

Dec. 18, 1962

E. H. LAND
PROCESS AND PRODUCT FOR DISTRIBUTING PHOTOGRAPHIC
MATERIAL BY CAPILLARY ACTION

3,069,266

Filed Oct. 31, 1960

3 Sheets-Sheet 1

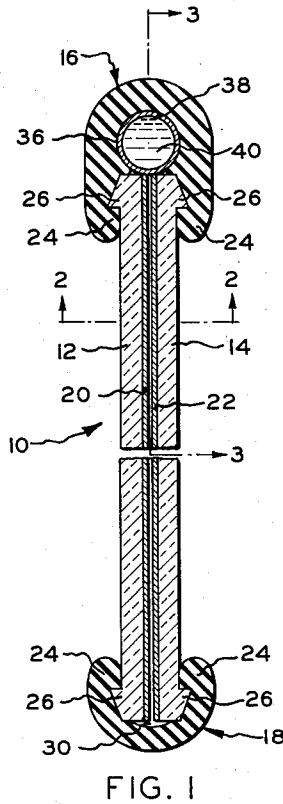


FIG. 1

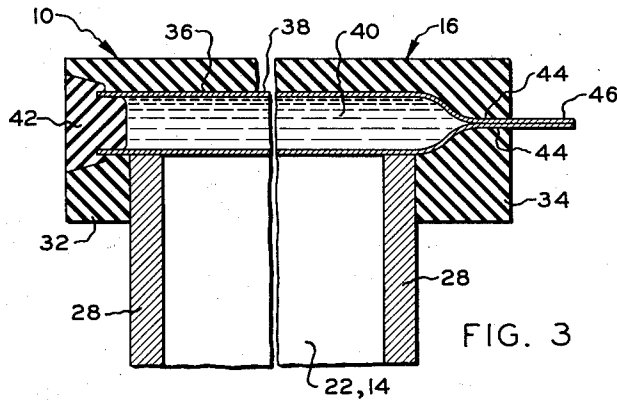


FIG. 3

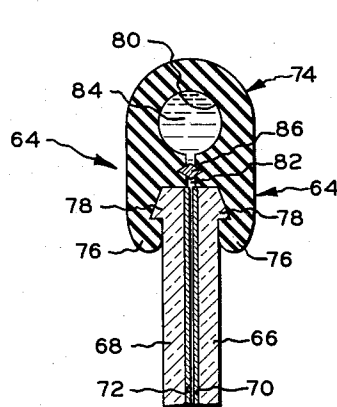


FIG. 5

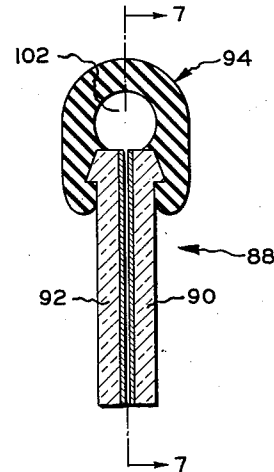


FIG. 6

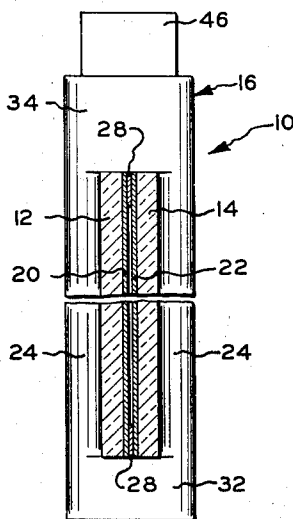


FIG. 2

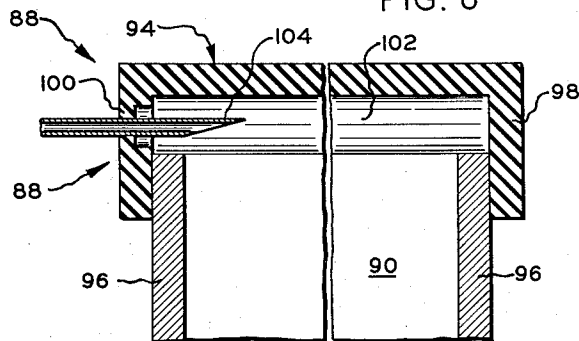


FIG. 7

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3 Sheets-Sheet 2

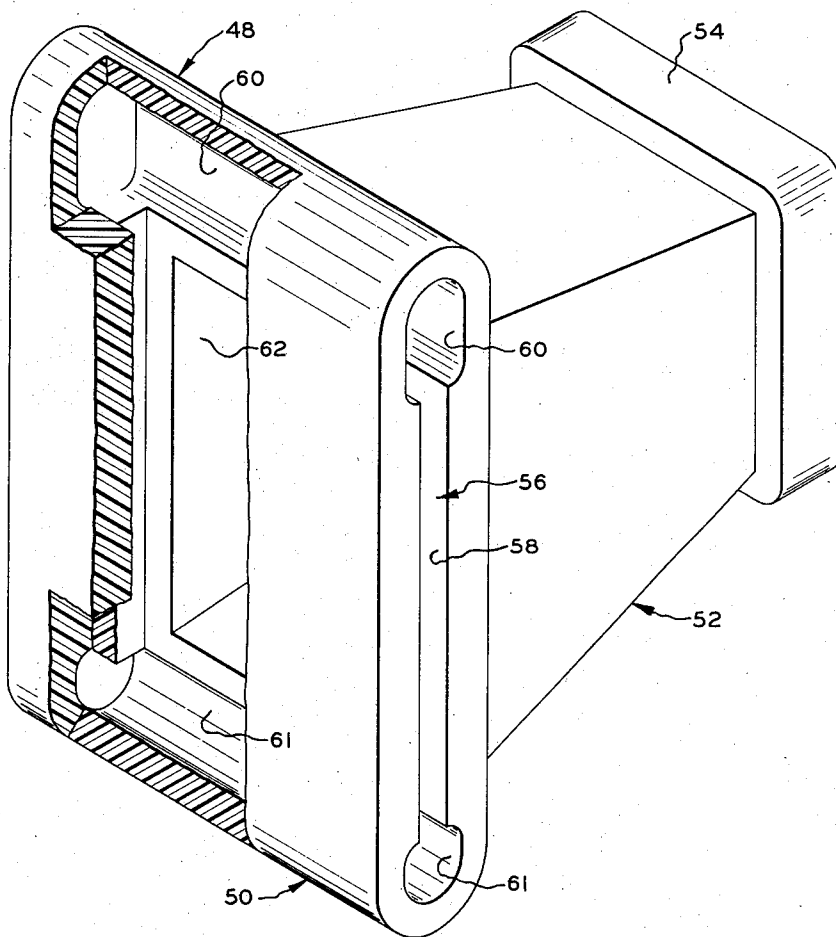


FIG. 4

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3,069,266

3 Sheets-Sheet 3

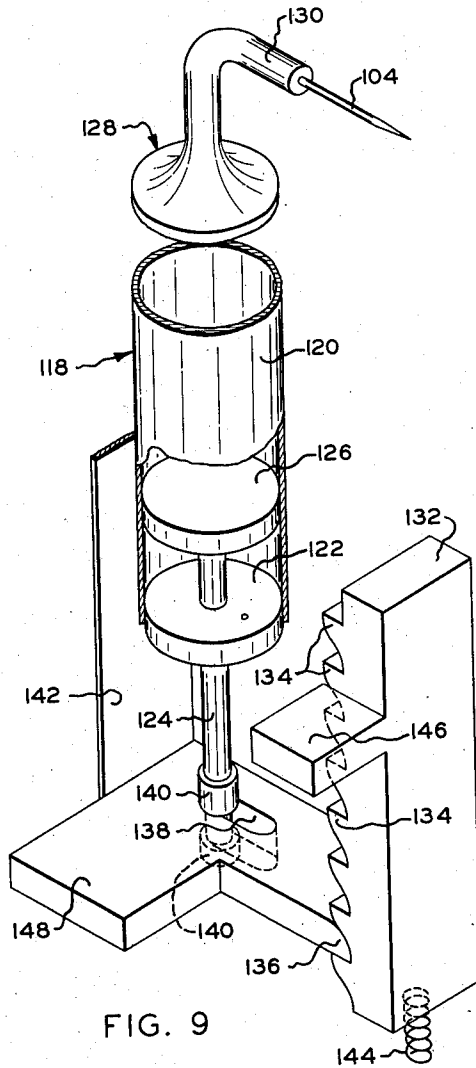


FIG. 9

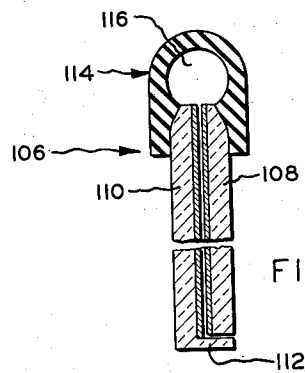


FIG. 8

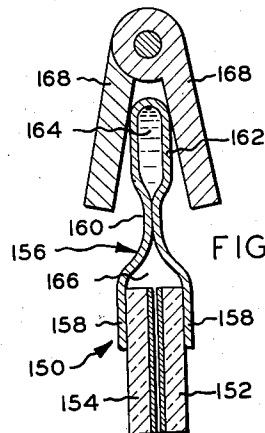


FIG. 10

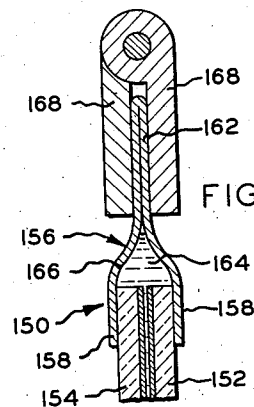


FIG. 11

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3,069,266

**PROCESS AND PRODUCT FOR DISTRIBUTING
PHOTOGRAPHIC MATERIAL BY CAPIL-
LARY ACTION****Edwin H. Land, Cambridge, Mass., assignor to Polaroid
Corporation, Cambridge, Mass., a corporation of Del-
aware****Filed Oct. 31, 1960, Ser. No. 68,323
16 Claims. (Cl. 96—48)**

This invention relates to photography and more particularly to photographic processes and products wherein a fluid is distributed between a pair of superposed sheets.

This application is a continuation-in-part of my co-pending application Serial No. 560,381, (now abandoned) filed January 20, 1956, for Photographic Process and Product.

A variety of photographic processes may be effected by spreading a fluid composition in a uniformly thin layer between a pair of superposed sheets. For example, a photosensitive stratum supported on one of the sheets may be developed by a processing composition spread between it and another sheet. Here, spreading may be effected after exposure to develop an existing latent image or before exposure so that the latent image formed immediately thereafter develops spontaneously. Alternatively, a photosensitive composition may be spread between the sheets in the presence of a developer to provide a stratum which, when photoexposed shortly after being formed, received a latent image that develops spontaneously.

