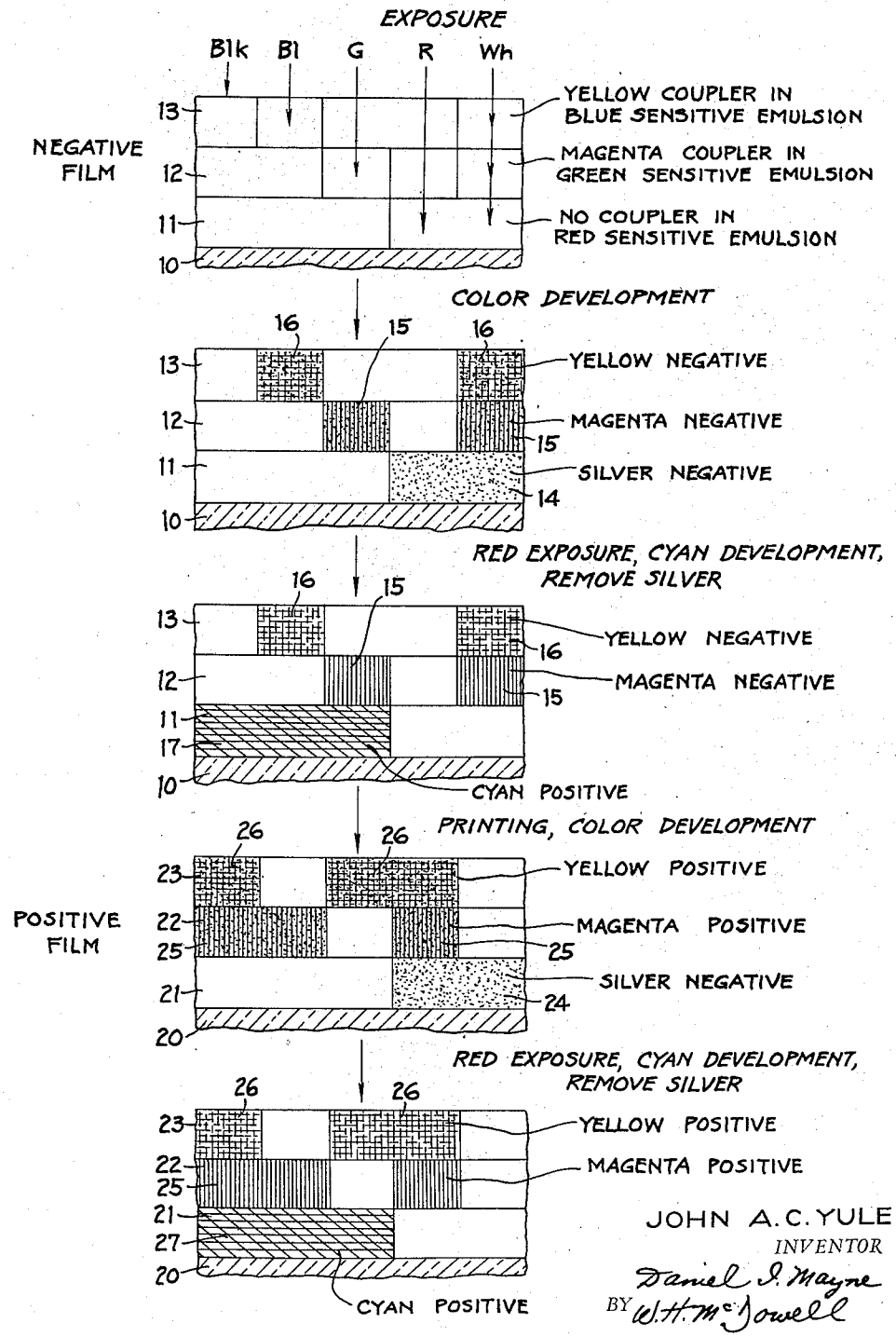
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PHOTOGRAPHIC COLOR CORRECTION PROCESS

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PHOTOGRAPHIC COLOR CORRECTION PROCESS

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This invention relates to a color correction process for photography and more particularly to an automatic masking method for producing color correction.

In subtractive processes of color photography involving two stages such as negative-positive processes, the imperfections of the dyes used in both stages add up to produce serious errors in color rendition which must be corrected by masking methods.

