

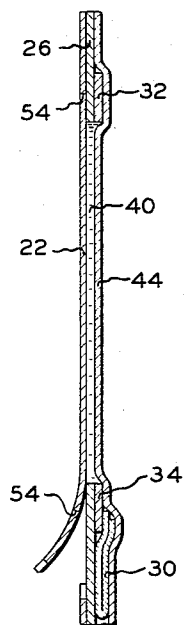
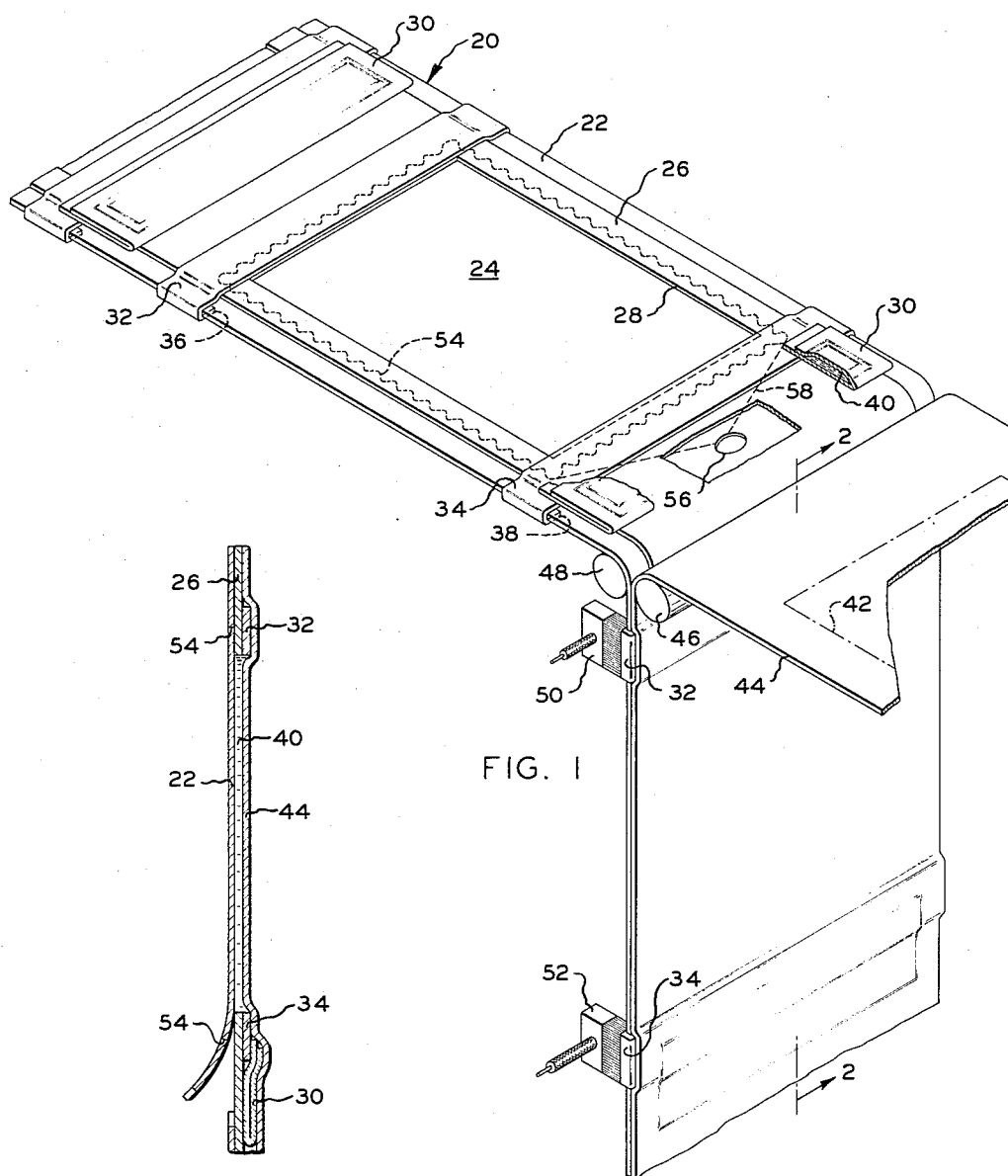
Nov. 30, 1965

