June 5, 1973 J. L. BAPTISTA ET AL 3,737,312

MULTICOLOR PHOTOGRAPHIC FILM ELEMENTS COMPRISING A MINIMUM SENSITIVITY SOUND TRACK RECORDING SILVER HALIDE EMULSION LAYER AND PROCESSES FOR THEIR USE

Filed March 16, 1972

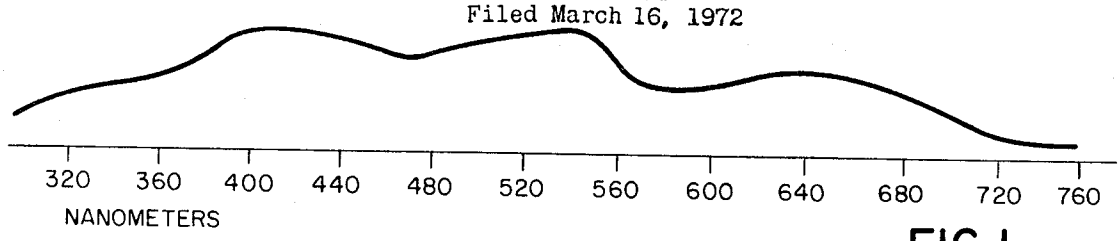


FIG. 1

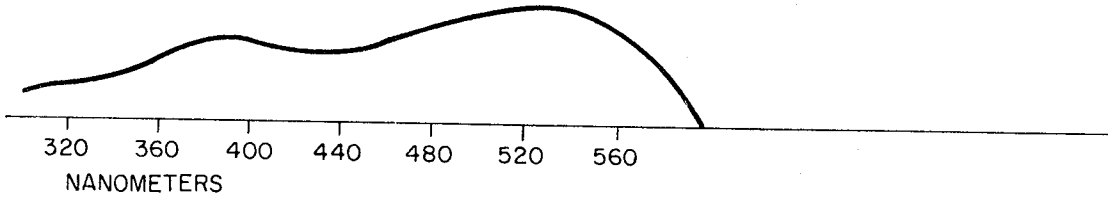


FIG. 2

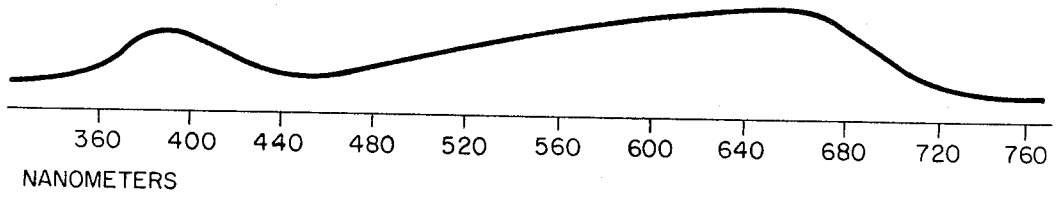


FIG. 3

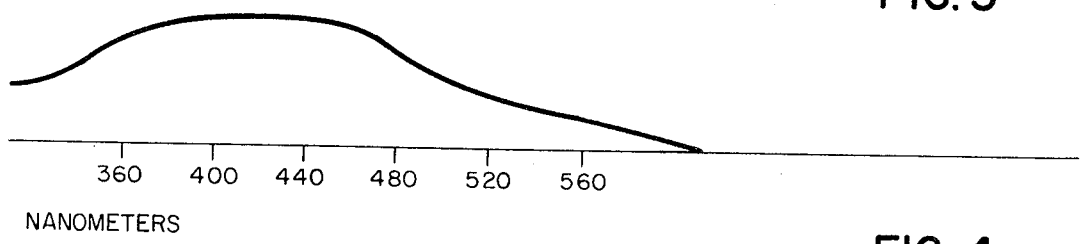


FIG. 4

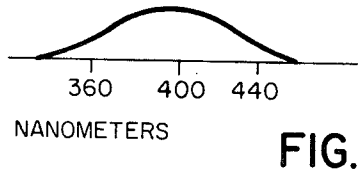


FIG. 5

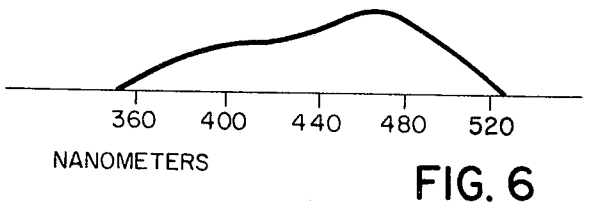


FIG. 6

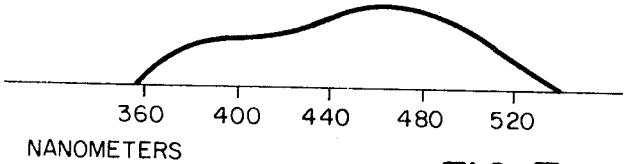


FIG. 7

ALBERT C. SMITH, JR
JOHN L. BAPTISTA
INVENTORS

BY James R. Fuchs

ATTORNEY

United States Patent Office 3,737,312
Patented June 5, 1973

3,737,312

MULTICOLOR PHOTOGRAPHIC FILM ELEMENTS COMPRISING A MINIMUM SENSITIVITY SOUND TRACK RECORDING SILVER HALIDE EMULSION LAYER AND PROCESSES FOR THEIR USE

John L. Baptista and Albert C. Smith, Jr., Rochester, N.Y., assignors to Eastman Kodak Company, Rochester, N.Y.

Continuation-in-part of abandoned application Ser. No. 100,614, Dec. 22, 1970. This application Mar. 16, 1972, Ser. No. 235,379

Int. Cl. G03c *1/16, 7/24, 5/50*

U.S. Cl. 96—4 21 Claims

ABSTRACT OF THE DISCLOSURE

Novel photographic elements are provided having a picture recording area and a sound track recording area comprising a transparent support having coated thereon three picture recording color-forming units which are so disposed and sensitized that each is essentially sensitive to a different primary color region of the visible spectrum, such color-forming units having minimum sensitivity to at least one region of the spectrum bridging adjacently sensitized color-forming units and an auxiliary image or sound track recording silver halide emulsion layer sensitive to such region of minimum sensitivity, said layer not forming an image upon image-forming exposure of the picture recording units, the color-forming units of adjacent spectral sensitivity having a photographic speed of at least 2 times the photographic speed of the auxiliary layer when selectively exposed in the region of minimum sensitivity. Subsequent to imagewise exposure of the picture and sound track recording areas, the element is processed by the novel method of processing which comprises (A) forming a picture record comprising silver and a nondiffusible dye in the picture recording area and an auxiliary image record or sound track record comprising silver in the sound track area and contacting the silver of the auxiliary layer with a ballasted silver bleach inhibitor and (B) removing the bleachable silver images remaining after step (A) and the residual or undeveloped silver halide.

This application is a continuation-in-part of our copending U.S. patent application Ser. No. 100,614, filed Dec. 22, 1970.

This invention relates to photographic film having an auxiliary metallic silver image. One aspect of this invention relates to color motion picture films having metallic silver sound tracks and photographic elements and processes useful in preparing such films.

It has been proposed to prepare multicolor motion picture films with a silver sound track by the use of a photographic element having a plurality of picture recording photographic color-forming units, each unit comprising at least one silver halide emulsion layer, and at least one auxiliary image recording or sound track recording silver halide emulsion layer. The auxiliary layer is used to record only the auxiliary image or sound track record. It is not used to record the picture record. This auxiliary layer can be used in several ways to retain the silver image of the sound track record or auxiliary image record in at least this layer. A first method comprises coating the auxiliary layer as the light-sensitive layer outermost from the support and above all the picture recording units. The picture record is recorded in the picture recording units. The auxiliary image or sound track record is recorded in at least the auxiliary layer. Subsequent to intitial development, the auxiliary layer is comprised of developed silver where exposed to the

auxiliary or sound track image and is comprised of silver halide in all other areas. Subsequent to this initial development, the element is contacted with a processing composition which contains a ballasted silver bleach inhibitor. This bleach inhibitor diffuses through the hydrophilic colloid auxiliary layer in proportion to the developed silver present. As a result, the silver of only the auxiliary image or sound track record is contacted with a ballasted silver bleach inhibitor. That silver which is contacted with a bleach inhibitor is rendered unbleachable and is not removed from the element during the subsequent bleaching and fixing or bleach-fixing steps of conventional color processing. The processed element is thus comprised of a multicolor dye picture image and a silver auxiliary or sound track image. Photographic elements and processes for preparing color motion picture films with auxiliary silver image records or silver sound track records are the invention of Bello and Holtz and are disclosed and claimed in a copending application entitled Film and Process Using Bleach Inhibitor for Producing Color Film With Silver Sound Record, Ser. No. 100,609, filed Dec. 22, 1970, and the continuation-in-part thereof filed Dec. 17, 1971.

Another method of preparing a color motion picture film with a silver auxiliary or sound track record makes use of a photographic element having a plurality of picture recording photographic color-forming units and an auxiliary image or sound track recording silver halide emulsion layer. In this photographic element, the auxiliary layer contains a bleach-inhibitor-releasing coupler which is capable of reacting with oxidized aromatic primary amine color developing agent to release a ballasted silver bleach inhibitor. This element is imagewise exposed as in the above method. The so-exposed element is color processed. During color development with aromatic primary amine color developing agent, the oxidized color developing agent resulting from the development of the latent image in the auxiliary layer reacts with the bleach-inhibitor-releasing coupler in this layer to release the ballasted silver bleach inhibitor. This bleach inhibitor then becomes adsorbed to at least the developed silver in the auxiliary layer to render this silver unbleachable. Following the remaining conventional color processing steps, the processed element is comprised of a multicolor dye picture record and a silver auxiliary or sound track record. These photographic elements and processes for preparing multicolor motion picture films with auxiliary silver images or silver sound records are the invention of Holtz and are disclosed and claimed in a copending application entitled Film Containing a Bleach-Inhibitor-Releasing Compound and Process for Preparing Auxiliary Silver Image or Silver Sound Record Therewith, Ser. No. 100,610, filed Dec. 22, 1970, and the continuation-in-part thereof filed Dec. 17, 1971.

