said container and escape of said liquid from said container except for said liquid entrained in said depressions.

9. In the treatment of photographic image-recording sheet material, the method of applying a viscous liquid

reagent to a surface of said sheet as a layer of uniform predetermined thickness on said surface, said method comprising:

submerging at least a portion of an applicator member formed of an elastomer in a quantity of a viscous liquid reagent;

forming depressions in the surface of said portion of said member;

before recovery of said elastomer progresses to any substantial extent, withdrawing said portion of said applicator member from said liquid with said liquid entrained in said depressions;

during withdrawal of said portion of said applicator member from said liquid, removing said liquid from said surface of said member while permitting said liquid to remain in said depressions; and

during recovery of said elastomeric material, pressing said portion of said member against another surface to substantially complete recovery of said elastomer, transfer said liquid entrained in said depressions to said other surface and distribute said liquid as a layer of substantially uniform thickness on said other surface.

10. A method as defined in claim 9 wherein said surface of said applicator member is endless and is moved into, through, and from said viscous liquid reagent; and said depressions are formed in said surface by pressing an endless sequence of embossing members into said portion of said surface submerged in said liquid reagent during movement of said applicator member.

11. A method as defined in claim 9 wherein said portion of said applicator member is withdrawn from said liquid and pressed against said other surface within an interval so related to the rate of recovery of said elastomer that said elastomer recovers substantially completely while said member is being pressed against said other surface.

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