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MULTICOLOR FILM AND PROCESS

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Fig. 1.

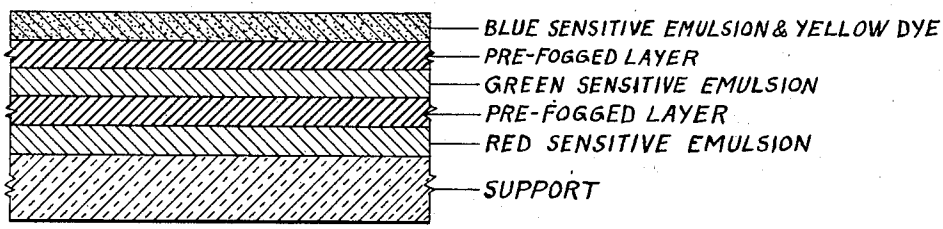
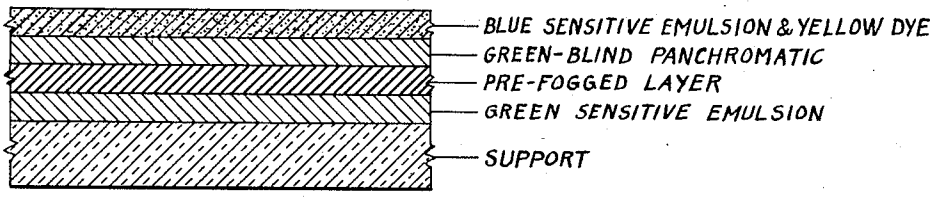


Fig. 2.



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MULTICOLOR FILM AND PROCESS

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6 Claims. (Cl. 95—2)

This invention relates to color photography, and more particularly to an improved film and process for color cinematography. It broadly provides for using the same film, for first the negative and finally the positive images and furthermore provides improved method of processing these images to duplicated color images. Another object of the invention is to provide an improved multilayer film. An additional object is to apply improved methods of processing such multilayer films to complete color films. Further objects will more plainly appear from the detailed description herein presented in illustration and not in limitation thereof.

Of the many methods suggested for preparing colored photographs, and in particular those dealing with multi-layer superposed layers, even the most improved of these requires such a degree of skill and control in the operations of processing to color that the average photographer cannot process his own exposures. Previous suggested methods of color cinematography involving superposed, multilayer films fall, generally, into two classes—those in which the layer are uniformly colored and the purpose of processing is to discharge the color differentially with respect to the silver image formed by development, and secondly, those in which colors are formed differentially in respect to the silver image resulting from development. Both processes are so involved that they have been beyond the skill and control of the average photographer. The former process, known commonly as a "bleach-out" process, depends on bleaching out dye in direct proportion to the density of silver in the image. In actual practice it has been difficult to bleach out the dyes entirely in those areas which should be clear of dye. Variations and impurities in the dyes themselves, variations in dyes of the same name or index number but made by different manufacturers, variations in the purity of the chemicals of the bleach-bath and local variations in the rates of penetration of these baths through the multi-layers, have made this proces incapable of producing colored photographs on a volume basis.

The second process is even more delicate in its processing requirements since it depends on the controlled diffusion of developers, bleach-baths and stop-baths through thin layers of gelatin. Variations in coating weight, hardness of gelatin, swelling characteristics of the gelatin, temperature of baths, etc., make extremely difficult the volume production of colored photographs by this method.

The present invention provides colored photographic pictures by the use of a novel arrangement of superposed multilayer photographic emulsions and a novel and simplified method of processing so that volume production of controlled quality is possible for the amateurs, professionals and cinematographic photographers.

In the accompanying drawing,

Fig. 1 is a section of film having three emulsion layers separated by pre-fogged layers on one side of a transparent support, and

Fig. 2 is a section of a modified film construction having a single pre-fogged layer.

The novel film itself which, when recording the original image, can be classed as a negative film, is composed of a series of photo-sensitive, silver-salt emulsions, individually sensitized to record blue, green and red regions of the spectrum, and prefogged silver-salt layers interposed between the color-sensitive layers. In a preferred form these layers are so arranged that light, after passing through the optical aperture, is first incident on a blue-sensitive emulsion, containing a water-soluble, yellow filter dye, such as Luxol Fast Yellow T, then a pre-fogged emulsion, then a green sensitive emulsion, another pre-fogged emulsion layer containing a soluble red dye (such as carmosine M), a red sensitive emulsion, and finally the base. The amount of silver-salt in these pre-fogged layers, and the fogging exposure given these emulsion layers is such that upon the first development of the layers a light-barrier layer will be formed in these pre-fogged emulsions so that substantially less than 1% of light will be transmitted by either of them. The present invention thereby provides for the control of the printing light penetration by means of the black barrier layers formed from the pre-fogged emulsion layers by the first development step.