Heretofore, it has been the usual practice to spread the fluid composition between the sheets by moving the sheets between a pair of specially designed pressure-applying members, such as precisely aligned and carefully fabricated rollers, the design of which may be complicated by the fact that the fluid composition is usually provided in a container located between the sheets. However, for many purposes, the use of rollers or other types of pressure-applying members may prove too costly or inconvenient and it is considered advantageous for these and other reasons to omit them from photographic apparatus of the type in which they are usually included.

The present invention has, as one of its objects, the provision of novel photographic processes and products in the form of photographic film units, which make it possible to distribute a fluid composition in a uniformly thin layer between a pair of superposed sheets without the aid of pressure-applying means, or the necessity of applying compressive pressure to the sheets.

The present invention finds applicability in a number of photographic processes involving formation of latent images in a variety of materials such as the noble metal salts, particularly the silver halides, ferric salts, diazonium compounds, and compounds of the type including dichromated gelatin. It is particularly applicable to processes of the silver transfer-reversal type, and especially a process, for example, wherein a photoexposed silver halide stratum is treated between two sheets by a silver halide developer and a silver halide solvent. The reagents reduce exposed silver halide to silver and react with unexposed silver halide to form a soluble silver complex which in turn is reduced to silver in a silver-receptive environment. This silver-receptive environment may be interspersed with the silver halide and the positive print so formed may be retained permanently between the sheets, or the silver-receptive environment may comprise a stratum on one of the sheets and is separated from the silver halide by stripping the sheets apart after the positive print has been formed.