Still another method of preparing a multicolor motion picture film with a silver auxiliary or sound track record involves the use of a photographic element having a plurality of picture recording photographic color-forming units and an auxiliary image or sound track recording layer. The auxiliary layer of the element of this method contains an incorporated ballasted silver bleach inhibitor. The element is imagewise exposed as in the preceding two methods and reversal color developed. During the black and white development step, the latent image in the auxiliary layer is developed to metallic silver and the bleach inhibitor incorporated in that layer becomes adsorbed to the developed silver. The undeveloped silver halide is chemically fogged and color developed. The ballasted silver bleach inhibitors are closely related to the fragments released from known development-inhibitor-releasing couplers. Many of these bleach inhibi-

tors exhibit development inhibition properties similar to the development inhibitor fragment. As a result, the chemically fogged silver halide remaining in the auxiliary layer subsequent to the black and white development is not developed during the color development step. Thus, the only silver present in the auxiliary layer is that silver which was developed during the black and white development step. This silver has adsorbed to it the ballasted silver bleach inhibitor and, consequently, is rendered unbleachable. Following color development the photographic element is carried through the remainder of the conventional reversal color processing steps and yields a multicolor motion picture film having a picture record comprised of multicolor dye images and an auxiliary image or sound track record comprised of silver. Photographic elements and processes for producing a motion picture film with a silver sound record by this method are the invention of Lestina, Kent and Holtz and are claimed in a copending application entitled, Film Containing Bleach Inhibitor and Process Therefor for Producing Color Film With Silver Sound Record, Ser. No. 100,613, filed Dec. 22, 1970, and the continuation-in-part thereof filed Dec. 17, 1971.

Conventional multicolor photographic elements contain a plurality (generally three) color-forming units, each unit comprising at least one (generally one or two) silver halide emulsion layer. In multicolor photographic elements containing three color-forming units, the units are so disposed and sensitized that each unit is primarily sensitive to a different primary color region of the visible spectrum. In the photographic elements described for the above three methods for preparing motion picture films with a silver auxiliary or sound track record, the auxiliary layer either must be, or conveniently is, located as the light-sensitive silver halide layer outermost from the support. In all of the above methods, for silver not to be retained in the picture record layers, the auxiliary layer must not form an image upon image-forming exposure of the picture recording units. This can be accomplished by sensitizing the auxiliary layer to some region of the electromagnetic spectrum to which the picture recording units are not sensitive, such as infrared radiation. However, the use of infrared sensitization is not desirable because of the lack of a good infrared source with which to expose infrared sensitized photographic elements in a motion picture printer. It has also been found that infrared sensitized emulsions are not always stable with resepct to their sensitometric properties during the storage period between manufacture and exposure. It is, therefore, desirable that the auxiliary layer not be sensitized to infrared radiation.

An alternative to exposing the auxiliary layer with infrared radiation is use of the ultraviolet region of the electromagnetic spectrum. However, this approach to exposing the auxiliary layer also has difficulties since, in general, silver halide emulsions have a natural sensitivity to ultraviolet radiation. This means that when the auxiliary layer is exposed with ultraviolet radiation, exposure of the picture recording unit also occurs. This difficulty can be overcome, however, by coating the auxiliary layer as the light-sensitive layer either closest to or outermost from the support and using an ultraviolet absorber in an interlayer between the auxiliary layer and the picture recording layers. Sound track exposure is then by ultraviolet radiation through the support or from the emulsion side, respectively. Generally, silver halide emulsions also have some native sensitivity to blue radiation. To prevent blue exposure of the auxiliary layer in the picture record area during picture record exposure, the auxiliary layer must have a photographic speed slower than that of the blue-sensitive layer. Since the auxiliary layer is slower than the blue-sensitive layer, upon exposure of the auxiliary layer with ultraviolet radiation the blue-sensitive layer is also exposed and because of its greater photographic speed is generally grossly over-exposed. This over-exposure manifests itself in the form of loss of definition of the sound track image in the sound track area and halation into the picture area. Halation in the picture area generally occurs in the form of a dye being formed where none should be formed or, in the case of reversal films, the lack of formation of a dye where dye should be formed. For example, in a yellow dye-forming blue-sensitive picture recording unit the halation can be so severe that a significant part of the picture record area contains an overall yellow dye density. For a yellow dye-forming blue-sensitive picture recording unit in a reversal film, a significant part of the picture record area can have an overall minus yellow cast which results in a blue coloration. The same problem, of course, exists for the green- and red-sensitive picture recording units. If sound track exposure is reduced to eliminate this halation problem, insufficient exposure of the auxiliary layer is obtained and an insufficient amount of silver developed in this layer. When this occurs, sufficient bleach inhibitor cannot diffuse into the auxiliary layer in the Bello and Holtz method or is not released from the bleach-inhibitor-releasing coupler during development in the Holtz method and, therefore, an inadequate amount of silver is retained during the bleaching and fixing or bleach-fixing steps. In the Lestina, Kent and Holtz method if insufficient silver is formed in the auxiliary layer there cannot be enough silver to which the bleach inhibitor can become adsorbed to retain an acceptable sound track during the bleaching and fixing or bleach-fixing steps.

Another problem in exposing multilayer motion picture print films having an auxiliary layer is that, in general, exposure is made from the emulsion side of the film for maximum sharpness of the printed image. Since the auxiliary layer generally is the outermost light-sensitive silver halide layer in these elements, exposure of the picture recording units must be made through the auxiliary silver halide emulsion layer. Due to the presence of silver halide grains in this auxiliary layer, a certain amount of sharpness of the picture record image is lost because of light scattering. The more silver halide the auxiilary layer contains, the greater is its turbidity and the greater the loss of sharpness of the picture record.

A silver sound track in a motion picture film must have a certain minimum density to yield a satisfactory signal-to-noise ratio for the useful life of the film. If all the silver for the sound track is to be obtained from the auxiliary layer in motion picture films of the type described above, the quantity of silver halide which must be contained in this auxiliary layer can be sufficient to cause a detectable loss of sharpness of the picture record.

It would be possible in the Bello and Holtz method and the Holtz method to reduce the silver halide content and thereby the turbidity of the auxiliary layer if part of the silver for the sound track could be obtained from one of the picture recording units, preferaably the picture recording unit adjacent to the auxiliary layer. However, if the auxiliary layer is sensitized to some region of the electromagnetic spectrum to which the picture recording units are not sensitive, such as infrared radiation, additive or double exposure with more than one kind of radiation must be accomplished to expose the picture recording units as well as in the auxiliary layer. This exposure can be done, for example, with a combination of infrared light and some other radiation such as ultraviolet radiation or blue light or green light. However, additive or double exposure of the sound track is inconvenient. It is preferable to expose the sound track with one kind of radiation or light such as ultraviolet radiation or blue light. The over-exposure and under-exposure problems still exist when sound track exposure is made by this method because of the photographic speed or spectral sensitivity relationships or both of the auxiliary layer to the picture recording layers.

It, therefore, appears desirable to provide photographic elements for the production of multicolor motion picture

films having silver auxiliary images or sound track records, which elements have a plurality of picture recording photographic color-forming units and an auxiliary image or sound track recording layer in which the auxiliary layer contains a reduced amount of silver halide or which avoids these exposure problems or both.

Accordingly, it is an object of our invention to provide novel photographic elements for the preparation of films having silver sound records or auxiliary silver images.

It is another object of our invention to provide novel methods for preparing films having silver sound records or auxiliary silver images.

Other objects will become apparent from the following specification and the appended claims.

Our novel process of preparing a multicolor motion picture record on film having a silver sound track or silver auxiliary image utilizes a multilayer photographic color film having a picture recording area and a sound track recording area comprising a transparent support having coated thereon: (1) three picture recording photographic color-forming units, each unit comprising at least one silver halide emulsion layer, which units are so disposed and sensitized that each is essentially sensitive to a different primary color region of the visible spectrum and records essentially blue, green or red light, such color-forming units having minimum sensitivity to at least one region of the spectrum bridging adjacently sensitized color-forming units and (2) an auxiliary image or sound recording silver halide emulsion layer sensitive to such region of minimum sensitivity, the auxiliary or sound recording layer not forming an image upon image-forming exposure of said picture recording units, the color-forming units of adjacent spectral sensitivity having a photographic speed of at least 2 and generally 2 to 15 times the photographic speed of the auxiliary layer when selectively exposed in the region of minimum sensitivity. On imagewise exposure of the picture and sound track recording areas, such a film is processed in accordance with the invention by: (A) forming a picture record comprising silver and a nondiffusible dye in the picture recording area and an auxiliary amage record or sound track record comprising silver in the sound track area and contacting the silver of the auxiliary layer with a ballasted silver bleach inhibitor and (B) removing the bleachable silver images remaining after step (A) and the residual or undeveloped silver halide.

In a *First Embodiment,* our novel process comprises processing a photographic element as described above wherein the auxiliary layer is coated as the outermost light sensitive layer and contains a substantially colorless nondiffusible compound which reacts with oxidized aromatic primary amine color developing agent and preferably decreases the rate of diffusion of a ballasted silver bleach inhibitor through the auxiliary layer and wherein one of the two picture recording color-forming units having adjacent spectral sensitivity is coated adjacent to the auxiliary layer which processing comprises: (A) initially developing silver halide in the element to form a picture record in the picture recording area comprising silver and an auxiliary image or sound track record in the sound track area comprising silver, (B) contacting the auxiliary layer with a ballasted silver bleach inhibitor to adsorb the bleach inhibitor onto at least the silver of the auxiliary layer, (C) reversal color developing, if necessary, to form a picture record comprising silver and a nondiffusible dye and (D) removing the bleachable silver images remaining after steps (A) through (C) and the residual or undeveloped silver halide.

In a *Second Embodiment,* our novel process comprises processing a photographic element as described above wherein the auxiliary layer contains a bleach-inhibitor-releasing coupler which processing comprises: (A) developing silver halide in the element with an aromatic primary amine color developing agent to form a picture record in the picture recording area comprising silver and a nondiffusible dye and an auxiliary or sound track image comprising silver, oxidized aromatic primary amine color developing agent reacting with the bleach-inhibitor-releasing coupler to release imagewise ballasted silver bleach inhibitor which becomes adsorbed to at least the silver of the auxiliary layer and (B) removing the bleachable silver images remaining after step (A) and the residual or undeveloped silver halide.

In a *Third Embodiment,* our novel process comprises processing a photographic element as described above wherein the auxiliary layer contains a nondiffusible ballasted silver bleach inhibitor, which processing comprises: (A) black and white developing the element to form a picture record comprising silver and a sound record comprising silver, fogging and color developing silver halide in said element to form a picture record comprising silver and a nondiffusible dye and (B) removing the bleachable silver images remaining after step (A) and the residual or undeveloped silver halide.

The elements used in the first and second embodiments can be used either in the negative-positive system of photography or the reversal system of photography. The element of the third embodiment is particularly adapted for use in the reversal photographic system.