In making a set of color separation negatives from an original subject such as a color transparency, it is known that the green-filter negative, for example, requires a red filter mask in order to correct for the improper green absorption of the cyan dye in the reproduction. In negative-positive processes, one method of producing this result includes forming a silver or colored masking image in one of the emulsion layers or in a separate layer of the negative material. At best, this is a tedious and expensive process and furthermore, the desired degree of correction is not readily obtainable.

According to the present invention, the complications of the previous color correction methods are avoided by providing sensitive materials processed in such a manner that the imperfections of the dye images of the first process correct for the imperfections of the dye images of the second process.

One object of my invention is to provide sensitive photographic materials suitable for making automatically color-corrected reproductions. Another object is to provide methods of processing the sensitive materials such that the dye images of an original film compensate for the deficiencies of the dye images produced in the final printing material. Other objects will appear from the following description of my invention.

In the various stages of the accompanying drawings are shown in greatly enlarged cross-sectional view representations of the appearance of negative and positive color films at different points in my process of color correction.

The objects of my invention are accomplished in part by processing one or more emulsions of a multi-layer color negative material to subtractively colored negative images and reversing the remaining emuslions and forming subtractively colored positive images therein. The negative image or images act as masks for the positive

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image or images and thus compensate for deficiencies of similar dye images in the subsequent reproduction. The positive image or images also behave as masks for the negative image or images. The effect of three masks is thus produced.

Specific embodiments of my invention will now be described with reference to accompanying drawings.

One method of effecting color correction according to the invention includes use of negative and positive color films constructed as shown in the first stage of the drawings according to which a support 10 of a cellulose ester is provided with the red-sensitive emulsion layer 11 free of coupler compound, the green-sensitive emulsion layer 12 containing a magenta coupler and the blue-sensitive emulsion 13 containing a yellow coupler. The couplers are incorporated into the emulsion layers in any well-known manner, as by use of water-insoluble coupler solvents, and a yellow filter layer may be interposed between layers 12 and 13 to limit the blue light exposure to layer 13. As shown in the drawings, exposure of the negative film to the red, green and blue primary aspects of the colored subject affects the emulsion layers in the areas indicated by the arrows. The film is then developed in a color developer of the following composition:

	Grams
p-Amino diethylaniline hydrochloride	2
Sodium sulfite	6
Sodium carbonate	50
Potassium bromide	5
Potassium thiocyanate	1
Water to 950 cc.	

As shown in the second stage of the drawings, the result is to produce silver negative images in areas 14 of layer 11, magenta and silver images in areas 15 of layer 12 and yellow dye and silver images in areas 16 of layer 13. The film is then developed in an MQ developer of the following composition:

	Grams
Monomethyl-p-aminophenylsulfate	6
Hydroquinone	10
Sodium sulfite	50
Sodium carbonate	30
Potassium bromide	5
Potassium thiocyanate	½
Water to 1000 cc.	

After washing, the film is exposed through the base with red light to reverse the red-sensitive layer 11 followed by color development in the following composition:

Solution A

	Grams
p-Amino diethylaniline hydrochloride	2
Sodium sulfite	6
Sodium carbonate	50
Potassium bromide	5
Potassium thiocyanate	1
Water to 950 cc.	

Solution B

	Grams
1,5-dihydroxy-2,6-dibromo naphthalene	1
p-Naphthylaminophenol sulfate	1
6-nitrobenzimidazole	0.1
Sodium hydroxide	2
Water to 50 cc.	

(*Solution B is added to Solution A*)

The film is then cleared of residual silver halide using an acid hypo fixing bath, washed, then bleached in a bath of the following composition.

Potassium ferricyanide	grams	50
Ammonium hydroxide 28%	cc	2½
Water to 1000 cc	grams	5

The result, following fixing and washing, as shown in the third stage of the drawings, is to obtain cyan dye positive images in area 17 of layer 11. Thus there is obtained a cyan positive mask for the negative magenta layer. Instead of adding unwanted green absorption as a negative cyan image would, this cyan image compensates for the green absorption which will be contributed by the positive cyan image in the final color photograph. The magenta negative on account of its red absorption acts as a green filter mask on the cyan image.