Accordingly, other objects of the invention are: to provide a photographic process whereby an exposed photo-

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sensitive stratum is processed by a fluid composition distributed between a pair of superposed sheets by capillary action; to provide a photographic product in the form of a film unit comprising a pair of rigid or rigidly supported sheets superposed and fixedly spaced a predetermined distance apart whereby a process of the aforementioned type may be effected; to provide a photographic product of the aforementioned type comprising a pair of sheets superposed with their inner surfaces so disposed that a fluid supplied to one edge of the sheets is caused to be drawn therebetween by capillary action, and means associated with one edge of the superposed sheets providing a chamber communicating with the space between said sheets; and the process employing said product to produce a visible photographic image including the step of releasing a fluid composition within said chamber so that it is drawn between said sheets by capillary action.

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

The invention accordingly comprises the several steps and the relation and order of one or more of such steps with respect to each of the others, and the product possessing the features, properties and the relation of elements 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 an exaggerated cross-sectional view of one form of the photographic product of the invention for effecting the processing thereof;

FIG. 2 is a cross-sectional view taken along the line 2—2 of FIG. 1;

FIG. 3 is a cross-sectional view taken along the line 3—3 of FIG. 1;

FIG. 4 is a diagrammatic perspective view, partially in section, of a camera with which the product of FIG. 1 is adapted to be employed for effecting the process of the present invention;

FIG. 5 is an exaggerated sectional view, similar to FIG. 1, of another embodiment of the product of the invention;

FIG. 6 is a view, similar to FIG. 5, of another embodiment of the invention;

FIG. 7 is an exaggerated cross-sectional view taken substantially along the line 7—7 of FIG. 6;

FIG. 8 is a view, similar to FIG. 6, of another form of the invention;

FIG. 9 is a diagrammatic perspective view, partially in section, illustrating typical apparatus for effecting the processing of the film units of FIGS. 6 through 8; and

FIGS. 10 and 11 are exaggerated cross-sectional views of still another embodiment of the film unit of the invention illustrating the method of employing said film unit.

Generally, each of the film units hereinafter specifically described comprises two rigid or rigidly supported sheets, at least one of which is transparent. The two sheets, during fabrication, are superposed with their inner surfaces parallel and close together, the spacing between the inner surfaces of the sheets being such that a fluid supplied to the space between the sheets at one edge thereof will be rapidly drawn between the sheets by capillary action without further manipulation of the sheets. While the film units described may be useful to effect a variety of processes, each film unit, together with the fluid spread between the sheets, is described as preferably including the materials necessary for producing a positive photographic print by silver transfer reversal. When such a film unit is in operation, the silver halide composition is

subjected between the sheets to a silver halide developer and a silver halide solvent and in practice one or more of these materials are made available at any of a variety of locations in the film unit, for example dispersed in a dry condition on one or both of the sheets. The arrangement is such that the developer and solvent do not act upon the silver halide composition until an aqueous fluid, which may or may not contain one or more of these materials, is spread between the sheets. Each film unit includes means associated with one edge of the sheets providing a chamber communicating with the space between said sheets. The aqueous fluid may be supplied within the chamber so that it can be released therein for spreading between the sheets or from an external source, in which case means are provided in the apparatus with which the film unit is employed for introducing the fluid into the chamber.

Following formation of the positive print, the two sheets may be separated from one another, one of the sheets then serving as a support for the print; or the sheets may be retained in superposition permanently so that they form a protective barrier against harm to or defacement of the print. Photographic processes and film units of the type wherein a pair of rigid sheets, between which a positive print is formed, are maintained in permanent superposition are described and shown in my copending application Serial No. 523,885 (now Patent No. 2,982,650, issued May 21, 1961), filed July 22, 1955.

The typical film unit may be so constituted that a photosensitive silver halide stratum is carried on one of the sheets, a silver-receptive stratum is carried on the other and the fluid includes an aqueous alkaline solution of a silver halide developer and a silver halide solvent. This fluid may be released for distribution between the sheets either after exposure of the silver halide stratum or immediately before exposure so that the latent image formed in the silver halide stratum is developed and a positive print is formed spontaneously. Any of the silver halide developer and silver halide solvent, and even the alkali, which are to effect silver transfer reversal may be carried in dry condition on either or both sheets or in the solution to be spread between the sheets. Alternatively, the fluid may comprise a photosensitive composition to be distributed between the sheets in the presence of a developer to provide a stratum which, when photoexposed shortly following its formation, receives a latent image that develops spontaneously. In this form of film unit, the developer may be carried in many ways, for example dispersed in dry condition on one of the sheets. This film unit requires no shielding from environmental light until the photosensitive composition is distributed between the sheets, and this may be effected within the exposure chamber of a camera where the photosensitive composition forms a photosensitive stratum which, when photoexposed through one of the sheets, receives a latent image from which a useful print is formed without further manipulation or treatment.

The two sheets comprising the film unit are positioned during fabrication with their inner surfaces parallel and spaced a predetermined distance apart. The spacing between the sheets is relatively small, ranging, for example, between two- and six-thousandths of an inch, so that a liquid introduced into or supplied to the space along one margin thereof is drawn between the sheets by capillary action. A nonviscous, aqueous liquid comprising any of the above-mentioned materials and reagents is ideally suited for spreading between the sheets by capillary action, particularly if the liquid contains inorganic salts such as sodium hydroxide which have a strong tendency to increase the surface tension of the liquid and thereby increase the area over which the liquid will spread by capillary action, and the rapidity at which the spreading occurs. The area and rapidity of spread of the liquid, due to capillary action, may be additionally increased by providing in the liquid a surface-active agent of the type which decreases the angle of contact of the liquid with the inner surfaces of the two sheets.