M. N. FAIRBANK
PHOTOGRAPHIC PROCESS FOR SPEEDING DEVELOPMENT
USING ELECTRIC CURRENT

3,220,836

Filed Nov. 4, 1960

3 Sheets-Sheet 1



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3 Sheets-Sheet 2

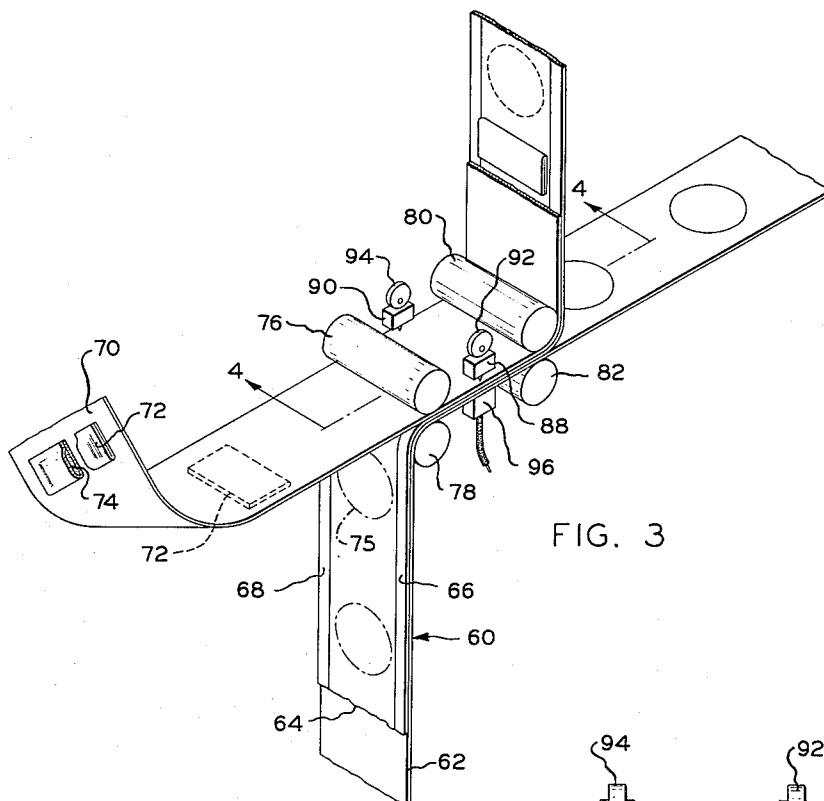


FIG. 3

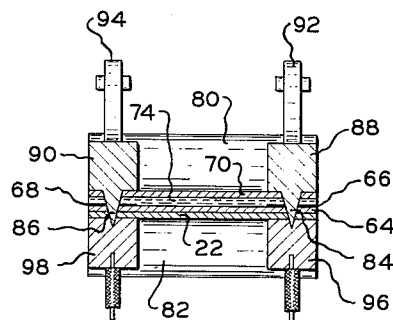


FIG. 5

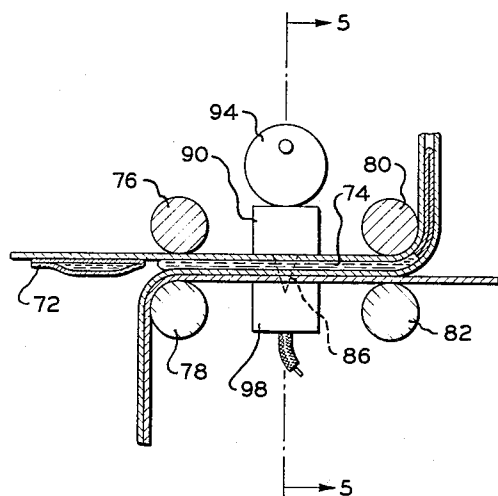


FIG. 4

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3 Sheets-Sheet 3

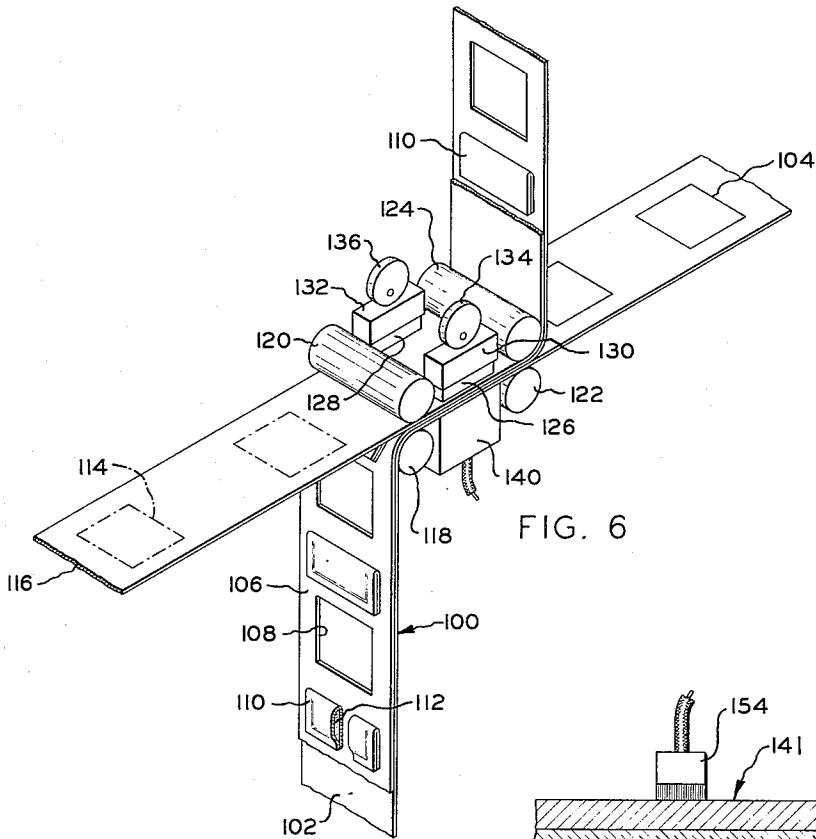


FIG. 6

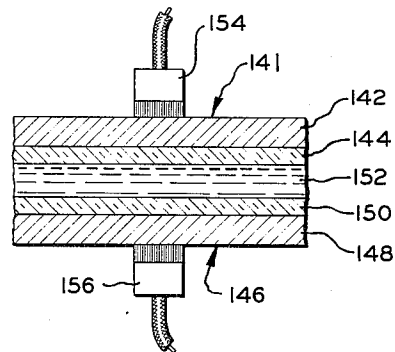


FIG. 8

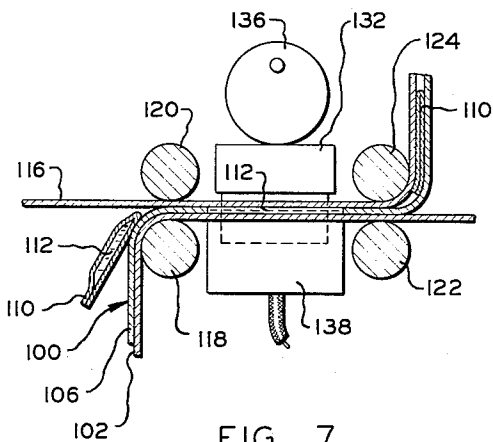


FIG. 7

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3,220,836

PHOTOGRAPHIC PROCESS FOR SPEEDING DEVELOPMENT USING ELECTRIC CURRENT

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Filed Nov. 4, 1960, Ser. No. 68,329

2 Claims. (Cl. 96—29)

This application is a continuation-in-part of copending application Serial No. 556,239, filed December 29, 1955, and now abandoned.

This invention relates to photography and, more particularly, to methods of and products for speeding the action of a photographic composition which has been applied in a thin layer to a photographic sheet.

As it is understood to the art, a photographic transfer process may be carried out to form, for example in an image-receptive sheet, a reverse image of the latent image contained in an exposed photosensitive sheet. By one practice, a transfer process may be effected by spreading a photographic or processing composition between and in contact with an image-receptive sheet and an exposed photosensitive sheet which are arranged in superposed relation. The processing composition employed is one which is capable of developing a latent image in the photosensitive sheet and of providing an imagewise distribution of image-forming components therein as a result of said development. These image-forming components are transferred without appreciably disturbing the imagewise distribution to the image-receptive sheet to provide the desired transfer image.

One process with which this invention is particularly concerned involves the application of an aqueous solution of a silver halide developer and a silver halide solvent, in a thin layer, to photoexposed gelatino silver halide sheet and an image-receptive sheet which are in superposed relation. The solution acts to reduce exposed silver halide to silver, to form by reacting with unreduced silver halide a water-soluble complex silver salt, to transfer it to the image-receptive sheet and there to reduce it to silver.