The picture recording layers processed in accordance with the invention are used to form subtractive dye images of the picture to be recorded. Preferably, the color-forming units form colors complementary in color to which they are sensitive. For example, the blue-sensitive layer can form a yellow dye image, the red-sensitive layer can form a cyan dye image and the green-sensitive layer can form a magenta dye image. Alternatively, these layers can be falsely sensitized, i.e., they can form colors not complementary to the color to which they are sensitive. If so desired, the layers can be used to form a dye or mixture of dyes which appear to have a neutral density.

In order to form subtractive dyes, the photographic elements are processed in the presence of photographic color-formers. Preferably, the color-formers are incorporated into the color-forming units but can be introduced into the system with the color developer. Photographic color-formers are well known and are also referred to as photographic couplers or color couplers. These couplers react with oxidized aromatic primary amine color developing agent to form the dye. In the well known three color system of subtractive color photography, 5-pyrazolone couplers are generally used to form magenta dyes, phenolic couplers, including naphtholic couplers, are generally used to form cyan dyes, and open-chain ketomethylene couplers are generally used to form yellow dyes.

When processing photographic elements that do not contain incorporated couplers, the exposed element is processed in the presence of a coupler-developer composition which contaains both a diffusible photographic developing agent such as the aromatic primary amines and a diffusible photographic coupler. The oxidized photographic developing agent couples with the diffusible color coupler to produce a nondiffusible dye at the site of silver halide development. Suitable typical color couplers which can be used in the coupler-developer compositions are disclosed in U.S. Pats. 2,252,718; 2,592,243 and 2,950,970.

If the element contains incorporated couplers, the exposed element is then processed in the presence of an aromatic primary amine color developing agent, such as the well known p-phenylenediamines. The oxidized color developing agent resulting from the reduction of the latent silver halide image couples with the incorporated coupler to form a non-diffusible image dye. Examples of non-diffusing photographic couplers which can be incorporated into the picture recording silver halide emulsion layers of our novel photographic element are the 5-pyrazolone couplers disclosed in U.S. Pats. 2,343,702; 2,369,489; 2,436,-130; 2,600,788; 3,006,759; 3,062,653; 3,311,476 and 3,419,391 and Belgian Pats. 698,354, the phenolic couplers disclosed in U.S. Pats. 2,367,531; 2,423,730; 2,474.-

293; 3,311,476; 3,419,390; 3,458,315 and 3,476,563 and the open-chain ketomethylene couplers disclosed in U.S. Pats. 2,206,142; 2,436,130; 3,728,658 and 3,408,149. The layers can also contain other couplers such as development-inhibitor-releasing couplers such as are disclosed in U.S. Pat. 3,227,554 and competing couplers such as disclosed in U.S. Pats. 2,808,329; 2,689,793 and 2,742,832.

The auxiliary layers or sound track recording layers of the photographic elements of the invention contain light-sensitive silver halide. This layer is used only to record the sound track or auxiliary image. The silver image which is retained in the photographic element during the bleaching and fixing or bleach-fixing processing steps is that silver which was developed in the auxiliary layer. In addition, sound track image or auxiliary image silver can be retained in at least one picture recording unit in the first and second embodiments.

The picture records are to be multicolor dye records and not black and white silver records. Latent images of the picture record must not form in the auxiliary layer. If this should occur silver would be developed in the picture record area of the auxiliary layer, would have bleach inhibitor adsorbed to it and would be retained in the element during the subsequent bleaching and fixing or bleach-fixing procedures. It is for this reason that latent images of the picture record must not form in the auxiliary layer. However, the auxiliary layer and at least one picture recording unit are exposed to the sound track record image or the auxiliary image. The problems of so-exposing a photographic element of this type were pointed out above.

Known multicolor photographic elements having an auxiliary layer have, for the most part, been designed for use in preparing films having either a silver or colored dye color correction masking image. The auxiliary layer or, in this case, masking layer of these known films has been designed such that any one of the picture recording layers or units or the auxiliary layer can be exposed independently of any of the other layers. Consequently, it has not been possible to use known multicolor photographic elements having an auxiliary or masking layer to prepare multicolor films having a silver auxiliary image or silver sound track according to the method of Bello and Holtz or the method of Holtz referred to above by exposing the auxiliary layer and at least one of the picture recording units with a single band of light rather than by additive exposure or double exposure without over- or under-exposure problems.

We have now discovered that in a multicolor photographic element having a plurality of picture recording photographic color-forming units and an auxiliary image or sound recording layer, picture image exposure can be made without image-forming exposure in the auxiliary layer and auxiliary image or sound track record exposure can be made in the auxiliary layer and at least one of the picture recording units without under-exposure of the auxiliary layer or over-exposure of the color-forming unit or units if the auxiliary layer is sensitive to at least the region of minimum sensitivity intermediate between the peak sensitivities of two of the color-forming units having adjacent spectral sensitivity and the color-forming units of adjacent spectral sensitivity have a photographic speed of at least 2 times the photographic speed of the auxiliary layer.

These regions of minimum sensitivity intermediate between the peak sensitivities of two of the color-forming units occur because of the nature of sensitizing dyes used to spectrally sensitize photographic silver halide emulsions. These dyes do not have a sharp cut-off in the sensitization they impart to silver halide. For example, the sensitization effect imparted by a particular dye will begin more or less gradually at some wavelength, reach a more or less defined peak and lose effectiveness again more or less gradually. In a color photographic element having more than one layer, each layer being sensitized substantially to a different primary color region of the visisble spectrum (i.e., blue about 400–500 nm., green about 500–600 nm. and red about 600–700 nm.), the sensitization of the different layers can overlap to some extent. The sensitization of a first layer can still be gradually tapering off at the wavelength where the sensitization of a second layer begins. At some point in this region of overlapping of sensitivity, the sensitization effect in the two layers will be very nearly equally at a minimum. The auxiliary layer can be so sensitized that it is at least sensitive to this region of minimum sensitivity. When the sound track record or auxiliary image record is printed, exposure is made with a narrow band of light having its maximum intensity in this region of minimum sensitivity between two of the color-forming units.

In a multilayer film having three color-forming units, each sensitive to a different primary color region of the visible spectrum, one such region of minimum sensitivity occurs between the blue and green regions of the visible spectrum. Depending upon the sensitizing dyes used in the blue- and green-sensitive color-forming units, the point of minimum sensitivity typically falls between about 460 and 500 nm. In the same type of film, another such region occurs between the green and red regions of the visible spectrum. Again, depending upon the particular sensitizing dyes used in the green- and red-sensitive color-forming units, the point of minimum sensitivity typically falls between about 550 and 590 nm.

In addition to the auxiliary layer being sensitive to at least these regions of minimum sensitivity, it must also have a photographic speed of at least 2 times less than the photographic speed of the two color-forming units of adjacent spectral sensitivity. This is necessary since the sensitizing dyes used to sensitize the auxiliary layer to these regions of minimum sensitivity likewise do not have sharp cut-offs in the sensitization they impart to the silver halide. Such dyes, therefore, impart sensitization to the auxiliary layer which overlaps with and extends into the sensitization of the color-forming units of adjacent spectral sensitivity. Therefore, to avoid exposure of the auxiliary layer during picture record exposure of the picture recording color-forming units, the auxiliary layer must have a photographic speed less than that of the picture recording color-forming units of adjacent spectral sensitivity.

The photographic speed of a silver halide layer to any particular wavelength of light is partly dependent upon the spectral sensitivity of the silver halide to that wavelength of light. If a silver halide emulsion is not sensitive to a particular wavelength of light, its photographic speed to that wavelength of light is zero or at least much less than the photographic speed of a silver halide emulsion which is spectrally sensitized to that wavelength of light. The auxiliary layer of the photographic elements of this invention is preferably sensitized with a sensitizing dye which imparts peak sensitization at about the region of minimum sensitivity intermediate between the sensitivities of the two color-forming units of adjacent spectral sensitivity. Since the peak occurs in this region of minimum sensitivity, the spectral sensitization and therefore the photographic speed of the auxiliary layer to wavelengths of light on either side of this peak is gradually diminishing. Conversely, the spectral sensitization and therefore the photographic speed of the color-forming units of adjacent spectral sensitivity to these same wavelengths of light is gradually increasing toward their respective peaks of sensitization. It can thus be seen that the spectral sensitivity and the photographic speed of the auxiliary layer is very nearly at its maximum in this region of minimum sensitivity of the color-forming units of adjacent spectral sensitivity while the spectral sensitivity and photographic speed of these color-forming units is decreasing. Therefore, in this region of minimum sensitivity, the photographic speed of the two color-forming units and the

photographic speed of the auxiliary layer are as nearly the same as possible.

As used herein and in the appended claims, the term "photographic speed" of a silver halide emulsion layer or color-forming units means the photographic speed of that unit or layer at the wavelength or wavelengths of light to which it is exposed and not the maximum photographic speed of the unit or layer which can, but does not necessarily, occur at some other wavelength of light.

We have discovered that if the photographic speed of the auxiliary layer of a photographic element of the type herein described which is sensitized as described above to the region of minimum sensitivity intermediate between the peak sensitivities of two of the color-forming units of adjacent spectral sensitivity is at least 2 times less than the photographic speed of the color-forming units of adjacent spectral sensitivity, picture record exposure can be made without exposing the auxiliary layer. On the other hand, an auxiliary image or silver sound track record exposure can be made which does not under-expose the auxiliary layer or over-expose the picture record layers. The speed of the picture recording color-forming units of a photogaphic element having more than one such unit can not all be equal and it will, therefore, be appreciated that the speed relationship of the auxiliary layer to these layers will be different for each layer. The picture recording unit can have a photographic speed as little as 2 times and as great as 15 times greater than the photographic speed of the auxiliary layer. With respect to exposure of these layers in the region of minimum sensitivity discussed above of the elements of the first and second embodiments to minimize the loss of sharpness and definition of the sound track image due to over-exposure, the picture recording unit adjacent to the auxiliary layer should have a photographic speed of from 2 to 5 times and preferably about 2½ to 3 times the photographic speed of the auxiliary layer in the region of minimum sensitivity. The reason for this is that part of the silver of this adjacent layer is to be retained as the sound track or auxiliary image silver which therefore allows the auxiliary layer to have a reduced silver halide content. The other picture recording color-forming unit of adjacent spectral sensitivity is not necessarily coated adjacent to the auxiliary layer (and cannot be so positioned in the first embodiment where the auxiliary layer must be coated as the outermost light-sensitive layer of the photographic element). If this other layer is not positioned adjacent to the auxiliary layer, the silver developed in this layer generally will not be contacted with a bleach inhibitor and will not be retained through the bleaching and fixing or bleach-fixing steps. This is true for all picture recording units of the third embodiment. Therefore, the only exposure requirements for this unit is that it not be so over-exposed as to create a halation problem resulting in unwanted dye formation in either the sound track or picture record area. Since the silver will not be retained, a slight loss of definition of the image due to moderate over-exposure does not become particularly significant since the image dyes are generally nearly transparent to the infrared radiation to which the typical photocell in optical motion picture projectors is most sensitive. Therefore, the photographic speed of the second color-forming unit of adjacent spectral sensitivity but non-adjacent physical positioning to the auxiliary layer can have a photographic speed of from about 2 to about 15 times the photographic speed of the auxiliary layer and particularly useful results are obtained when the photographic speed of the second unit is not greater than 12 times the photographic speed of the auxiliary layer. If the second picture recording photographic color-forming unit of adjacent spectral sensitivity is also positioned physically adjacent to the auxiliary layer as, for example, is possible in the bleach-inhibitor-releasing method of Holtz, the bleach inhibitor released during development with aromatic primary amine color developing agent can diffuse into both of these adjacent picture recording color-forming units and become adsorbed to developed silver in these units, which silver will then be retained through the bleach-fixing or bleaching and fixing steps. In this case, over-exposure of the sound track image preferably is avoided in both these color-forming units. For best results, it is therefore desirable that the photographic speed of the second color-forming unit also be in the range of from 2 to 5 times the photographic speed of the auxiliary layer.