One or both of the rigid sheets are transparent, depending on whether the two sheets are to be separated or are to remain in superposition following production of a photographic print, and if the sheets are retained in superposition, whether the print produced between the sheets is to be viewed by reflected or transmitted light. Suitable materials for this purpose are glass and glasslike organic polymers which are optically clear and water insoluble. Examples of suitable glasslike organic polymers are acrylates, styrenes, cellulose, vinyl chloride copolymers, and condensation polymers. These sheets should have a sufficiently high modulus of flexure to resist deformation and sheets composed of such glass and glasslike materials have been found to be sufficiently rigid when as little as one-hundredth of an inch thick. For good optical clarity, it is preferred that these sheets be no more than two-thousandths of an inch thick.

Reference is now made to FIGS. 1 through 3 wherein there is illustrated one form of film unit embodying the present invention. This film unit, generally designated at 10, comprises a pair of rigid sheets 12 and 14 mounted in superposed relation. The two sheets are retained together by a suitably formed frame completely surrounding the sheets as described in my above-mentioned application, or, as in the form shown, by a pair of retaining elements 16 and 18. Still another means for holding the two sheets together at either or both ends thereof may comprise a notch and a catch adapted to be engaged in the notch, formed as an integral part of the end section or sections of the two sheets. Sheet 12 is shown as supporting a stratum 20 which in one form contains a photosensitive silver halide, and sheet 14 is shown as supporting a stratum 22 which in one form contains silver precipitating nuclei. Retaining elements 16 and 18 are generally channel-shaped in cross section and are secured around opposite end edge sections of the sheets. The retaining elements may be provided with reentrant side wall sections 24 adapted to engage corresponding raised shoulders or ridges 26 on the outer surfaces of the sheets adjacent their ends so as to retain element 16 in engagement with the sheets. Suitable materials for the retaining elements are preferably materials such as organic plastics and rubber which can be readily formed by molding and are substantially rigid so as to retain the sheets together, yet sufficiently deformable to permit the retaining elements to be engaged with or disengaged from the sheets. Sheets 12 and 14 are spaced apart by such means as spacer strips 28 secured between the longitudinal edges of the sheets. Spacer strips 28 may be formed of any suitable material, preferably one which is incompressible, and may be formed, for example, of an adhesive material which serves to secure the sheets together as well as to predeterminedly space them apart.

Retaining element 18 is substantially equal in length to the width of sheets 12 and 14 and is open at both ends. This retaining element is so formed as to provide, when coupled with a pair of sheets at one end thereof, a passage 30 extending from end to end of the retaining element and communicating with the space between the sheets. This passage allows for the escape of air from between the sheets as a fluid is spread therebetween, commencing at the opposite edge, as well as providing a reservoir for collecting excess liquid.

Retaining element 16 is substantially longer than the width of the sheets and includes end sections 32 and 34 which extend around the lateral edges of the sheets. Retaining element 16 is so formed as to provide an elongated rounded chamber 36 at least equal in length to the width of the sheets and communicating with the space between the sheets. Mounted within chamber 36 is an elongated container 38 carrying an aqueous fluid indicated at 40 which, in one form, comprises an aqueous alkaline solution, a silver halide developer and a silver halide solvent. Fluid 40 is provided in an amount at least sufficient to completely fill the space between the

sheets when spread by capillary action substantially from end to end thereof.

Container 38 is of the type disclosed in my copending application Serial No. 820,266, filed June 15, 1959 and, in the form shown, is generally cylindrical and extends completely from end to end of chamber 36. The wall of container 38 is preferably thin and flexible and is formed of a material which is impervious to fluid 40 and preferably impervious to air and water vapor. Container 38 is secured at one end in a round opening in end section 32, a plug 42 being provided for closing the opening in the end section as well as for closing the end of the container. The other end of container 38 extends through a tapered passage 44 in end section 34. Passage 44 converges to a width substantially equal to twice the thickness of the material comprising the wall of container 38 so that the end of the container extending through the passage is retained in a closed position. An end portion 46 of the container extends beyond end section 34 whereby the container may be manually grasped, the container being adapted to be withdrawn from chamber 36 in the direction of its elongation through passage 44. The inner facing surfaces of the wall of the container in the region of end portion 46 may be secured or bonded together to assure sealing of the container. As the container is withdrawn, plug 42 remains secured in end section 32, leaving the end of the container open and the sides of passage 44 act to progressively compress the container, causing its fluid contents to be released within chamber 36 for distribution between the sheets.

Before or immediately following spreading of fluid 40 from chamber 36 between sheets 12 and 14, stratum 20, which as stated above in one form contains silver halide, is photoexposed to produce therein a latent image. Fluid 40, as stated above in one form, contains a developer which reduces exposed silver halide in stratum 20 to silver, and a silver halide solvent which reacts with unreduced silver halide to form a complex silver salt that diffuses to stratum 22 where, in the presence of unexhausted silver halide developer and a silver precipitating agent, it is reduced to silver. The period initiated by spreading fluid 40 and terminated by completing negative formation in stratum 20 and positive formation in stratum 22 ordinarily ranges from 40 to 120 seconds in duration. The two sheets 12 and 14 supporting, respectively, strata 20 and 22, may then be stripped apart or the sheets may be allowed to remain in superposition, as described in my aforementioned application Serial No. 523,885, with the solution thereafter dried to form a more or less solid residue which may serve as an adhesive to at least aid in holding the sheets together.

In embodiments of the film unit employing a gelatino silver halide emulsion, it may be desirable to coat or otherwise treat the gelatin in order to inhibit or delay the absorption of water of the processing fluid by the gelatin; yet such treatment should be of the character which does not interfere with image formation and transfer. The gelatin is subjected to this treatment in order to prevent the gelatin from swelling so rapidly as to close the capillary interspace before the processing liquid has had an opportunity to spread over the desired area. As an example of a photosensitive element useful in the invention and comprising a gelatino silver halide emulsion treated to inhibit swelling, glass lantern slide plates, manufactured by Eastman Kodak Company, were treated with a solution of tetra isopropyl titanate in hexane. The solution was prepared consisting of 1 to 2 percent by volume of tetra isopropyl titanate in hexane, and the treatment consisted of flowing the solution on the emulsion surface, draining the excess, repeating the process after about five minutes drying time, and then allowing the slide to dry over night under room conditions before use.