In using this film, it is exposed normally in a camera, after which it is given a development in any developer such as is well-known in reversal processes as a "first developer" (Developer 1). After development and washing, the film now consists of three color-separation negative-image layers bearing both silver and unexposed, undeveloped, silver-salt images and two layers of metallic silver in which there may be small amounts of non-color sensitized silver salts. The film is now preferably exposed through the base with a red or white printing light which exposes only the silver-salt image remaining in the red sensitive layer. The red light does not affect the other two layers because of their lack of sensitivity to the red light used as the printing light,

and secondly, the black, metallic silver, barrier-layer prevents substantially all of the printing light from pasing through to the other layers.

The film is now developed in a minus-yellow or blue-green color forming developer; a suitable developer for this purpose is as follows:

Developer 2

Potassium carbonate	grams	40
Sodium sulfite, anhy	do	5
Diethyl-paraphenylenediamine hydrochloride	grams	3
Water to	liter	1

to which is added a solution of

2:3:4-Trichlor-alpha naphthol	grams	2
Ethyl alcohol	c. c.	25

This developer forms both silver and minus-yellow dye images from the exposed silver-halide of only the red-sensitive layer. The film is then thoroughly washed.

The top, or blue-sensitive layer, is now exposed to a blue or white (preferably white) printing light. The printing light does not print-in the middle layer because of the metallic silver barrier layer between the top and middle layers. The entire film is then treated with a minus-blue color-forming developer, a suitable formula for such a developer being:

Developer 3

Potassium carbonate	grams	40
Sodium sulfite, anhy	do	5
Diethyl-paraphenylenediamine hydrochloride	grams	3
Water to	liter	1

to which is added the following solution:

Benzoyl acetone 3 grams dissolved in 25 c. c. ethyl alcohol.

After development, the blue-sensitive layer will contain both metallic silver and yellow dye images.

There now remains the green-sensitive middle layer, on both sides of which are black, metallic-silver barrier layers. This central layer is preferably chemically exposed by bathing the film in a 5% aqueous solution of sodium arsenite or a 5% aqueous solution of hydrogen peroxide. This chemical exposure will make sensitive the silver salts remaining in the middle layer. However, it is also possible to print, expose, or make sensitive the silver salts of the middle layer by means of X-ray exposure of the entire film or by means of mechanical vibrations of a class known as "ultra-sonic" vibrations. In the latter case the entire film, during the latter part of the washing operation following the yellow development, may be subjected to ultra-sonic vibrations, or the film, after washing, may be immersed in water or some non-film solvent and then subjected to ultra-sonic vibrations.

This central layer can also be exposed by means of heat rays, in which case the entire film should be immersed in 5% formaldehyde solution before exposing to the heat rays.

As another means of "chemical exposure", the entire film may be treated with an aqueous solution of approximately 5% of some organic, sulfur-bearing compound such as, for example, guanidine sulfate. The effectiveness of guanidine sulfate as a fogging agent for silver-halides is well known. It has been suggested to incorporate this material in liquid silver-halide emulsions during preparation, in which case it pre-fogged the emulsion so that the resulting film upon development, but without additional exposure, would blacken completely to the solarization or reversal stage. But for our use, it is only necessary to treat the film with an aqueous solution of guanidine sulfate to chemically expose the middle layer.

After the middle layer has been exposed, the entire film is treated with a minus-green or magenta color-forming developer, a suitable formula for which is as follows:

Developer 4

Potassium carbonate	grams	40
Sodium sulfite, anhy	do	5
Diethyl-paraphenylenediamine hydrochloride	grams	3
Water to	liter	1

to which is added the following:

Thio-indoxyl-carboxylic acid	grams	3
Ethyl alcohol	c. c.	25

After this final development, the silver is removed from all the layers by means of such well-known reducers as Farmer's Reducer, used either as a combined bath or separately, by immersing the film in a 5% solution of potassium ferricyanide and then immersing in a 20–40% sodium thiosulfate solution.