It is often desirable to increase the speed of such a process, for example, at low temperatures tending to retard the reaction or at ordinary temperatures in devices which require that the image associated with a latent image produced at a given time be observed almost immediately thereafter. In the past, the speed of such a process has been increased by means of heating units which radiate energy to the layer of photographic composition. Such heating units, however, require high power input and suffer high power loss. In accordance with the present invention, energy is applied directly to the layer of composition in order to reduce power input and power loss to a minimum.

The primary object of this invention is to speed the action on a photographic sheet of a thin layer of photographic composition by passing through it an electrical current.

Other objects of the present invention are: to provide a photographic process comprising the steps of applying a photographic composition to an exposed photosensitive sheet in a layer and passing through it an electrical current; to provide a process of the foregoing type in which the layer is applied by spreading the composition between an exposed photosensitive sheet and an image-receptive sheet which are in superposed relation; to provide a process of the foregoing type in which an exposed photosensitive layer and an image-receptive layer are laminated together and the composition is spread in a layer upon the free face of the photosensitive layer; to provide a process

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of the foregoing type in which the photosensitive sheet contains a gelatino silver halide emulsion and the composition includes an aqueous solution of a silver halide developer and a silver halide solvent.

Further objects of the present invention are: to provide a photographic assemblage comprising means for passing an electrical current through a photographic composition spread in a thin layer between an exposed photosensitive sheet and another sheet; to provide a photographic assemblage comprising a base layer and an image layer which are electrically non-conducting, the image layer providing at least a frame which is adapted to receive at least a photographic image, and at least a pair of electrically conducting strips extending continuously along opposite extremities of the frame; to provide an assemblage of the foregoing type in which adjacent edges of the strips are in substantial parallelism; to provide an assemblage of the foregoing type wherein the image layer contains a gelatino silver halide emulsion; to provide an elongated assemblage of the foregoing type wherein the conducting strips are substantially perpendicular to the longitudinal edges thereof; and to provide an elongated assemblage of the foregoing type wherein the conducting strips are substantially parallel to the longitudinal edges thereof.

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 appended 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 isometric view of an association of photographic materials being processed in accordance with the present invention;

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

FIG. 3 is an isometric view of another association of photographic materials being processed in accordance with the present invention;

FIG. 4 is a sectional view taken substantially along the line 4—4 of FIG. 3;

FIG. 5 is a sectional view taken substantially along the line 5—5 of FIG. 4;

FIG. 6 is an isometric view of a further association of photographic materials being processed in accordance with the present invention;

FIG. 7 is a sectional view taken substantially along the line 7—7 of FIG. 6; and

FIG. 8 is a sectional view of still another association of photographic materials being processed in accordance with the present invention.

The passage of an electrical current through a thin layer of photographic composition has been found to increase the speed with which it reacts.

This current may be either alternating or direct. In order that the layer react at uniform speed with all regions of a frame contacted by it, it is desirable that the current flux across the layer be constant. One technique for achieving such a condition is to extend, continuously along opposite edges of the frame, electrically conducting strips the adjacent edges of which are parallel to each other. Such strips are in the form either of discrete laminations, for example of from .005 to .001 of an inch thick, or evaporated coatings, for example of from .005 to .001 of an inch thick, and are composed of materials such as gold, silver, platinum and carbon which do not react disadvantageously with the composition.

FIG. 1 and 2, in general, illustrate a process in which a viscous aqueous solution of a silver halide developer, a silver halide solvent and an alkali is spread in a uniformly thin layer between the superimposed surfaces of a photoexposed photosensitive gelatino silver halide sheet and an image-receptive sheet, for example by advancing the sheets between a pair of pressure-applying rollers. In accordance with the present invention, the sheets are maintained in superposed relation for a predetermined period during which an electrical current is passed through the layer of solution and a transfer print forms in a frame of the image-receptive sheet. At the end of this period, the frame is stripped from the layer of solution and the photosensitive sheet for observation.