Lantern slide plates treated in this manner were assembled with rigid image-receiving sheets to form film

units according to the invention and useful in the method thereof. By way of example, the receiving sheets employed for this purpose were prepared according to the method described in copending application Serial No. 48,327, filed in the names of Edwin H. Land and Meroe M. Morse on August 8, 1960, and consisted of a dispersion of silver precipitating nuclei in the form of gold condensed from the vapor phase onto the surface of a rigid glass plate. Film units were produced by securing a glass lantern slide plate, treated in the manner described, in face to face relation with a glass image-receiving sheet, prepared as described, at the margins of the sheets with a gap between the sheets having a depth ranging between .0025 and .0035 inch, the gap being maintained by spacing elements located between the facing surfaces of the glass plates.

Film units prepared in this manner were exposed to actinic light and treated by immersion of an edge of the plates in a nonviscous processing fluid prepared in the manner described in U.S. Patent No. 2,662,822, issued December 5, 1953, in the name of Edwin H. Land and comprising:

Water	cc	1860
Sodium sulfite	grams	119
Sodium hydroxide	do	74.6
Sodium thiosulfate	do	14.5
Toluhydroquinone	do	52

The processing liquid was drawn into the interspace between the glass plates of the film unit by capillary action to cover the area of the plates exposed and produced a transfer image therein.

Reference is now made to FIG. 4 of the drawings wherein there is illustrated photographic apparatus in the form of a camera 48 with which the film unit of the invention is adapted to be employed for producing a photographic print. The camera comprises a housing having a rear section 50 and a tapered forward section or bellows 52 mounting a conventional lens and shutter assembly 54. In one side of the camera housing there is provided a passage 56 having a narrow elongated intermediate section 58 adapted to slidably receive the pair of superposed sheets comprising a film unit and upper and lower enlarged end sections 60 and 61, respectively, adapted to receive retaining elements 16 and 18 located at the ends of the film unit. The focal surface of the lens of assembly 54 is located within intermediate section 58 of the passage so that the photosensitive stratum of a film unit located within passage 56 is positioned for exposure. The camera housing includes a passage 62 providing an optical path between the lens and intermediate section 58 of passage 56.

Camera 48 is employed in conjunction with a film unit 10 by introducing the film unit into passage 56, commencing at one longitudinal edge of the film unit adjacent end section 32 of retaining element 16, and moving the film unit into exposure position with sheets 12 and 14 completely within passage 56 and with end section 34 of retaining element 16 and end portion 46 of container 38 extending from upper enlarged section 60 of passage 56. A suitable retaining element and/or closure may be provided on the side of rear housing section 50 adjacent passage 56 for releasably retaining a film unit within the passage and/or for light-sealing at least intermediate section 58 of the passage. The fluid contents of container 38 may be released within chamber 36 for spreading between the sheets by grasping the container at end portion 46 and withdrawing it from the chamber through tapered passage 44. Spreading of the fluid contents of the container is effected with the film unit in exposure position either immediately before exposure is made or following exposure. The film unit is then allowed to remain within the camera during a predetermined processing period at the end of which it may be removed from the camera. It is apparent from this

description of the operation of the camera that the latter can be very simple and inexpensive to fabricate since all the materials and mechanism necessary to process the film unit are included in the film unit itself, the camera merely providing exposure means and a chamber in which the film unit is positioned during exposure and processing.

Film unit 10 is positioned for spreading of the fluid preferably with chamber 36 and container 38 disposed with their common axis in a substantially horizontal plane, that is, with the transverse edges of the sheets disposed horizontally so that the fluid contents of the container are more or less evenly distributed throughout the length of the chamber (and the width of the space between the sheets) when the fluid is released; and with sheets 12 and 14 extending downward in generally vertical planes so that substantially all the fluid released within chamber 36 is made available for spreading in the space between the sheets. The sheets are positioned sufficiently close together so that normally there is no tendency for the fluid to flow between the sheets under the influence of gravity. By virtue of this arrangement capillary action is effective both to spread the fluid (downward) between the sheets and to prevent the fluid from flowing (downward) from between the sheets under the influence of gravity when the supply of fluid in chamber 36 is exhausted.

In the forms of film unit wherein one of the sheets carries a photosensitive stratum, means must be provided for preventing exposure of the photosensitive material by environmental light prior to photoexposure within the camera. Where the two sheets are to be stripped apart or retained together and the image viewed by reflected light, one of the sheets may be formed of an opaque material or with an opaque coating and a suitable opaque cover sheet may be provided for the other transparent sheet. This cover sheet (not shown) may be so formed that it can be separated from the transparent sheet of the film unit within the camera and removed therefrom to permit photoexposure through the transparent sheet.

Another form of film unit embodying the invention is illustrated in FIG. 5 and is designated at 64. Film unit 64 is similar in most respects to film unit 10 and includes a pair of rigid sheets 66 and 68 supporting, respectively, strata 70 and 72 and a retaining element 74 secured around the end edges of the sheets and retained in engagement with the sheets by reentrant sections 76 engaged with raised ridges 78 on the end sections of the sheets. Retaining element 74 provides an elongated rounded chamber 80 extending at least from side to side of the sheets and communicating with the space between the sheets through a narrow passage 82, also extending substantially from side to side of the sheets. Chamber 80 contains sufficient processing fluid, indicated at 84, to at least completely fill the space between the sheets when spread therebetween by capillary action. Fluid 84 is prevented from being drawn between the sheets by an elongated closure element 86 positioned in closing relation within passage 82. The closure element may be of any convenient cross-sectional configuration and, in the form shown, is an equi-lateral parallelogram. Closure element 86 and retaining element 74 are so constructed that one end of the closure element extends through an opening in the end of the retaining element whereby the closure element may be grasped and withdrawn in the direction of its elongation from passage 82, releasing fluid 84 for spreading between the sheets.