The foregoing is a preferred embodiment of the present invention that is subject to various modifications among these is the following:

In a modification of our invention, a green-blind panchromatic layer occupies the central position of the multi-layer films instead of the green sensitive emulsion layer. This green-blind, red-sensitive layer is sensitized by means of sensitizers such as are disclosed by Piggot and Rodd, application Serial No. 540,180, allowed as of Jan. 23, 1936. The multilayer film used in this modification consists of a support coated on one side with a green sensitive emulsion on which is coated a layer of pre-fogged emulsion, on which is coated a green-blind panchromatic emulsion and on which, finally, is coated a blue-sensitive emulsion containing a removable yellow dye. As will be plainly shown by the steps of processing, the green-blind characteristics of the panchromatic layer make it possible to eliminate the layer of pre-fogged emulsion between the blue- and red-sensitive emulsions.

Using a multilayer film as described above, exposure is made in a camera with the emulsion facing the lens.

The steps of processing the exposed film to a colored positives are as follows:

1. Develop in a contrasty developer, for example, any of the well-known "1st" developers of a reversal process.

2. After washing, the film is flashed thru the base with white or green light which exposes the green sensitive layer but not the red or blue layers due to the barrier layer of metallic silver formed by the first development.

3. The film is developed in a magneta color-forming developer, such as "Developer 4" of the preferred procedure.

4. After removing the developer from the film by washing, the emulsion side of the film is flashed to orange-red light which exposes the central layer.

5. The film is now developed in a blue-green color-forming developer such as, for example, "Developer 2" in the preferred form.

6. After freeing the film of developer by washing, the emulsion side is flashed by means of

white light which exposes the blue-sensitive layer.

7. The film is now developed in a yellow color-forming developer, such as is given under "Developer 3" in the preferred form.

8. After washing the silver deposits in the different layers are removed by means of a reducing agent such as Farmer's Reducer or by treatment with cupric bromide, followed by a clearing bath of hypo and the final wash.

Another modification of the present invention is as follows:

A film similar to that used in the preceding modification is employed for the multicolor positive prints. In this modification, three color-separation negatives are required. These may be made either in a camera or from a colored transparency or from a colored reflection print by reflection copying. Positive prints in black and white may be made from these negatives or the negatives themselves may be reversed into positive records Three positive separation records are printed onto the multilayer film previously described, in the preceding modification. The sequence of printing operations is not important but the following serves as illustrative of a preferred procedure:

(*a*) The blue record positive is printed by white or blue light onto the top layer.

(*b*) Red record positive is printed by orange red light, through the top layer onto the central layer.

(*c*) The green record positive is printed by green or white light, through the base onto the bottom layer.

(*d*) The film is developed in an ordinary developer, such as the "first" developer of a reversal process and the film is processed to color by following through the steps two to eight inclusive as described in the preceding modification.

The foregoing preferred embodiments and modifications of the present invention are intended in illustration and not in limitation thereof, and all variations thereof are intended to be included within the spirit and scope of the appended claims.

We claim:

1. A photographic element comprising a transparent base having at least two differentially sensitized emulsion layers superimposed thereon, one of said layers being imposed directly upon the base and a layer of pre-fogged silver salts interposed between said emulsion layers.

2. A photographic element comprising a transparent base having three differentially sensitized emulsion layers seuperimposed thereon, one of said layers being imposed directly upon the base and a prefogged silver salt layer between each of said emulsion layers.

3. A photographic element comprising a transparent base having three emulsion layers sensitized red, green and blue, respectively, superposed thereon, the red layer being imposed directly on said base, a pre-fogged silver salt layer interposed between each of the emulsion layers and a yellow filtering layer positioned in front of said red sensitized layer.

4. A photographic element comprising a transparent base having three emulsion layers sensitized red, green and blue, respectively, superposed thereon, the red layer being imposed directly on said base, a pre-fogged silver salt layer interposed between each of the emulsion layers, said blue sensitized layer containing a yellow screening dye.

5. A photographic element comprising a transparent base, a green sensitized emulsion layer imposed directly on said base, a pre-fogged silver salt layer imposed on said green layer, a green-blind panchromatic emulsion layer coated upon said pre-fogged layer and a blue sensitized emulsion layer imposed upon said panchromatic layer.

6. A photographic element as set forth in claim 5 wherein the blue sensitized layer contains a yellow screening dye.

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