The photographic materials illustrated as being subjected to this process comprise a photographic assemblage 20 which includes an image-receptive sheet 22 having a succession of frames or picture areas 24, a masking sheet 26 having a succession of openings 28 aligned with the frames, a succession of containers 30 so attached to the masking sheet that one container is associated with one frame, and a succession of pairs of metallic strips 32 and 34, the strips of a pair extending between the longitudinal edges of the assemblage at opposite ends of a frame and being reversely bent around an edge of image-receptive sheet 22 at 36 and 38. An aqueous solution 40 within a container 30 is adapted to be spread in a layer (FIG. 2) between an exposed frame 42 of a photosensitive sheet 44 and a frame 24 which have been advanced between a pair of pressure-applying rollers 46 and 48. In order to cause electrical current flow through this layer of solution, an electromotive force is applied between strips 32 and 34 by a pair of brushes 50 and 52 which contact reversely bent portions 36 and 38 of the strips.

The specific composition and construction of the above-described elements, which will be apparent to persons skilled in the art, now will be summarized briefly.

Photosensitive sheet 44 includes a suitable base layer and a suitable photosensitive layer or stratum which, for example, contains a photosensitive heavy metal salt capable of forming a latent image upon exposure and capable of being developed to produce a visible image comprising the metal of said salt. One preferred photosensitive layer comprises a gelatino silver halide emulsion of the type described in T. T. Baker, "Photographic Emulsion Technique," American Photographic Publishing Co., Boston, 1948, Chapter IV. Photosensitive ferric salts of the type described, for example in L. P. Clerc, "Photography Theory and Practice," Second Edition, published 1937, by Pitman Publishing Company, page 402, paragraph 621 et seq., and Crowley Patents Nos. 2,093,421, 2,113,423, 2,130,070, 2,130,071, 2,137,015 may also comprise the photosensitive layer. Image-receptive sheet 22 includes a suitable base layer and a suitable image-receptive layer or stratum which, for example, contains a silver precipitating agent, the presence of which, in a silver diffusion-transfer-reversal process, has a desirable effect on the amount and character of silver precipitated on the image-receptive layer. Where it is desired to form the transfer-image in the thin layer of spread photographic or processing composition, a silver precipitating agent may be incorporated therein. In this latter case, sheet 22 serves to confine and facilitate the spreading of the processing composition. Materials of this type are more specifically described in United States Letters Patents Nos. 2,698,237 and 2,698,245, issued to Edwin H. Land on December 28, 1954.

Aqueous solution 40 includes a silver halide developer such as hydroquinone, a silver halide solvent such as sodium thiosulfate, an alkali such as sodium hydroxide and a viscosity-increasing, film-forming material such as an alkali-inert polymer. Suitable polymers for increasing the viscosity of the aqueous solution, for example, are water-soluble cellulosic materials such as hydroxyethyl cellulose, carboxymethyl cellulose and carboxymethyl-

hydroxyethyl cellulose. In a preferred form, container 30, within which this solution is confined, is constructed from a blank of three-ply sheet material having a single fold. The outer ply, serving as a support, is composed of a thin, relatively inexpensive, tough material, preferably a paper such as kraft paper. The intermediate ply is composed of a substantially vapor- and liquid-imperious material, for example, a metal foil such as lead foil. The inner ply is composed of a suitable thermoplastic or thermosetting plastic material, for example a polyvinyl acetal such as polyvinyl butyral or polyvinyl formal, which protects the container contents from contamination. At opposite end portions of each container, the two folds of the inner ply are sealed to each other as by the application of heat and/or pressure. Those two sections of the two folds defining the mouth are bonded together by a strip of adhesive so constituted that the cohesive forces between it and the inner ply are less than the cohesive forces between end portions of the inner ply sealed together. Since the bonding forces between those section defining the mouth are less than the bonding forces between other sections of the container, the application of opposed compressional forces to the container causes discharge of the container's contents through its mouth. Various photographic compositions and containers of the above type are further described in United States Patent No. 2,543,181, issued to Edwin H. Land on February 27, 1951.