The auxiliary layer can be comprised simply of a silver halide emulsion, a silver halide emulsion containing a bleach-inhibitor-releasing coupler or a silver halide emulsion containing a nondiffusible ballasted silver bleach inhibitor. The silver halide content can vary widely such as from 10 milligrams per square foot or less to 100 milligrams per square foot or more silver as silver halide. As stated previously, the quantity of silver halide present in the auxiliary layer will have an effect upon the turbidity of the element and the sharpness of the image printed in the element. For best results, it is therefore preferred that the auxiliary layer contain from about 10 milligrams per square foot to about 80 milligrams per square foot silver as silver halide and preferably from about 15 milligrams per square foot to about 60 milligrams per square foot. Particularly useful results are obtained when the auxiliary layer contains from about 20 to about 40 milligrams per square foot silver as silver halide.

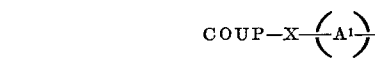
The grain size of the silver halide of the auxiliary layer can vary widely. For example, the average grain size can range from about 0.05 micron or less to about 0.5 micron or greater. Preferably, the grain size is as small as possible without requiring such high intensity exposure in the sound record area that the underlying picture recording units in the sound area are over-exposed causing loss of definition of the sound record. An average grain size of from about 0.05 micron to about 0.2 micron is preferred.

The silver halide emulsions used in the auxiliary layer can be negative developing out emulsions or they can be fogged direct-positive emulsions. They can comprise silver chloride, silver bromide, silver chlorobromide, silver bromoiodide, silver chlorobromoiodide or mixtues thereof.

The auxiliary layer of the photographic element not containing a bleach-inhibitor-releasing coupler or a nondiffusible ballasted silver bleach inhibitor can contain other addenda. For example, if the element is not to be processed in the presence of a coupler-developer composition, the picture recording color-forming unit or units contain incorporated couplers and the auxiliary layer can contain one or more compounds which react with oxidized aromatic primary amine color developing agent. These compounds can be referred to as oxidized color developer scavengers. Their presence in the auxiliary layer is highly desirable as they serve to prevent the wandering of oxidized color developing agent from the points of silver halide development in the sound track area of the auxiliary layer into the picture area of the picture recording layers. If this wandering should occur, the oxidized color developing agent can couple with the incorporated coupler present in the picture area to yield dyes where none should have formed. The quantity of such a scavenger compound which is added to the auxiliary layer should be an amount at least sufficient to consume that quantity of oxidized color developing agent which would be produced if all the silver halide in the auxiliary layer were developed to silver. The determination of the amount necessary can readily be made by one skilled in the art. Examples of such scavenger compounds include octylhydroquinone, dioctylhydroquinone, p-aminophenols, hydrozines, ascorbic acid derivatives and other compounds such as are disclosed in U.S. Pats. 2,403,721; 2,675,314; 2,356,486; 2,360,290; 2,701,197; 2,704,713; 2,728,659; 2,732,300 and

2,735,765 as well as photographic color couplers. Certain nondiffusible color couplers which when incorporated into the auxiliary layer of the element of the first embodiment increase the effectiveness of the auxiliary layer in preventing the diffusion of the bleach inhibitor into the underlying picture recording color-forming units in the picture area while allowing the bleach inhibitor to diffuse into the silver contained in the auxiliary layer and picture recording units in the sound track area. Couplers suitable for incorporation in the auxiliary layer of this novel photographic element include those shown above as suitable for incorporation in the picture recording units of the element.

Suitable bleach-inhibitor-releasing couplers useful in the auxiliary layer include those shown in the Holtz application referred to above. Particularly useful bleach-inhibitor-releasing couplers have the formula:



wherein:

COUP is a photographic color coupler radical substituted in its coupling position with the group



X represents sulfur or selenium;

the group



represents an organic radical that forms a ballasted silver bleach inhibitor with the X radical when said coupler is reacted with oxidized aromatic primary amine color developing agent;

a represents 0, 1, 2, 3, 4,5 or 6;

R^1 represents nitro, halo, an alkyl group, an aryl group, a thio group containing from 3 to 22 carbon atoms, an amido group containing from 4 to 22 carbon atoms, a carbonyl group, a carbamoyl group, an alkoxy group or an aryloxy group;

A^1 represents a carbonyl group, a thiocarbonyl group, a carboxymethylene group, a 3 to 6 membered carbocyclic ring or a 3 to 6 membered heterocyclic ring containing at least one carbon atom and at least one heteroatom selected from the group consisting of nitrogen, oxygen, sulfur and selenium such that R^1 does not represent a carbonyl group, a carbamoyl group or an amido group when A^1 represents a carbonyl group or a thiocarbonyl group and such that the grouping



represents a moiety having a molecular weight of from 100 to 1,000 and such that when A^1 represents a carbocyclic ring or a heterocyclic ring said carbocyclic or hetrocyclic ring is substituted with a hydrophobic moiety.

Preferably, a scavenger for oxidized developing agent, such as hydroquinone (e.g., dioctylhydroquinone) or a photographic coupler, is incorporated in the auxiliary layer. As used herein, the word "scavenger" refers to any compound which reacts with oxidized developing agent to prevent the wandering of such oxidized agent away from a site of development, and does not release bleach inhibitor. If the oxidized color developing agent should wander away from the site of development, it can react with a color coupler at some other location, for example, in one of the picture recording units in the film to produce a dye. The production of this dye at a location away from the site of color development would cause false coloration of the developed image. It can thus be seen that it is desirable that the auxiliary layer contain at least that quantity of oxidized developing agent scavenger and BIR compound which would be required to react with all the oxidized color developing agent that would result from a development of all silver halide in the auxiliary layer. This amount can readily be determined by one skilled in the art.

In general, the quantity of bleach-inhibitor-releasing (BIR) compound necessary to react with all the oxidized color developing agent which would be produced upon complete development of the silver halide in the auxiliary layer would be made than the quantity necessary to release sufficient bleach inhibitor to fully protect the developed silver from the bleach. Certain of the bleach inhibitors, if present in a quantity in excess of that amount necessary to fully protect the developed silver from bleaching, can cause adverse effects, such as inteference with fixing, development inhibition, undesired reaction with oxidized color developing agent or diffusion to developed silver which should not be protected by bleach inhibitor. Therefore, it is desirable that the auxiliary layer contain approximately that quantity of BIR compound which will release sufficient bleach inhibitor moiety to substantially fully protect all the developed silver of the sound track record. This quantity of BIR compound represents a quantity less than that needed to react with all the oxidized color developing agent resulting from development of all the silver halide in the auxiliary layer. For these reasons, it is therefore desirable to incorporate an oxidized developing agent scavenger, such as a non-BIR competing coupler, into the auxiliary layer in addition to the BIR compound. The combined amount of the scavenger and BIR compound should be present in at least the quantity necessary to react with all the oxidized color developing agent that will be produced by developing all the silver halide in the auxiliary layer. Typically, the ratio of the scavenger (e.g., non-BIR coupler) to the BIR compound will be one to several times the quantity of BIR compound incorporated. For example, the quantity of scavenger in the auxiliary layer often is four to ten times the quantity of BIR compound in this layer. As a further example, generally about 100% of the developed silver can be retained if approximately 0.01 to 0.03 millimole of ballasted silver bleach inhibitor is released during development of an auxiliary layer comprising about 70 milligrams per square foot silver as silver halide of about 0.1 micron average grain size. The quantity of ballasted silver bleach inhibitor which must be released to retain about 100% of the developed silver which has been developed from silver halide of other grain sizes can readily be determined by one skilled in the art.

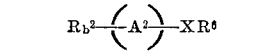
When the BIR compound is a coupler, the oxidized developing agent scavenger and the competing coupler can be, but need not be, the same type of coupler as the BIR coupler. For example, if the BIR coupler is a 5-pyrazolone coupler, the competing coupler can also be a 5-pyrazolone or another type of coupler, such as a phenolic or open-chain ketomethylene coupler. It can thus be seen that the dyes produced from the reaction of the BIR and competing couplers need not be of similar hue. This is because the silver of the auxiliary layer is not bleached out and consequently absorbs all colors of light to yield a neutral rendition of the auxiliary image or sound track. These dyes can be diffusible if they are washed out of the element without substantially staining any part of either the sound track or picture record areas. Otherwise, the dyes so formed from the BIR coupler and the competing coupler should be non-diffusible.

When an oxidized developing agent scavenger is used, its rate of reactivity is preferably about the same as the rate of reactivity of the BIR compound with the oxidized color developing agent. This "matching" of reactivity with oxidized color developing agent is to insure the release of the proper amount of bleach inhibitor. If the scavenger is less reactive than the BIR compound, most of the BIR compound will react with the oxidized color developing agent before the scavenger reacts. In this event, most of the bleach inhibitor will be released early in the development step when there is very little developed silver to which the bleach inhibitor can become adsorbed. If the

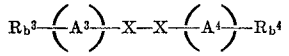
scavenger is more reactive than the BIR coupler, nearly all of the silver halide will have to be developed before the BIR compound will react with oxidized color developing agent to release a bleach inhibitor. Therefore, unless there is nearly complete exposure and development of the silver halide in the auxiliary layer the developed silver will not be protected by bleached inhibitor and will be removed during subsequent bleaching and fixing operations. Thus, it can be seen that it is desirable to have a mixture of BIR compound and scavenger (e.g., non-BIR coupler) in the auxiliary layer and that the BIR compound and the scavenger should react at a generally similar rate with oxidized color developing agent. Preferably, the scavenger is a competing coupler which forms a nondiffusible cyan dye which absorbs at least some radiation longer than about 700 nm., thereby contributing to the infrared density provided by the auxiliary silver image.