Another form of film unit embodying the invention is indicated at 88 in FIGS. 6 and 7 and is shown together with means for introducing and releasing a quantity of processing fluid within a chamber communicating with the space between the superposed sheets. Film unit 88 includes a pair of rigid sheets 90 and 92 secured in facing relation at one end by a retaining element 94 and separated a predetermined distance apart by a pair of

spacing strips 96 located between the longitudinal margins of the sheets. Retaining element 94 includes end walls 98 and 100 and is so formed as to define an elongated rounded chamber 102 at least equal in length to the width of the sheets and communicating with the space between the sheets. At least a portion of end wall 100 is formed of a flexible material such as rubber which may be pierced by the hollow needle 104 of a syringe through which a quantity of processing fluid may be introduced into chamber 102 for spreading between the sheets. This form of film unit may be employed in a camera of the type shown in FIG. 4 and described above, the rear section of the camera being sufficiently enlarged to include the components of a syringe having a hollow needle 104 which extends into upper enlarged end sections 60 of passage 58 in position to pierce wall 100 of retaining element 94 as the film unit is moved into exposure position. When the film unit is in exposure position, the open end of needle 104 is located within chamber 102 and the syringe, the construction and operation of which will be described hereinafter, may be actuated to inject a predetermined quantity of processing fluid into said chamber.

Another embodiment of a film unit of the type wherein the processing fluid is injected into a chamber communicating with the space between the sheets by a syringe is illustrated at 106 in FIG. 8 of the drawings. Film unit 106 comprises a pair of rigid sheets 108 and 110 secured together in facing relation at their lateral margins preferably by an adhesive which obviates the necessity for separate retaining elements. Sheet 110 may include a flange 112 along one end edge adapted to extend across the space between the sheets toward the outer surface of sheet 108 beyond the end of the latter to aid in positioning the sheets relative to one another and/or prevent the admission of light between the sheets. There is provided secured around the opposite ends of the sheets an enclosure element 114 secured, for example, by an adhesive and defining a chamber 116 extending at least from side to side of the sheets and communicating with the space between the sheets. Film unit 106 is employed in substantially the same manner as film unit 94, enclosure element 114 having an end wall adapted to be pierced by the needle of a syringe.

The aforementioned syringe, adapted to be embodied in a camera 48 and employed in conjunction with film units of the type described, is illustrated in FIG. 9 of the drawings and designated at 118. The syringe includes a cylindrical barrel 120 closed at one end by a plug or cap 122 having an opening through which extends a shaft 124 attached to a plunger or piston 126 located for sliding movement within barrel 120. A cap 128 is provided on the opposite end of the barrel 120 and includes a tapered neck 130 at the end of which is secured needle 104. Neck 130 is curved, depending on the location and position of the syringe within the camera relative to enlarged end section 60 of slot 56 so that needle 104 extends into section 60 in position to pierce the end wall of the element of the film unit introduced into section 60. Barrel 120 is preferably adapted to contain, when piston 126 is located against plug 122, processing fluid in an amount sufficient for a plurality of film units and means are provided for moving piston 126 sufficiently a number of times so that during each movement an amount of fluid sufficient to process one film unit is ejected through needle 104. This means for moving plunger 126 and controlling the amount of fluid ejected thereby includes an actuating bar 132 having formed along one side thereof a series of projecting teeth 134 positioned in engagement with an engagement member 136 secured to the end of shaft 124. Each of teeth 134 includes a flat projecting face adapted to positively engage member 136 when operating bar 132 is moved in one direction (upward viewing FIG. 9) so as to move shaft 124 and piston 126 axially (upward) away from plug 122 to-

ward cap 128 and thereby cause the ejection of fluid contained in barrel 120; and an inclined face which coacts with engagement member 136 to deflect to the latter rather than engage member 136 when operating bar 132 is moved (downward) in the opposite direction. So that engagement member 136 may be deflected during downward movement of bar 132, member 136 is provided with a slot 138 through which shaft 124 projects. The shaft includes locking rings 140 located on opposite sides of member 136 so as to prevent axial movement of the shaft with respect to member 136 while permitting movement of the member in a plane perpendicular to the axis of said shaft. Resilient means, such as a leaf spring 142, is provided in engagement with member 136 for urging the member into engagement with teeth 134 on operating bar 132. The distance between the flat faces of adjacent teeth is substantially equal to the length of the upward movement of piston 126 necessary to eject the predetermined amount of fluid required for processing one film unit. Operating bar 132 is so mounted as to be slidable in the direction of its elongation, movement of bar 132 being limited to this same distance between flat faces of adjacent teeth so that one movement (upward) of the bar can cause the ejection of only sufficient fluid to process one film unit. A spring, indicated at 144, may be provided for urging operating bar 132 upward to the full limit of its movement in the direction required to cause the ejection of fluid and bar 132 is provided with an engagement arm 146 which projects exteriorly of the camera housing, for example through a slot therein, to provide means for manually operating the syringe. Engagement member 136 also includes a manually engageable arm 148 adapted to project exteriorly of the camera housing.

The syringe is operated to inject a predetermined quantity of processing fluid into a film unit in response to arm 146 being manually depressed so as to move bar 132 downward against the bias of spring 144 to its limit of movement, at which point the flat face of one of teeth 134 engages member 136 and then moving bar 132 and/or allowing the bar to move under the bias of spring 144 upward to the limit of its movement, thereby causing a quantity of fluid to be ejected from the syringe. This reciprocating movement is imparted to operating bar 132 for each successive film unit to be processed, member 136 being deflected from engagement with teeth 134 during downward movement and being engaged by the next successive tooth 134 on the upward movement of bar 132. The barrel of the syringe can be refilled by inserting a container, filled with the processing fluid and having a flexible end closure, into upper enlarged section 60 of passage 56 until needle 104 punctures the end closure. Piston 126 is then drawn downward toward plug 122, causing the fluid to be drawn from the container into barrel 120. To permit downward movement of the piston, engagement arm 148 is manually grasped and is moved against the bias of spring 142 from engagement with teeth 134. Engagement member 136 may then be moved downward to a position wherein member 136 will be engaged by the flat face of the first or lowest tooth 134 when bar 132 is again depressed.