The total number of corrections which are obtained in this way may be estimated by considering the three images of the negative in pairs. Images which are reversed with respect to each other will correct each other. In this example, the positive cyan image on the negative magenta image will correct the latter for the effects of the green absorption of the cyan dye. At the same time, the negative magenta image will correct the positive cyan image for the red absorption of the magenta dye. The magenta and yellow images are both negative so they will not correct each other. The cyan image is a positive, and the yellow image is a negative, and therefore, the red absorption of the yellow dye (which is usually negligible) and the blue absorption of the cyan will be corrected.

The element of the third stage of the drawings is then printed by white light onto a sensitive film constructed as previously described and shown in the first stage of the drawings. However, this film may be provided with an opaque rather than transparent support. The exposed film is then developed in the above color developing solution containing no coupler compound with the result shown in the fourth stage of the drawings—the red-sensitive emulsion layer 21 containing the silver negative image 24, the green-sensitive layer 22 containing the magenta dye and silver positive images 25 and the blue-sensitive layer 23 containing the yellow dye and silver positive images 26. Layer 21 is then exposed through the base to red light, developed in the cyan color-forming developer as was layer 11

of the second stage and after bleaching the silver images in the film and fixing, the film appears substantially as shown in the last stage of the drawings now containing cyan, magenta and yellow positive dye images corresponding to the original subject in areas 27, 25 and 26, respectively.

It will be apparent that the masked element of the third stage has modulated the exposing light for the reproduction in a manner such that the quantity of yellow and magenta dye formed in areas 26 and 25 is less than theoretically required with perfect dyes but is satisfactory considering the imperfect absorptions of the dyes available nowadays. Compared to a reproduction made without the masking procedure of the invention, among other pleasing effects, the greens and blues of the reproduction are much brighter and the reds are also somewhat cleaner since the red absorption of the magenta dye is corrected for. Also, all colors are more saturated, or the excessive contrast of color transparencies is eliminated without loss of color saturation.

In a similar manner, any of the other layers, e. g., the magenta (green-sensitive) layer may be reversed in the color negative material and in the reproduction. As before, this layer of the sensitive elements contains no coupler.

It may be desirable with another set of dyes, or in order to produce other corrections, to reverse two layers of the negative film, for example, the cyan and yellow layers. Correction will thus be obtained for the green absorption of the cyan and for the red and blue absorptions of the magenta. In the manner described the layers to be reversed originally contain no coupler compound and after color development of the third layer, the two layers are separately exposed and developed in color developers containing the required coupler compound. The reproduction is made by printing and processing a similar film as described, again reversing the two corresponding layers in the reproduction material.

The process may also be applied to film sensitized in the natural order, the lowermost red-sensitive emulsion containing cyan coupler, the green- and blue-sensitive emulsions being free of coupler compound. After exposure, the film is developed in a coupler-free color developer to form a cyan negative in the red-sensitive layer. The green- and blue-sensitive emulsion layers are then separately re-exposed and developed respectively to magenta and yellow positive dye images. The resultant film as above contains magenta and yellow positive images and a cyan negative image which mutually mask each other. This intermediate film is then printed onto a similar material and the same layers reversed to produce the color-corrected reproduction of the original subject. The process of the invention may also be applied to single layer photographic elements of the so-called mixed grain type containing silver halide grains sensitized to the primary regions of the spectrum and dispersed in a single layer.

My process is also applicable to the color correction of subtractive dye images produced by bleaching out uniformly dyed emulsion layers in the regions of silver images therein by processes, for example, described in Seymour U. S. Patent 2,184,022, granted December 19, 1939 and Ehrenfried U. S. Patent 2,322,001, granted June 15, 1943. A typical sensitive material producing satisfactory results comprises a cellulose ester support carrying in order thereon blue-sensitive