Suitable nondiffusible ballasted silver bleach inhibitors useful in the auxiliary layer include those shown in the Lestina, Kent and Holtz application referred to above. Particularly useful bleach inhibitors of this type include those having the formula:

(I)



(II)



and

(III)



wherein:

b represents 0, 1, 2, 3, 4, 5 or 6;

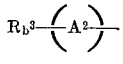
X represents a member selected from the group consisting of sulfur and selenium;

R^2, R^3, R^4 and R^5 each represents a member selected from the group consisting of nitro- halo, an alkyl group, an aryl group, a thio group containing from 3 to 22 carbon atoms, an amido group containing from 4 to 22 carbon atoms, a carbonyl group, a carbamoyl group, an alkoxy group and an aryloxy group;

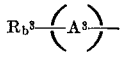
R^6 represents a member selected from the group consisting of hydrogen and an acyl group;

$Y^{\oplus}$ represents a basic cation;

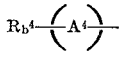
A^2, A^3, A^4 and A^5 each represents a member selected from the group consisting of a carbonyl group, a thiocarbonyl group, a carboxymethylene group, a 3 to 6 membered carbocyclic ring and a 3 to 6 membered heterocyclic ring containing at least one carbon atom and at least one heteroatom selected from the group consisting of nitrogen, oxygen, sulfur and selenium such that R^2, R^3, R^4 and R^5 do not represent a carbonyl group, a carbamoyl group or an amido group when A^2, A^3, A^4 and A^5 represent a carbonyl group of a thiocarbonyl group and such that the grouping



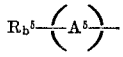
the grouping



the grouping



and the grouping



each represents a moiety having a molecular weight of from 100 to 1,000 and such that when A^2, A^3, A^4 and A^5 represent a carbocyclic or a heterocyclic ring, said ring has attached to it at least one hydrophobic moiety which renders said bleach inhibitor substantially nondiffusible in a hydrophilic colloid.

The addition of the scavenger compounds, competing couplers, color couplers, BIR couplers and incorporated non-diffusible ballasted silver bleach inhibitors in the silver halide emulsion layers used in the photographic films of the invention can be accomplished by a variety of known techniques. One of these techniques involves the use of certain organic solvents. These coupler solvents can be either of the low boiling or water-soluble type which are removed from the emulsion by evaporation or washing following dispersion of the coupler and solvent in the emulsion or they can be of the high boiling, organic, crystalloidal type which remain incorporated in the emulsion. A description of the low boiling coupler solvents and the methods by which they can be used to disperse photographic couplers is found in Vittum et al., U.S. Pat. 2,801,170, particularly at column 2, lines 3 to 32. Also refer to U.S. Pat. 2,861,170, Fierke et al., U.S. Pat. 2,801, 171, particularly at column 10, lines 33 to 51. High boiling crystalloidal coupler solvents are those which are substantially water-insoluble having a low molecular weight and a high boiling point (above 175° C. at atmospheric pressure). Examples of this type of coupler solvent include those shown in Fierke, U.S. Pat. 2,801,171 at column 10, lines 22 to 32; Julian, U.S. Pat. 2,949,360 at column 2, lines 3 to 18 and Jelley et al., U.S. Pat. 2,322,027 at page 2, column 2, line 45 through page 3, column 2, line 6.

The selection of other addenda such as sensitizing dyes and the method of their incorporation in the silver halide emulsions of the picture recording color-forming units and the auxiliary layer can be made by one skilled in the art who wishes to tailor the emulsions for particular purposes and needs. Examples of sensitizing dyes useful for sensitizing the auxiliary layer to a typical region of minimum sensitivity intermediate between the peak sensitivities of the blue- and green-sensitive picture recording color-forming units are 3-ethyl-5-(1-ethyl-4-(1H)pyridylidene) rhodanine, 3-ethyl-5-(3-ethyl - 2 - benzothiazolinylidene) rhodanine and anhydro-3,3'-bis-(2 - carboxyethyl)thiazolinocarbocyanine hydroxide. The first two dyes are disclosed in Brooker et al., J. Am. Chem. Soc., 73, 5326 (1951). A sensitizing dye useful for sensitizing the auxiliary layer to a typical region of minimum sensitivity intermediate between the peak sensitivities of the green- and red-sensitive picture recording color-forming units is anhydro-3',9-diethyl - 5 - methoxy - 5 - phenyl - 3 - (3-sulfobutyl)oxaselenacarbocyanine hydroxide.

Gelatin or any other conventional photographic hydrophilic colloid can be used as a vehicle for silver halide in the auxiliary layer and in the silver halide emulsion layers of the picture recording units.

The photographic elements described herein are exposed in accordance with the invention to a multicolor picture record and a sound track record. The picture record exposure can be accomplished in a camera. Generally, however, picture record exposure is from a multicolor film such as an internegative or positive transparency and is done on a motion picture printer such as those commercially available. Sound track exposure is generally from a sound track record contained in a film. Picture record exposure of our novel photographic elements is accomplished in a conventional manner using the appropriate light sources, filters and intensities to obtain a proper color balance. Sound track exposure can also be accomplished in the conventional manner. It, however, is necessary to filter the printing light for the sound track exposure to obtain a narrow band of light having its maximum intensity at about the region of minimum sensitivity intermediate between the peak sensitivities of two of the color-forming units having adjacent spectral sensitivity to which region the auxiliary layer is sensitive. The intensity of this exposure is, of course, adjusted to obtain proper exposure of the sound track record in the auxiliary layer and the two color-forming units having adjacent spectral sensitivity.

The so-exposed element is then processed according to the procedure set forth above. The processing procedures

vary according to whether the exposed element is to be reversal color developed or is to be directly color developed. The first step of the processing is initial development of the photographic element. If it is to be reversal developed, initial development will be with a black and white developer, the reaction products of which do not cause formation of a dye image. If the photographic element is to be directly color developed, the initial color development is with a color developing agent, such as the aromatic primary amines and typically p-phenylenediamines, the reaction products of which react with couplers to form dye images. If the auxiliary layer of the photographic element does not contain a BIR coupler or a ballasted nondiffusible silver bleach inhibitor, the photographic element is, subsequent to initial development, contacted with a ballasted silver bleach inhibitor to adsorb the bleach inhibitor onto at least the silver of the auxiliary layer. For reversal processing, the photographic element is then reversal color developed with a color developing agent such as the aromatic primary amines after fogging undeveloped silver halide.

If the auxiliary layer contains a photographic coupler, the auxiliary layer must not be fogged and color developed. Such elements are those containing the BIR coupler or those which contain a substantially colorless nondiffusible compound which reacts with oxidized aromatic primary amine color developing agent and which decreases the rate of diffusion of a ballasted silver bleach inhibitor through the auxiliary layer (embodiments one and two). In one case, a dye would be formed in the auxiliary layer which would give false coloration to the picture record. In the BIR element, bleach inhibitor would be released which would cause retention of silver in the auxiliary layer. Reversal fogging can be accomplished with light rather than with a chemical fogging agent.

The element which contains the nondiffusible ballasted silver bleach inhibitor (the third embodiment) in the auxiliary layer, however, is conveniently chemically fogged for reversal development. Although not understood, it is known that reversal development of the auxiliary layer having incorporated therein a nondiffusible ballasted silver bleach inhibitor does not take place if the element is chemically fogged with such fogging agents as amine boranes as disclosed in U.S. Pat. 3,246,987. Reversal development, however, does take place if the auxiliary layer is light fogged.

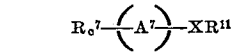
The elements are then bleached and fixed or bleach-fixed.

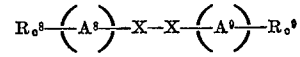
The photographic elements of the invention are developed with photographic alkaline developing solution. The developing solutions for the black and white development step of reversal processing can contain such conventional developing agents as hydroquinone and methyl-paraminophenol. The developing solutions for color development typically contain aromatic primary amine color developing agents. These developing agents are well known in the art and generally are p-phenylenediamines. Suitable color developing agents include

3-acetamido-4-amino-N,N-di-ethylaniline,
p-amino-N-ethyl-N-β-hydroxyethylaniline sulfate,
p-amino-ethyl-β-hydroxyaniline,
N,N-diethyl-p-phenylenediamine,
2-amino-5-diethylaminotoluene,
N-ethyl-β-methanesulfonamidoethyl-3-methyl-4-amino-aniline,
4-amino-N-ethyl-3-methyl-N-(β-disulfoethyl)-aniline

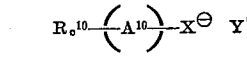
and the like. Additional typical suitable color developing agents include those shown in Bent et al., 73 JACS 3100–3125 (1951) and U.S. Pats. 2,193,015; 2,449,919; 2,522,240; 2,592,363; 2,592,364; 2,196,739; 2,301,381 and 2,304,953.

Subsequent to initial development, the element (first embodiment) which contains neither a BIR coupler or a nondiffusible ballasted silver bleach inhibitor is contacted with a ballasted silver bleach inhibitor composition. Suitable ballasted silver bleach inhibitors include those shown in the Bello and Holtz application referred to above, the disclosure of which is incorporated herein by reference. Particularly suitable ballasted silver bleach inhibitors have the formula:

(I) 

(II) 

and

(III) 

wherein:

c represents 0, 1, 2, 3, 4, 5 or 6;

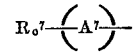
X represents a member selected from the group consisting of sulfur and selenium;

R^7, R^8, R^9 and R^{10} each represents a member selected from the group consisting of nitro, halo, an alkyl group, an aryl group, a thio group containing from 3 to 22 carbon atoms, an amido group containing from 4 to 22 carbon atoms, a carbonyl group, a carbamoyl group, an alkoxy group and an aryloxy group;

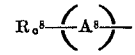
R^{11} represents a member selected from the group consisting of hydrogen and an acyl group;

$Y^{\oplus}$ represents a basic cation;

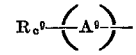
A^7, A^8, A^9 and A^{10} each represents a member selected from the group consisting of a carbonyl group, a thiocarbonyl group, a carboxymethylene group, a 3 to 6 membered carbocyclic ring and a 3 to 6 membered heterocyclic ring containing at least one carbon atom and at least one heteroatom slected from the group consisting of nitrogen, oxygen, sulfur and selenium such that R^7, R^8, R^9 and R^{10} do not represent a carbonyl group, a carbamoyl group or an amido group when A^7, A^8, A^9 and A^{10} represent a carbonyl group or a thiocarbonyl group and such that the grouping



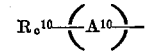
the grouping



the grouping



and the grouping



each represents a moiety having a molecular weight of from 100 to 1,000 and such that when A^7, A^8, A^9 and A^{10} represent a carbocyclic or a heterocyclic ring, said ring has attached to it at least one hydrophobic moiety.