Reference is now made to FIGS. 10 and 11 of the drawings wherein there is shown another form of film unit designated at 150 and embodying the invention together with means for manipulating the film unit to cause the spreading of the processing fluid between the sheets. Film unit 150 includes, in addition to a pair of rigid sheets 152 and 154 secured together in facing relation with their inner surfaces spaced a predetermined distance apart, a collapsible container 156. Container 156 is formed preferably of a single rectangular sheet of flexible material, such as paper, plastic, metallic foil and the like, which is impervious to the processing fluid and preferably water vapor impervious. This sheet, at least as long as the width of sheets 152 and 154, is folded upon

itself and its longitudinal edge sections 158 (opposite the fold) are secured to the ends of sheets 152 and 154. The end edges of the sheet are bonded together to define a cavity communicating with the space between the sheets. This cavity is divided longitudinally into two sections by bonding or adhering the inner surfaces of the sides of the cavity together along a region, indicated at 160 and located mediate the fold and edge sections 158. The film unit is provided with cavity 162 located nearest the fold containing a quantity of fluid 164 sufficient to at least completely fill the space between the sheets when spread therebetween, while the second cavity 166, which communicates directly with the space between the sheets, is empty. To release the fluid within cavity 166 for spreading between the sheets, the walls of container 156 in the region of fluid-filled cavity 162 are subjected to compressive pressure, for example, by such means as a pair of jaws 168. The pressure thus generated in fluid 164 causes the bond between the walls of the container in region 166 separating the two cavities from one another to rupture and the fluid to flow into cavity 166 so that it can be drawn into the space between sheets 152 and 154 by capillary action. Jaws 168 may be very simple in construction and operation and may be provided in the camera; or, if it is desired, under certain circumstances the container may even be compressed manually prior to introduction of the film unit into the camera.

While various forms of film units have been shown and described, including specific means for supplying a quantity of processing fluid and releasing said fluid in a chamber associated with the end of a pair of sheets, spaced apart so that said fluid is caused to be spread therebetween by capillary action, and communicating with the space between the sheets, other forms of film units falling within the scope of the invention may occur to persons skilled in the art. For example, the processing fluid may be provided in a frangible container mounted within a flexible enclosure providing a chamber communicating with the space between the sheets. The frangible container, which provides a barrier between the fluid and the space between the sheets, may be adapted to be crushed or broken by compressive pressure applied through the walls of the enclosure so as to release its contents for spreading between the sheets. A frangible container suitable for use in the present invention is disclosed in my Letters Patent No. 2,627,459, issued February 3, 1953.

Since certain changes may be made in the above product and process without departing from the scope of the invention herein involved, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

What is claimed is:

1. The method of treating a light-sensitive material located in a layer between a pair of liquid-confining sheets to form a visible photographic image, which method comprises the steps of: forming a capillary interspace of substantially uniform capillary depth throughout its length and width between the inner surfaces of said sheets by superposing said sheets with said inner surfaces spaced a predetermined minute distance apart and so holding said sheets with said inner surfaces thereof rigidly fixed with respect to one another that a free-flowing liquid will move through said capillary interspace by capillary action to form a continuous layer of substantially uniform thickness throughout the length and width of said interspace; supplying a quantity of a free-flowing liquid, including an agent capable of initiating the processing of said light-sensitive material to produce a visible image, to said interspace between said sheets at one edge thereof; spreading said liquid in a layer between said sheets by capillary action to form a sandwich including said light-sensitive material and said agent for initiating processing; at some stage in said method, exposing

said light-sensitive material to actinic radiation to produce an image in said light-sensitive material; and reacting said liquid with said exposed light-sensitive material to produce a visible photographic image.

2. The method of claim 1 wherein said liquid is spread prior to exposure of said light-sensitive material to actinic radiation.

3. The method of treating a light-sensitive material located between a pair of substantially liquid impervious rigid sheets to form a visible photographic image, which method comprises forming a capillary interspace of substantially uniform capillary depth throughout its length and width between the inner surfaces of said sheets by superposing said sheets with said inner surfaces fixedly spaced from one another by a minute distance such that a free-flowing liquid will move between said sheets by capillary action to form a sandwich including a uniformly distributed photosensitive material; supplying a quantity of a free-flowing aqueous liquid reagent capable of processing an exposed light-sensitive material to produce a visible image, to said capillary interspace between said sheets at one edge thereof; spreading said liquid reagent in a thin layer of substantially uniform thickness throughout the length and width of said interspace between said sheets by capillary action to form a sandwich including a continuous layer of said liquid and said uniformly distributed photosensitive material; exposing said photosensitive material to produce an image therein; and reacting said liquid reagent with said exposed photosensitive material to form a visible photographic image.

4. The method of claim 3 wherein said quantity of said free-flowing liquid is provided initially in a chamber communicating with said interspace at said one edge, flow of said liquid from said chamber into said capillary interspace is prevented by a barrier provided in said chamber, and said barrier is withdrawn from said chamber for releasing said liquid to flow into said capillary interspace for spreading within said interspace by capillary action.

5. A photographic method as defined in claim 3 wherein said free-flowing liquid reagent is supplied to said interspace from a chamber communicating with said capillary interspace at said one edge, said chamber is defined by a container located externally of said sheets and coupled with said one edge of said sheets, a wall of said container is perforated by forcing a tubular member through said wall into said chamber and a quantity of said liquid reagent is introduced through said tubular member into said chamber to be withdrawn therefrom into said capillary interspace between said sheets by capillary action.

6. A photographic method as defined in claim 3 wherein said quantity of said free-flowing liquid reagent is provided in a first section of a two sectioned container located externally of said sheets and having a second section providing a chamber coupled with said sheets at one edge thereof and communicating with said interspace between said sheets, and compressive pressure is applied to said first section of said container for causing its liquid contents to be discharged into said chamber of said second section to be withdrawn therefrom into said interspace between said sheets by capillary action.

7. A photographic method as defined in claim 3 comprising providing said quantity of said free-flowing liquid in an elongated container located within a chamber disposed externally of said sheets and communicating with said capillary interspace at said one edge of said sheets, withdrawing said container in the direction of its elongation from said chamber and as said container is being withdrawn, causing said liquid to be discharged from said container into said chamber to be withdrawn by capillary action into said capillary interspace between said sheets.