Masking sheet 26 is composed, for example, of a paper such as sulfate kraft condenser paper. The layer formed by solution 40 released from container 30 follows a path which, initially approximately as wide as the mouth of the container, expands toward the opposite edges of assemblage 20, covers frame 24 completely and thereafter contracts. Masking sheet 26, by overlapping the edges of frame 24, prevents their being contacted by layer 40 and, thereby, provides the frame with a clean white border. Frame 24 may be detached from the remainder of image-receptive sheet 22 and from masking sheet 26 by means of perforations 54 which separate frame 24 from image-receptive sheet 22 and a strippable bond by which the masking sheet is joined to the image-receptive sheet. Detachment is facilitated by finger-engageable, tearout holes 56 in image-receptive sheet 22, one of which holes is associated with one frame and is connected to it by lines of perforations 58. The bond by which masking sheet 26 and image-receptive sheet 22 are joined may be produced by coating adjacent surfaces of the sheets with relatively incompatible plastic materials and sealing the resulting laminations together by heat and/or pressure. Details of such a bond are more fully described in Patent No. 2,563,387, issued on August 7, 1951, to William J. McCune, Jr.

In operation, when assemblage 20 and photosensitive sheet 44 are advanced in superposed relation between rollers 46 and 48, solution 40 is ejected from container 30 and is spread between frame 24 and frame 42 in a layer to provide what may be termed a sandwich. The thickness of the spread layer, which is preferably on the order of a few thousandths of an inch, depends upon the thickness of masking sheet 26. Thereafter, an electromotive force is applied between strips 32 and 34 by brushes 50 and 52 which are coupled to a suitable power supply and which contact reversely bent portions 36 and 38 of the strips. Ordinarily, in the absence of an applied electromotive force, if photosensitive sheet 44, image-receptive sheet 22 and solution 40 are composed of the materials specifically described above, in order that a satisfactory transfer print be formed, frames 24 and 42 must remain in superposed relation for a period ranging from 40 to 120 seconds in duration. An electromotive force within the range of 50 to 600 volts, D.C. or A.C., applied between strips 32 and 34, which are spaced approximately four inches apart, reduces the duration of this processing period to approximately 10 seconds.

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FIGS. 3, 4 and 5 illustrate a process in which a viscous aqueous solution of a silver halide developer, a silver halide solvent and an alkali is applied to a laminated sheet having a photoexposed photosensitive gelatino silver halide layer and an image-receptive layer the adjoining faces of which are strippably bonded together. In accordance with the present invention, the sheet and a layer of this solution spread upon the free face of the photosensitive layer are maintained in intimate contact for a predetermined period during which an electrical current is passed through the solution layer and a transfer print forms in the image-receptive layer. At the end of this period, the solution layer and the photosensitive layer are stripped from the image-receptive layer so that the transfer print may be observed.

The photographic materials, illustrated as being subjected to the foregoing process, comprise a laminated sheet 60 which includes, in sequence, a base layer and an image-receptive layer designated as a unit by 62, a photosensitive gelatino silver halide layer 64 and a pair of metallic strips 66 and 68 extending along the longitudinal edges of the sheet. A backing sheet 70 on which are mounted a succession of containers 72, carrying a solution 74 of the foregoing type, is designed to be superposed on photosensitive sheet 64 in such a manner that solution 74 is ejected from a container 72 and is spread in a thin layer between the backing sheet and a latent image 75 formed in photosensitive layer 64. Solution layer 74 is maintained in this condition for a predetermined processing period during which an electromotive force is applied between strips 66 and 68 and a transfer print forms in image-receptive layer 62. Thereafter, backing sheet 70, together with solution layer 74 and photosensitive layer 64, are stripped as a unit for image-receptive layer 62.

Image-receptive layer 62, photosensitive layer 64, containers 72 and solution 74 are similar in composition respectively to the image-receptive layer of image-receptive sheet 22, the photosensitive layer of photosensitive sheet 44, containers 30 and solution 40, described in detail above.

The photographic apparatus illustrated as effectuating the foregoing process includes a first pair of pressure-applying rollers 76 and 78 between which sheets 60 and 70 are adapted to advance initially and a second pair of rollers 80 and 82 between which the sheets are adapted to advance thereafter. Rollers 76 and 78 are adapted to superpose sheets 60 and 70 and to spread solution 74 between them. Rollers 80 and 82 cooperate with rollers 76 and 78 to maintain associated portions of these sheets in superposed relation for a predetermined processing period during which a latent image in frame 75 is processed and a transfer print is formed in image-receptive layer 62, and to strip sheet 70, solution layer 74 and photosensitive layer 64, as a unit, from image-receptive layer 62 in order to permit the transfer print to be observed. In order to cause electrical current flow through solution layer 74, an electromotive force is applied between strips 66 and 68 by a pair of barbs 84 and 86 which penetrate the superposed edges of sheets 60 and 70 so as to electrically couple strips 66 and 68 to an electrical power supply. Barbs 84 and 86, carried by followers 88 and 90, are actuated by a pair of cams 92 and 94 the motion of which is synchronized with the motion of sprockets (not shown) which meter sheets 60 and 70 between rollers 76 and 78 and rollers 80 and 82. Barbs 84 and 86 are adapted to contact a pair of anvils 96 and 98 which are the terminals of the electrical power supply. Barbs 84 and 86, by projecting through sheets 60 and 70, make electrical connection between strips 66 and 68 and anvils 96 and 98, respectively.