The bleachable silver images and the residual or undeveloped silver halide are removed from the photographic element by bleaching and fixing or bleach-fixing. Bleach compositions contain, for example, alkali metal dichromates or ferricyanides as the oxidizing agents. Bleach-fix compositions contain both an oxidizing agent such as an iron salt of ethylenediamine tetraacetic acid (EDTA) and a silver halide solvent. Fixing solutions contain silver halide solvents such as ammonium and alkali metal, e.g., potassium and sodium, sulfite, thiosulfate and thiocyanate. For removal of the bleachable silver images and the residual or undeveloped silver halide, the bleach-fix compositions containing salts of ethylenediamine tetraacetic acid have been found to be particularly useful.

The processing of these elements can be carried out using available processing equipment such as the presently used continuous processing apparatus widely available. Processing temperatures can vary widely. Suitable proc-

essing temperatures include those which are now used for processing other conventional types of film. These temperatures typically range from about 20° C. or less to about 60° C. or higher. Temperatures of about 25° C., 40° C. and 50° C. are typical in high speed processing procedures.

The terms "picture record area" and "sound record area" as used herein refer to areas of motion picture film as these areas can be seen in a plane view. Visualizing a strip of motion picture film and beginning with, for example, the left edge and proceeding to the right edge, the following areas are observed. Closest to the left edge are sprocket perforations used to transport the film via the means of sprockets through the apparatus associated with motion picture preparation and viewing. Adjacent to the sprocket perforations are the individual frames containing the picture record. These frames extend across a major part of the width of the film and the area between the side lines of the picture frames extending along the length of the film is referred to as the picture record area. To the right of and adjacent to the picture record area is the sound track or sound record area. This area is a narrow area extending along the length of the film. To the right of and adjacent to the sound record area is either the edge of the film or a second set of sprocket perforations which is adjacent to the right edge of the film.

A better understanding of our invention can be had by reference to the drawings. FIG. 1 illustrates the composite spectral sensitivity of a conventional color photographic film having three color-forming units, which units are so disposed and sensitized that each unit is primarily sensitive to a different primary region of the visible spectrum. FIG. 2 illustrates the spectral sensitivity of the green-sensitive magenta forming unit of this conventional multilayer film. FIG. 3 illustrates the spectral sensitivity of the red-sensitive cyan forming unit of this conventional multilayer film. FIG. 4 illustrates the spectral sensitivity of the blue-sensitive yellow forming unit of this conventional multilayer film. FIG. 5 represents the native sensitivity of a gelatino silver chlorobromide (20 mol percent bromide) emulsion of the type which can be used in the auxiliary layer of the elements of our invention. FIGS. 6 and 7 illustrate the spectral sensitivity of the silver chlorobromide emulsion of FIG. 5 when spectrally sensitized. In FIG. 6, maximum sensitivity occurs at about 470 nm. In FIG. 7, maximum sensitivity occurs at about 480 nm. It can be seen that the region of minimum sensitivity intermediate between the peak sensitivities of two of the color-forming units of adjacent spectral sensitivity of the conventional film of FIG. 1 occurs at about 480 nm. and about 590 nm. It can also be seen that the auxiliary layer, if sensitized as in FIGS. 6 and 7, would have a maximum sensitivity occuring at about the region of minimum sensitivity intermediate between the peak sensitivities of the blue-sensitive and green-sensitive layers of this conventional multilayer film. In FIGS. 1 through 7, proceeding from the horizontal axis, the vertical axis represents decreasing exposure. The vertical scale is the same in all figures.

The following examples are included for a further understanding of the invention.

EXAMPLE 1

A multilayer color photographic element having picture recording and sound recording areas and having three picture recording color-forming units each sensitive to a different primary color region of the visible spectrum and an auxiliary sound recording layer of the composition indicated below and containing a sensitizing dye which sensitizes the auxiliary layer to at least the blue-green region of the visible spectrum and having the structure described below is given, through a step tablet, a simulated picture exposure with white light and a sound track exposure, through Wratten filters, which trasmit light as indicated in Table I and is processed according to the procedure set forth below. In the following element structure description, the approximate coverages of all components are expressed parenthetically as milligrams per square foot.

Elemet structure: A transparent cellulose acetate film support is coated, on one surface in order from the support, with (1) a blue-sensitive picture recording photographic color-forming unit comprised of gelatin (340), silver (60) as silver bromoiodide (one mole percent iodide), a nondiffusible open-chain ketomethylene yellow forming photographic coupler (130) and dibutyl phthalate as coupler solvent (130), (2) an interlayer comprised of gelatin (60) and 2,5-dioctyl hydroquinone (7.5), (3) a red-sensitive picture recording photographic color-forming unit comprised of gelatin (280), silver (40) as silver chlorobromide (20 mole percent bromide), a non-diffusible phenolic cyan forming photographic coupler (75) and dibutyl phthalate as coupler solvent (225), (4) an interlayer comprised of gelatin (60) and 2,5-dioctyl hydroquinone (7.5), (5) a green-sensitive picture recording photographic color-forming unit comprised of gelatin (220), silver (80) as silver chlorobromide (20 mole percent bromide), a non-diffusible 5-pyrazolone magenta forming photographic coupler (135) and tricresyl phosphate (65) as coupler solvent, (6) an interlayer comprised of gelatin (60) and 2,5-dioctyl hydroquinone (7.5), (7) an auxiliary sound recording layer comprised of gelatin (113), silver (20) as silver chlorobromide (20 mole percent bromide) of about 0.1 micron average grain size, magenta dye-forming coupler 1-(6-chloro-2,4-dimethylphenyl)-3 - [α - (m - pentadecylphenoxy) - butyramido]-5-pyrazolone (36), tritolyl phosphate (18) as coupler solvent, sensitizing dye 3-ethyl-5-(3-ethyl-2-benzothiazolinylidene)-rhodanine (150 mg./mole of silver) (imparts maximum sensitization at about 480 nm.) and (8) an overcoat comprised of gelatin (90).

Processing procedure

(1) Prebath	15 sec.
(2) Wash	15 sec.
(3) Color develop	8 min., 45 sec.
(4) Rinse	15 sec.
(5) Stop	2 min.
(6) Wash	1 min.
(7) Bleach inhibitor bath	1 min., 15 sec.
(8) Wash	1 min.
(9) Bleach-fix	2 min.
(10) Wash	6 min.
(11) Stabilizer	15 sec.
Process temperature	24° C.

The chemical composition of the processing baths is as follows:

(1) Prebath

Borax ($Na_2B_4O_7 \cdot 10H_2O$)	g.	20
Sodium sulfate, desiccated	g.	100
Sodium hydroxide, 10% solution	ml.	10

Water to make 1 liter.

(3) Color developer

Sodium hexametaphosphate	g.	2
Sodium sulfite, desiccated	g.	4
2-amino - 5 - diethylaminotoluenemonohydrochloride		3
Sodium carbonate, monohydrate	g.	20
Potassium bromide	g.	2

Water to make 1 liter.

(5) Stop bath

Acetic acid, glacial	ml.	24.5
Sodium bisulfite	g.	6.4

Water to make 1 liter.

(7) Bleach inhibitor bath

5-mercapto-1-m-nonanamido-phenyltetrazole ___g__	0.4
Trisodium phosphate, Na_3PO_4—$12H_2O$ _____g__	19.0
Water to make 1 liter.	
pH adjusted to 12.1.	

(9) Bleach-fix

Hydrochloric acid, conc. _____ml__	9.2
Sodium sulfite _____g__	12
Ammonium iron EDTA (1.56 molar solution) _____ml__	92
Ammonium thiosulfate (60% solution) _____ml__	200
Water to make 1 liter.	

(11) Stabilizer

Formaldehyde (37% solution) _____ml__	20
Octylphenoxy polyethoxy ethanol (Triton X–100) _____ml__	0.6
Water to make 1 liter.	

In order to compare the photographic speed of the auxiliary layer to the speed of the blue- and green-sensitive layers, the auxiliary layer is coated as a single layer on the support, exposed and processed as above. The speed differentials between the green-sensitive and auxiliary layers are measured at 0.14 density above fog. The additional density between the green- and blue-sensitive layers is determined at 0.94 above fog. The speed ratio between the auxiliary and green- and blue-sensitive layers for the various exposures is shown in Table I.

TABLE I

Exposure number	Wratten filter(s)	$\lambda_{max.}$ (nm.)	Bandwidth at half height (nm.)	Speed ratios: Green sensitive to auxiliary	Speed ratios: Blue sensitive to auxiliary
1	98	430	50	2.0	40
2	98 plus 2E	436	36	1.6	23
3	98 plus 3	460	26	2.9	17
4	98 plus 4	468	18	3.2	6.7
5	98 plus 8	476	10	4.3	6.0

The above results demonstrate that the photographic speed of the auxiliary layer is sufficiently low in the blue- and green-primary regions of the visible spectrum to prevent exposure of the auxiliary layer during picture record exposure. The data also shows the speeds of the blue- and green-sensitive layers with respect to the speed of the auxiliary layer are sufficiently low to allow proper exposure of all three layers with a single exposure under the conditions of exposures No. 4 and 5. Some halation was detected in the form of unwanted yellow dye under exposure conditions No. 3 and became progressively worse with Nos. 2 and 1. When the multilayer element is exposed to a multicolor picture record and a sound track record under exposure conditions No. 4 and 5 and processed as above, a dye picture record substantially free of silver and an excellent silver sound record are obtained.

EXAMPLE 2

Multilayer color photographic elements similar to the element of Example 1 except as distinguished below are given through a step tablet, picture exposures with white light and sound track exposures through filter packs which transmits at the maximum shown in Table II and processed in a manner similar to Example 1 except for the bleach-fix composition which is as shown below.

Element No. 1: A multilayer color photographic element of similar element structure to that of Example 1 except that the auxiliary layer (7) comprises gelatin (113), silver (25) as silver chlorobromide (20 mole percent bromide) of about 0.1 micron average grain size, magenta dye-forming coupler 1-(6-chloro-2,4-dimethylphenyl) - 3 - [α-(m-pentadecylphenoxy)-butyramido]-5-pyrazolone (46), tricresyl phosphate (23) as coupler solvent and sensitizing dye 3-ethyl-5-(3-ethyl-2-benzothiazolinylidene)-rhodanine (150 mg./mole of silver) (imparts maximum sensitization at about 480 nm.).