silver bromide emulsion containing a yellow azo or vat dye, a red-sensitive chloride emulsion containing a cyan azo or vat dye and an undyed green-sensitive chloride emulsion layer uppermost. After exposure of the sensitive element to the colored subject the film is developed in a black and white developer, fixed and the dyes in the blue and red-sensitive layers are bleached out in the regions of their silver images using, for example, an alkaline stannous chloride solution. After fixing and washing, the silver image in the top layer is then bleached to silver halide with a cupric chloride solution and after washing, the top layer is exposed to white light and developed by controlled diffusion methods in a color developer containing a magenta coupler. Following the color development step and bleaching silver in the film with cupric chloride solution or potassium ferricyanide solution, the film is fixed and washed. The result is to obtain yellow and cyan positive images in the lower layers which function as masks for the magenta negative image in the top layer and the images mutually mask each other. The intermediate film is then printed onto the same type of sensitive material previously used followed by development in a black and white developer and fixing. As before, the top layer is then bleached to silver halide, developed to magenta dye and after removal of the silver in the various layers, the complete film contains cyan, magenta and yellow in proportions yielding images duplicating the original subject. In a variation of the process, the order of coating the red- and blue-sensitive emulsion layers on the support may be reversed and a blue-sensitive chloride emulsion may be used in place of the bluse-sensitive bromide emulsion.

It is to be understood that the disclosure herein is by way of example and that I consider as included in my invention all modifications and equivalents falling within the scope of the appended claims.

I claim:

1. The method of making a color corrected photograph which comprises exposing to a colored subject an original color film having silver halide emulsions sensitized to the primary regions of the visible spectrum, at least one of said emulsions but no more than two containing a coupler compound capable of reacting with a color developing agent to form dye images of color complementary to the sensitivity of said emulsion, the remaining emulsions being free of coupler, developing the so-exposed portions to silver and subtractively colored negative dye images in said emulsions containing color former and to only negative silver images in the remaining emulsion by means of a color developing composition free of coupler compound, re-exposing the residual silver halide of said remaining emulsion and color developing the so-exposed silver halide therein to a positive dye image of color complementary to the emulsion sensitivity, exposing to the resultant negative and positive dye images a second color film of substantially the same composition as said original color film, developing therein three different subtractively colored dye images of which those corresponding to said negative dye images are negative thereto and positive to the original subject and those corresponding to said first-mentioned positive images are positive thereto and to said original subject.

2. The method of making a color corrected photograph which comprises exposing to an original colored subject a multi-layer color film having three silver halide emulsion layers sensitized to the primary regions of the visible spectrum, at least one of said emulsion layers but no more than two containing a coupler capable of reacting with a color developing agent to form dye images of color complementary to the sensitivity of the layer containing the coupler, and the remaining layer being free of coupler, developing the so-exposed portions to silver and subtractively colored negative dye images in said layers containing couplers and only to negative silver images in the remaining layer by means of a color developing composition free of coupler, re-exposing the residual silver halide of said remaining layer and color developing the so-exposed silver halide therein to a positive dye image of color complementary to the sensitivity of said layer, exposing to the resultant negative and positive dye images a second multi-layer color film composed essentially as said first-mentioned color film, developing therein three different silver and subtractively colored dye images of which those corresponding to said negative dye images are negative thereto and positive to said original subject and those corresponding to said first-mentioned positive images are positive thereto and to said original subject.

3. The method of making a color-corrected photograph which comprises exposing to an original colored subject a multi-layer color film having three superposed silver halide emulsion layers sensitized to the primary regions of the visible spectrum, the blue and green-sensitive emulsion layers containing couplers capable of reacting with a color developing agent to form yellow and magenta dye images respectively, the red-sensitive emulsion layer being free of coupler, developing the so-exposed portions to negative silver and yellow and magenta dye images in said blue- and green-sensitive layers, respectively, and only to a negative silver image in the red-sensitive layer, re-exposing the residual silver halide of the red-sensitive layer and color-developing the so-exposed silver halide therein to a positive silver and cyan dye image, exposing through the resultant dye images a second color film composed essentially as said first-mentioned color film, developing the so-exposed portions in the blue- and green-sensitive layers to yellow and magenta dye images, respectively, which are negative with respect to said negative yellow and magenta dye images and positive to the original subject, and developing in the exposed portions in the red-sensitive layer only a silver image negative with respect to the original subject, re-exposing the residual silver halide of the red-sensitive layer, and color-developing the so-exposed silver halide therein to a cyan dye image which is positive with respect to said positive cyan dye image and positive to said original subject.

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