In operation, when sheets 60 and 70 are advanced between rollers 76 and 78, solution 74 is ejected from container 72 and is spread between the sheets in a thin layer. Thereafter, barbs 84 and 86 penetrate the superposed

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edges of sheets 60 and 70 so that an electromotive force is applied between strips 66 and 68. At the end of a predetermined period during which a latent image in photosensitive layer 64 is processed and a transfer print forms in image-receptive layer 62, photosensitive layer 64, solution layer 74 and backing sheet 70 are stripped from image-receptive layer 62 so that the transfer print may be observed. By virtue of the quick-drying character of solution layer 74, notwithstanding the continuity of strips 66 and 68, current flows only between sections of the strips lying between superposed portions of sheets 60 and 70 extending from rollers 76 and 78 to rollers 80 and 82.

FIGS. 6 and 7 illustrate a photographic process which, with the exception of the manner in which the electromotive force is applied, is generally similar to the process of FIGS. 1 and 2. The photographic materials, illustrated as being subjected to this process, comprise a photographic assemblage 100 which includes an image-receptive sheet 102 having a succession of frames 104, a masking sheet 106 having a succession of openings 108 aligned with the frames, and a succession of containers 110 so attached to the masking sheet that one container is associated with one frame. A solution 112 with a container 110 is adapted to be spread in a layer (FIG. 7) between an exposed frame 114 of a photosensitive sheet 116 and a frame 104 which have been superposed. In accordance with the present invention, frame 104 and frame 114 are maintained in superposed relation for a predetermined period during which an electrical current is passed through solution layer 112 and a transfer print forms in the image-receptive sheet. At the end of this period, solution layer 112, masking sheet 106 and photosensitive sheet 116 are stripped from image-receptive sheet 102 so that the transfer print may be observed.

Image-receptive sheet 102, photosensitive sheet 116, masking sheet 106, containers 110 and solution 112 are similar in composition, respectively, to image-receptive sheet 22, photosensitive sheet 44, masking sheet 26, containers 30 and solution 40, described in detail above.

The photographic apparatus, illustrated as effectuating the foregoing process, includes a first pair of pressure-applying rollers 118 and 120, similar to rollers 76 and 78 described above, between which sheets 100 and 116 are adapted to advance initially, and a second pair of rollers 122 and 124, similar to rollers 80 and 82 described above, between which the sheets are adapted to advance thereafter. Rollers 118 and 120 are adapted to superpose sheets 102 and 116 and to spread solution 112 between them. Rollers 118 and 120 cooperate with rollers 122 and 124 to maintain portions of sheets 100 and 116 in superposed relation for a predetermined processing period during which a latent image in frame 114 is processed and a transfer print is formed in frame 104. In order to cause electrical current to flow through solution layer 112, an electromotive force is applied across the solution layer by means of a pair of blades 126 and 128 which penetrate the superposed edges of sheets 100 and 116 so as to electrically couple opposite extremities of the solution layer to an electrical power supply. Blades 126 and 128, carried by followers 130 and 132, are actuated by a pair of cams 134 and 136 the motion of which is synchronized with the motion of sprockets (not shown) which meter sheets 100 and 116 between rollers 118 and 120 and rollers 122 and 124. Blades 126 and 128 are adapted to contact a pair of anvils 138 and 140 which are the terminals of the electrical power supply. Blades 126 and 128, by projecting through sheets 100 and 116, make electrical connection between the opposite edges of solution layer 112 and anvils 138 and 140 respectively.