8. A photographic product in the form of a film unit comprising a pair of substantially rigid, liquid-confining sheets superposed with their inner surfaces in sub-

stantially fixed relation and rigidly spaced a predetermined minute distance apart to provide a continuous capillary interspace of substantially uniform capillary depth between said sheets through which a free-flowing liquid will move by capillary action to form a continuous layer for effecting the processing of a layer of photographic, photosensitive image-recording material located between the outer surfaces of said sheets; a layer of a photographic material disposed between said sheets on one of said sheets, said sheets having at least a pair of adjacent edges defining a boundary of said interspace; means located externally of said sheets and secured to at least one of said sheets adjacent said edges for containing a quantity of said liquid; means for conducting said liquid to said interspace between said sheets at said adjacent edges so that said liquid may be drawn by capillary action into said interspace between said sheets; and means for releasing said liquid to flow into said interspace, said photosensitive material being provided initially in one of said layer between said sheets and said liquid.

9. A photographic product in the form of a film unit comprising a pair of substantially rigid, liquid-impervious sheets fixedly supported in superposed relation with their inner surfaces spaced a predetermined distance apart to provide a continuous capillary interspace of substantially uniform depth between said sheets within which a free-flowing liquid will move by capillary action; photographic, photosensitive image-recording material; a developer for said photosensitive material capable of reacting therewith to produce a visible image; a layer of a photographic material disposed between said sheets on one of said sheets, a quantity of a free-flowing aqueous liquid capable of initiating the development of said photosensitive material following exposure thereof; each of said sheets having an edge substantially adjacent said edge of the other of said sheets; said interspace extending to said adjacent edges; means located externally of said sheets and coupled with said sheets at said edges providing a chamber communicating with said interspace at said edges for containing said quantity of said liquid and for conducting said liquid to said interspace so that said liquid may be drawn by capillary action into said interspace between said sheets; and means releasably retaining said liquid in said chamber apart from said interspace, said photosensitive material and said developer therefor being provided initially in at least one of said layer between said sheets and said liquid.

10. The photographic product of claim 9 wherein said means for containing and conducting said liquid to said space between the sheets comprises a collapsible container located externally of said sheets and including a first section providing said chamber for containing said liquid and a second section communicating with said capillary interspace, the walls of said second section of said container being secured to the exterior marginal portion of said sheets at said edges, said first and second sections of said container being separated by a sealed portion capable of being ruptured by the application of compressive pressure to said first section of said container to permit the flow of said liquid from said first section into said second section where said liquid is available to be drawn into said capillary interspace.

11. A photographic product in the form of a film unit comprising a pair of substantially rigid, liquid-impervious sheets fixedly supported in superposed relation with their inner surfaces spaced a predetermined distance apart to provide a continuous capillary interspace of substantially uniform depth between said sheets within which a free-flowing liquid will move by capillary action; photographic, photosensitive image-recording material; a developer for said photosensitive material capable of reacting therewith to produce a visible image; a quantity of a free-flowing aqueous liquid including said photosensitive material and at least one ingredient of said developing composition for said photosensitive material, the remaining ingredients of

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said developing composition being disposed on one of said sheets between sheets and so constituted to be rendered reactive by contact with said liquid; each of said sheets having an edge substantially adjacent said edge of the other of said sheets; said space extending to said adjacent edges; means located externally of said sheets and coupled with said sheets at said edges providing a chamber communicating with said interspace at said edges for containing said quantity of said liquid and for conducting said liquid to said interspace so that said liquid may be drawn by capillary action into said interspace between said sheets; and means releasably retaining said liquid in said chamber apart from said interspace.

12. A photographic product in the form of a film unit comprising a pair of substantially rigid liquid-impervious sheets located in superposed relation; holding means fixedly retaining said sheets with their inner surfaces rigidly spaced a predetermined fixed distance apart to provide a continuous capillary interspace of substantially uniform capillary depth between said inner surfaces through which a free-flowing photographic liquid will move between said sheets by capillary action to form a sandwich comprising at least three layers, at least one of said layers being located between the outer surfaces of said sheets, comprising said liquid, being continuous and including a uniformly distributed photographic, photosensitive image recording material; said sheets having adjacent edges defining one end of said interspace; a container located externally of said sheets and secured to said sheets at said adjacent edges; said container providing an elongated chamber extending approximately from side to side of said interspace at said adjacent edges and carrying a quantity of said free-flowing photographic liquid for distribution within said interspace; means for conducting said liquid from said chamber to said interspace at said adjacent edges; and an elongated barrier within said container means for preventing the flow of said liquid from said chamber into said interspace, said

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barrier means being movable from said chamber in the direction of elongation of said barrier substantially parallel with said adjacent edges of said sheet to permit the flow of said liquid to said interspace for distribution throughout said interspace by capillary action.

13. The photographic product of claim 12 wherein said liquid comprises said photosensitive material and at least one ingredient of a developing composition for said photosensitive material, and the remaining ingredients of said developing composition are deposited between said sheets on one of said sheets in condition to be rendered reactive by contact with said liquid.

14. The photographic product of claim 12 wherein said container also provides a passage connecting said chamber with said capillary interspace at said adjacent edges, and said barrier comprises a member located in closing relation in said passage between said chamber and said interspace.

15. The photographic product of claim 12 wherein said barrier comprises an elongated tubular member containing said liquid; and means are provided for engaging said tubular member during withdrawal thereof from said chamber in the direction of elongation of said tubular member to effect the release of said liquid in said chamber for distribution within said interspace.

16. The photographic product of claim 15 wherein said means engaging said tubular member to release said liquid comprise means for progressively compressing the walls of said tubular member during withdrawal thereof to cause the discharge of said liquid from said tubular member into said chamber.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,069,266

December 18, 1962

Edwin H. Land

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 1, lines 29 and 30, for "received" read -- receives --; column 2, line 63, for "benig" read -- being --; column 3, line 27, for "May 21, 1961" read -- May 2, 1961 --; column 7, line 56, for "Fuid" read -- Fluid --; column 9, line 3, strike out "to", second occurrence; column 12, line 30, for "product" read -- produce --.

Signed and sealed this 15th day of December 1964.

(SEAL)

Attest:

ERNEST W. SWIDER
Attesting Officer

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