Element No. 2: A multilayer color photographic element similar to Element No. 1 of this example except containing the sensitizing dye 3-ethyl-5-(1-ethyl-4(1H)-pyridylidene)-rhodanine (100 mg./mole of silver) (imparts maximum sensitization at about 470 nm.) in place of the sensitizing dye shown for the auxiliary layer of Element No. 1.

The composition of the bleach-fix bath is as follows:

(9) Bleach-fix

Hydrochloric acid, conc. _____ml__	9.2
Sodium sulfite _____g__	12
Ammonium iron EDTA (1.11 molar solution) _____ml__	92
Ammonium thiosulfate (60% solution) _____ml__	200
Water to make 1 liter.	
pH adjusted to 6.5.	

The speed relationships between the auxiliary layer and the blue-sensitive and green-sensitive layers are determined as in Example 1. Cross-modulation tests are made to determine the optimum density to give minimum distortion in the sound track print. Tests of this type are described in Baker, J. O. and Robinson, D. H., J. Soc. Motion Picture Engineers, 30, 1–17 (1938), Kellogg, E. W., J. Soc. Motion Picture Engineers, 44, 151–193 (1945) and Mees, C. E. K., The theory of the Photographic Process, 1st edition, N.Y., MacMillan Co., (1942), chapter 22, pages 949 ff. The density must be high enough that the sound can be clearly reproduced above random background noise and that the sound track will retain quality without attrition through scratches and other damage during use. In practice, it has been found that a silver density to infrared light in the range of 1.0 to 1.4 can be considered optimum.

TABLE II

Element number	Sound track exposure (max.)	Speed ratio: Green sensitive to auxiliary	Speed ratio: Blue sensitive to auxiliary	Cross modulation density
----------	470	3.7	9.8	41.20
----------	481	3.5	8.9	1.01

The cross modulation densities of these elements are within the range which gives acceptable sound volume and film durability. The speed ratios of the various layers are within the range determined in Example 1. The above elements when given multicolor picture record exposure and sound track exposure and processed as above and projected with an optical sound projector are subjectively evaluated by observers as yielding an excellent picture record and sound record.

EXAMPLE 3

A multilayer color photographic element similar to the element of Example 1 except that the auxiliary sound recording layer (7) comprised of gelatin (140), silver (50) and silver chlorobromide (20 mole percent bromide) of about 0.1 micron average grain size, BIR coupler 1-hydroxy-4-[1-(3-undecanamidophenyl) - tetrazol-5-ylthio]-N-(2 - n - tetradecyloxyphenyl)-2-naphthamide

(15), competing coupler 1-hydroxy-N-(2-n-tetradecyloxyphenyl)-2-naphthamide (75), tricresyl phosphate (45) as coupler solvent and sensitizing dye 3-ethyl-5-(3-ethyl-2-benzothiazolinylidene)-rhodanine (150 mg./mole of silver) (imparts maximum sensitization at about 480 nm.) is given through a step tablet, picture exposure with white light and sound track exposure with a narrow band of light having maximum intensity at 470 nm. and is processed as shown below:

	Sec.
(1) Prebath	10
(2) Wash	10
(3) Color develop	90
(4) Wash	10
(5) Stop-fix	60
(6) Wash	30
(7) Bleach-fix	60
(8) Wash	120
(9) Stabilize	10

Process temperature, 38° C.

Processing baths 1, 3, 7 and 9 are the same as baths 1, 3, 9 and 11, respectively, of Example 1. The composition of the stop-fix bath is as follows:

(5) Stop-fix bath

Sodium thiosulfate ---g--	240
Sodium sulfite, desiccated ---g--	15
Acetic acid, 28% ---ml--	28
Boric acid, crystals ---g--	7.5
Potassium alum ---g--	15

Water to make 1 liter.

The cross modulation density of the processed element is within the range which gives acceptable sound volume and film durability. The above element when given multicolor picture record exposure and sound track exposure, processed as above and projected with an optical sound projector is subjectively evaluated by observers as yielding an excellent picture record and sound record.

EXAMPLE 4

A conventional incorporated coupler reversal print film, ofr example, Eastman Ektachrome Reversal Print Film, having picture recording and sound recording areas and having coated on a transparent cellulose acetate film support, in order from the support, a gelatino silver halide color-forming unit primarily sensitive to the red region of the visible spectrum and containing a phenolic cyan-forming photographic coupler, a gelatino-silver halide color-forming unit primarily sensitive to the green region of the visible spectrum and containing a 5-pyrazolone magenta forming photographic coupler, a yellow dye filter layer and a gelatino silver halide color-forming unit primarily sensitive to the blue region of the visible spectrum and containing an open-chain ketomethylene yellow forming photographic color coupler is overcoated with an auxiliary gelatino silver chlorobromide (20 mole percent bromide) (0.1 micron average grain size) emulsion layer sensitized to the blue-green region of the visible spectrum with 3-ethyl-5-(1-ethyl - 4(1H)-pyridylidene)-rhodanine which imparts maximum sensitization at about 470 nm. and having a photographic speed at this peak sensitivity of at least 2 times slower than the photographic speed of the slower of the blue- and green-sensitive layers when these layers are selectively exposed with blue-green light having its maximum intensity at about 470 to 480 nm. The auxiliary layer contains 1-(3-nonanamidophenyl)-5-mercaptotetrazole as a nondiffusible ballasted silver bleach inhibitor. The element is given a white light flash exposure in the sound track area of sufficient intensity to fully expose the red-, green- and blue-sensitive color-forming units but of insufficient intensity to expose the auxiliary layer. Subsequently, the element is given a white light exposure to a multicolor picture record in the picture record area and a blue-green exposure in the sound track area to a sound track record with a narrow band of light having a maximum intensity at about 480 nm. with a bandwidth at half height of about 20 nm. and is processed as shown below:

	Sec.
(1) Prebath	40
(2) Neutralizer	30
(3) Black and white developer	60
(4) Stop bath	30
(5) Wash	60
(6) Color developer	180
(7) Stop bath	30
(8) Wash	60
(9) Bleach-fix	180
(10) Wash	60
(11) Stabilizer	30

Process temperature: 52° C.

The chemical composition of the above processing baths is shown below:

(1) Prehardener

Water ---ml--	800
p-Toluenesulfinic acid, Na salt ---g--	.5
Sulfuric acid (18 N) ---ml--	5.41
Dimethoxytetrahydrofuran ---ml--	4.3
Sodium sulfate ---g--	154
Sodium bromide ---g--	2
Sodium acetate ---g--	20
Formaldehyde (37.5%) ---ml--	27
N-methylbenzothiazolium-p-toluene sulfonate (antifoggant) (1.0%) ---ml--	3

Water to 1 liter.

(2) Neutralizer

Water ---ml--	800
Hydroxylamine sulfate ---g--	22
Sodium bromide (anhydrous) ---g--	17
Sodium sulfate (anhydrous) ---g--	50
Glacial acetic acid ---ml--	10
Sodium hydroxide ---g--	5.7

Water to 1 liter.

(3) Black and white developer

Water ---ml--	800
Sodium sulfite (anhydrous) ---g--	44
Sodium tetraborate (borax) ---g--	12
Hydroquinone ---g--	8
Phenidone ---g--	.55
Sodium bromide ---g--	1.3
Sodium hydroxide ---g--	.75

Water to 1 liter.

(4) Stop bath

Water ---ml--	800
Glacial acetic acid ---ml--	30
Sodium hydroxide ---g--	5.35

Water to 1 liter.

(6) Color developer

Water ---ml--	800
Benzyl alcohol ---ml--	5.25
Potassium bromide ---g--	1.68
Potassium iodide ---g--	5.3
Sodium metaborate (Kodalk) ---g--	85
Sodium sulfite ---g--	2
4-amino-3-methyl - N - ethyl-N-β-(methanesulfonamido)-ethylaniline (color developer) ---g--	5.25
Tetramethylammonium hydrotriborate ---g--	.1

Sodium hydroxide to pH 10.7.
Water to 1 liter.

(9) Bleach-fix

Water	ml	600
Ammonium iron (III) ethylenediamine tetraacetic acid	g	60
Sodium sulfite	g	12
Ammonium thiocyanate	g	12
Ammonium thiosulfate 60%	ml	200
Sodium EDTA	g	6.7

Water to 1 liter.

(11) Stabilizer

Renex 30 (a polyethylene ether alcohol sold by Atlas Chemical)	ml	0.14
Formaldehyde (37.5%)	ml	7

Water to 1 liter.

The processed film contains a yellow, magenta and cyan dye image picture record and an intelligible silver sound track.

Results similar to those obtained in Examples 2 to 4 are obtained when the auxiliary sound recording layer is sensitized to the region of the spectrum bridging the red- and green-sensitized picture recording units with, for example, anhydro - 3',9 - diethyl - 5 - methoxy-5-phenyl - 3 - (3 - sulfobutyl)-oxaselenacarbocyanine hydroxide.

The invention has been described in detail with particular reference to certain preferred embodiments thereof, but it will be understood that variations and modifications can be effected within the spirit and scope of the invention.

We claim:

1. In a multilayer color photographic element comprising a support having coated thereon:

(1) three picture-recording photographic color-forming units, each unit comprising at least one silver halide emulsion layer, said color-forming units having, respectively, an effective sensitivity to a different primary color region of the visible spectrum to record blue, green and red light, said color-forming units having a minimum sensitivity to at least one region of the spectrum intermediate the peak sensitivity of two color-forming units of adjacent spectral sensitivity; and,

(2) an auxiliary image-recording unit comprising a photographic silver halide emulsion layer;

said photographic element being capable of recording:

(1) an auxiliary record comprising silver, at least a portion of said silver record being in said auxiliary unit; and,

(2) a picture record comprising silver, essentially all of said picture record silver being in said picture color-forming units;

the improvement wherein:

(1) said auxiliary unit is sensitive to said region of minimum sensitivity intermediate the peak sensitivity of said two color-forming units of adjacent spectral sensitivity; and,

(2) said two color-forming units of adjacent spectral sensitivity have a photographic speed of from 2 to 15 times the photographic speed of said auxiliary image-recording unit when exposed to radiation on said region of minimum sensitivity.