In operation, when sheets 100 and 116 are advanced between rollers 118 and 120, solution 112 is ejected from container 110 and is spread between the sheets in a thin layer. Thereafter, blades 126 and 128 penetrate the superposed edges of sheets 100 and 116 so that an electromotive

force is applied across solution layer 112. At the end of a predetermined period, during which a latent image in frame 114 is processed and a transfer print forms in frame 104, solution layer 112, masking sheet 106 and photosensitive sheet 114 are stripped from image-receptive sheet 102 so that the transfer print may be observed.

FIG. 8 illustrates still another photographic process which, with the exception of the manner in which the electromotive force is applied, is generally similar to the process of FIGS. 1, 2 and 3. The photographic materials, illustrated as being subjected to this process, generally of the type described above, comprise a photosensitive sheet 141 including a support layer 142 and a gelatino silver halide layer 144, an image-receptive sheet 146 including a support layer 148 and an image-receptive layer 150, and a viscous aqueous solution 152 of a silver halide developer, a silver halide solvent and an alkali. Here, however, support layers 142 and 148 are composed of a conducting material such as metal foil so that current passage through a layer of solution 152, which has been spread between layers 144 and 150, may be induced by the application of an electromotive force between a pair of brushes 154 and 156 which contact support layers 142 and 148, respectively. By virtue of the proximity, during processing, of support layers 142 and 148, a relatively low voltage only need be applied.

Although the present invention has been described above in relation to silver transfer-reversal processes, it is to be understood that it is applicable to other photographic black-and-white as well as color processes. For example, when it is desired to provide a positive transfer print or image in terms of a dye or dyes, the image-forming components produced during processing in the photosensitive sheet include a color-providing substance. The expression "color-providing substance," as used herein, is intended to include all types of substances or reagents which may be utilized to produce a positive image in terms of a dye.

The color-providing substances may comprise dyes or intermediates for dyes and are not necessarily of the same color as the image dye to be produced, and may be of a different color or a neutral hue. For purposes of illustration, mention may be made of the following types of color-providing substances which may be utilized in employing inventive concepts of this invention:

(1) Color formers or couplers which react with the oxidation product of color couplers to produce a dye; see, for example, U.S. Patents Nos. 2,559,643, 2,661,293, 2,698,244 and 2,698,998.

(2) Self-coupling developers, e.g., a silver halide developing agent capable of coupling with itself, when oxidized, to form a dye; see, for example, U.S. Patent No. 2,698,244.

(3) Dye developers, that is, complete dyes which possess a silver halide developing function; see, for example, the copending application of Howard G. Rogers, Serial No. 748,421, filed July 14, 1958, and now U.S. Patent 2,983,606, which is a continuation-in-part of applications Serial No. 415,073, filed March 9, 1954, and Serial No. 518,979, filed June 29, 1958, and both now abandoned.

(4) Leuco dye developers, that is, dyes utilized in their leuco or reduced form and which possess a silver halide developing function but which must be oxidized after transfer to the image-receptive sheet; see for example, the copending application of Howard G. Rogers, Serial No.

765,925, filed October 8, 1958 and now U.S. Patent 2,909,430, which is a continuation-in-part of application Serial No. 464,175, filed October 22, 1954, and now abandoned.

(5) Coupling dyes, i.e., a complete dye which is capable of coupling with the oxidation product of a color developer, e.g., diethyl para-phenylenediamine, to form an immobile dye; see, for example, U.S. Patent No. 2,774,668.

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 photographic process comprising the steps of spreading, in a thin layer, between a first stratum composed of an exposed silver halide material having therein a latent image and a second image receiving stratum, an electrically conductive processing composition for developing said exposed silver halide material to produce an imagewise distribution of image-forming components, there being a pair of electrically conductive members at separated extremities of at least one of the contiguous faces of the strata in electrical contact with a part of said processing composition, and simultaneously applying a voltage across said pair of electrically conductive members to thereby cause an electric current to flow through said layer between the members of said pair and reacting said processing composition with said silver halide material, and thereafter transferring said image-forming components to said image-receiving stratum to form a visible image therein, said processing composition having a value of electrical resistance so related to the magnitude of said voltage as to cause said layer to become heated by the current flowing therethrough whereby said visible image is produced significantly more rapidly than when the aforesaid process is carried out without the application of said voltage across the members of said pair.

2. The process defined by claim 1 wherein said voltage has a magnitude between 50 and 600 volts and the time for producing said visible image is reduced from a period ranging between 40 to 120 seconds to a period of approximately ten seconds.

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HAROLD N. BURSTEIN, *Examiner*.