2. A multilayer photographic color film comprising a transparent support having coated thereon: (1) three picture recording photographic color-forming units, each unit comprising at least one silver halide emulsion layer, which units are so disposed and sensitized that each is essentially sensitive to a different primary color region of the visible spectrum and records essentially blue, green or red light, said color-forming units having minimum sensitivity to at least one region of the spectrum bridging adjacently sensitized color-forming units and (2) an auxiliary sound recording silver halide emulsion layer sensitive to said region of minimum sensitivity, said auxiliary sound recording layer not forming an image upon image-forming exposure of said picture recording units, said color-forming units of adjacent spectral sensitivity having a photographic speed of 2 to 15 times the photographic speed of said auxiliary layer when selectively exposed in said region of minimum sensitivity.

3. In a multilayer color photographic element comprising a support having coated thereon:

(1) a picture-recording photographic color-forming unit comprising at least one silver halide emulsion layer primarily sensitive to blue radiation and containing a nondiffusible photographic color coupler capable of forming a nondiffusible yellow dye;

(2) a picture-recording photographic color-forming unit comprising at least one silver halide emulsion layer primarily sensitive to green radiation and containing a nondiffusible photographic color coupler capable of forming a nondiffusible magenta dye;

(3) a picture-recording photographic color forming unit comprising at least one silver halide emulsion layer primarily sensitive to red radiation and containing a nondiffusible photographic color coupler capable of forming a nondiffusible cyan dye; and,

(4) an uaxiliary image-receiving unit comprising a photographic silver halide emulsion layer;

said color-forming units of said photographic element having a minimum sensitivity to at least the region of the spectrum bridging said blue and green-sensitive color-forming units; said photographic element being capable of recording:

(1) an auxiliary record comprising silver, at least a portion of said silver record being in said auxiliary unit; and,

(2) a picture record comprising silver and dye, essentially all of said picture record silver being in said picture recording color-forming units;

the improvement wherein:

(1) said auxiliary unit is sensitive to said region of minimum sensitivity; and,

(2) said blue and green-sensitive color-forming units each having a photographic speed of from 2 to 15 times the speed of said auxiliary layer when exposed to radiation in said region of minimum sensitivity.

4. A multilayer photographic color film comprising a transparent support having coated thereon (1) a picture recording photographic color-forming unit comprising at least one silver halide emulsion layer sensitive primarily to the blue region of the visible spectrum and containing a nondiffusing photographic coupler which is capable of reacting with oxidized aromatic primary amine color developing agent to form a nondiffusing yellow dye, (2) a picture recording photographic color-forming unit comprising at least one silver halide emulsion layer sensitive primarily to the red region of the visible spectrum and containing a nondiffusing photographic coupler which is capable of reacting with oxidized aromatic primary amine color developing agent to form a nondiffusing cyan dye, (3) a picture recording photographic color-forming unit comprising at least one silver halide emulsion layer sensitive primarily to the green region of the visible spectrum and containing a nondiffusing photographic coupler capable of reacting with oxidized aromatic primary amine color developing agent to form a nondiffusing magenta dye, said color-forming units having minimum sensitivity to at least the region of the spectrum bridging the blue- and green-sensitive color-forming units and (4) an auxiliary sound recording silver halide emulsion layer sensitive to said region of minimum sensitivity, said auxiliary sound recording layer not forming an image upon image-forming exposure of said picture recording units, said blue-sensitive and said green-sensitive color-forming units having a photographic speed of from 2 to 15 times the photographic speed of said auxiliary layer when exposed in said region of minimum sensitivity.

5. A multilayer photographic color film of claim 4 wherein said auxiliary layer is coated as the outermost light-sensitive layer from the support and contains a substantially colorless nondiffusible compound which reacts with oxidized aromatic primary amine color developing agent and which decreases the rate of diffusion of a ballasted silver bleach inhibitor through the auxiliary layer and wherein one of said green-sensitive and blue-sensitive picture recording color-forming units is coated adjacent to said auxiliary layer, said adjacently coated color-forming unit having a photographic speed of from 2 to 5 times the photographic speed of said auxiliary layer when selectively exposed in said region of minimum sensitivity and the remaining color-forming unit of said blue-sensitive and said green sensitive color forming units having a photographic speed of from 2 to 15 times the photographic speed of said auxiliary layer when selectively exposed in said region of minimum sensitivity.

6. A multilayer photographic color film of claim 4 wherein said auxiliary sound recording layer contains a bleach-inhibitor-releasing coupler.

7. A multilayer color film of claim 4 wherein said auxiliary sound recording layer contains a nondiffusible ballasted silver bleach inhibitor.

8. A multilayer photographic color film comprising a transparent support having coated thereon (1) a picture recording photographic color-forming unit comprising at least one silver halide emulsion layer sensitive primarily to the blue region of the visible spectrum and containing a nondiffusing photographic coupler which is capable of reacting with oxidized aromatic primary amine color developing agent to form a nondiffusing yellow dye, (2) a picture recording photographic color-forming unit comprising at least one silver halide emulsion layer sensitive primarily to the red region of the visible spectrum and containing a nondiffusing photographic coupler which is capable of reacting with oxidized aromatic primary amine color developing agent to form a nondiffusing cyan dye, (3) a picture recording photographic color-forming unit comprising at least one silver halide emulsion layer sensitive primarily to the green region of the visible spectrum and containing a nondiffusing photographic coupler capable of reacting with oxidized aromatic primary amine color developing agent to form a nondiffusing magenta dye, said color-forming units having minimum sensitivity to at least the region of the spectrum bridging the red- and green-sensitive color-forming units and (4) an auxiliary sound recording silver halide emulsion layer sensitive to said region of minimum sensitivity, said auxiliary sound recording layer not forming an image upon image-forming exposure of said picture recording units, said red-sensitive and said green-sensitive color-forming units having a photographic speed of from 2 to 15 times the photographic speed of said auxiliary layer when exposed to said region of minimum sensitivity.

9. A multilayer photographic color film of claim 8 wherein said auxiliary layer is coated as the outermost light-sensitive layer from the support and contains a substantially colorless nondiffusible compound which reacts with oxidized aromatic primary amine color developing agent and which decreases the rate of diffusion of a ballasted silver bleach inhibitor through the auxiliary layer and wherein one of said green-sensitive and red-sensitive picture recording color-forming units is coated adjacent to said auxiliary layer, said adjacently coated color-forming unit having a photographic speed of from 2 to 5 times the photographic speed of said auxiliary layer when selectively exposed in said region of minimum sensitivity and the remaining color-forming unit of said red-sensitive and said green-sensitive color-forming units having a photographic speed of from 2 to 15 times the photographic speed of said auxiliary layer when selectively exposed in said region of minimum sensitivity.

10. A multilayer photographic color film of claim 8 wherein said auxiliary sound recording layer contains a bleach-inhibitor-releasing coupler.

11. A multilayer color film of claim 8 wherein said auxiliary sound recording layer contains a nondiffusible ballasted silver bleach inhibitor.

12. A multilayer photographic color film comprising a transparent support having coated thereon, in order from the support, (1) a picture recording photographic color-forming unit comprising at least one silver halide emulsion layer sensitive primarily to the blue region of the visible spectrum and containing a nondiffusing photographic coupler which is capable of reacting with oxidized aromatic primary amine color developing agent to form a nondiffusing yellow dye, (2) a picture recording photographic color-forming unit comprising at least one silver halide emulsion layer sensitive primarily to the red region of the visible spectrum and containing a nondiffusing photographic coupler which is capable of reacting with oxidized aromatic primary amine color developing agent to form a nondiffusing cyan dye, (3) a picture recording photographic color-forming unit comprising at least one silver halide emulsion layer sensitive primarily to the green region of the visible spectrum and containing a nondiffusing photographic coupler capable of reacting with oxidized aromatic primary amine color developing agent to form a nondiffusing magenta dye, said color-forming units having minimum sensitivity to at least the region of the spectrum bridging the blue- and green-sensitive color-forming units, and (4) an auxiliary sound recording silver halide emulsion layer sensitized to said region of minimum sensitivity with 3-ethyl-5-(3-ethyl-2-benzothiazolinylidene)-rhodanine and containing as a photographic coupler 1-(6-chloro-2,4-dimethylphenyl)-3-[α-(m-pentadecylphenoxy)-butyramido] - 5 - pyrazolone, said auxiliary sound recording layer not forming an image upon image-forming exposure of said picture recording units, said green-sensitive color-forming unit having a photographic speed of from 2 to 5 times the photographic speed of said auxiliary layer when selectively exposed in said region of minimum sensitivity and said blue-sensitive color-forming unit having a photographic speed of from 2 to 15 times the photographic speed of said auxiliary layer when selectively exposed in said region of minimum sensitivity.

13. A multilayer photographic color film comprising a transparent support having coated thereon (1) a picture recording photographic color-forming unit comprising at least one silver halide emulsion layer sensitive primarily to the blue region of the visible spectrum and containing a nondiffusing photographic coupler which is capable of reacting with oxidized aromatic primary amine color developing agent to form a nondiffusing yellow dye, (2) a picture recording photographic color-forming unit comprising at least one silver halide emulsion layer sensitive primarily to the red region of the visible spectrum and containing a nondiffusing photographic coupler which is capable of reacting with oxidized aromatic primary amine color developing agent to form a nondiffusing cyan dye, (3) a picture recording photographic color-forming unit comprising at least one silver halide emulsion layer sensitive primarily to the green region of the visible spectrum and containing a nondiffusing photographic coupler capable of reacting with oxidized aromatic primary amine color developing agent to form a nondiffusing magenta dye, said color-forming units having minimum sensitivity to at least the region of the spectrum bridging the blue- and green-sensitive color-forming units, and (4) an auxiliary sound recording silver halide emulsion layer sensitized to said region of minimum sensitivity with anhydro-3,3'-bis-(2-carboxyethyl)-thiazolinocarbocyanine hydroxide and containing as a bleach-inhibitor-releasing coupler 1-hydroxy - 4 - [1-(3-undecanamidophenyl)-tetrazol - 5 - ylthio]-N-(2-n-tetradecyloxyphenyl-2-naphthamide, said auxiliary sound recording layer not forming an image upon image-forming exposure

of said picture recording units, said blue-sensitive and said green-sensitive color-forming units have a photographic speed of from 2 to 15 times the photographic speed of said auxiliary layer when selectively exposed in said region of minimum sensitivity.

14. A multilayer photographic color film comprising a transparent support having coated thereon (1) a picture recording photographic color-forming unit comprising at least one silver halide emulsion layer sensitive primarily to the blue region of the visible spectrum and containing a nondiffusing photographic coupler which is capable of reacting with oxidized aromatic primary amine color developing agent to form a nondiffusing yellow dye, (2) a picture recording photographic color-forming unit comprising at least one silver halide emulsion layer sensitive primarly to the red region of the visible spectrum and containing a nondiffusing photographic coupler which is capable of reacting with oxidized aromatic primary amine color developing agent to form a nondiffusing cyan dye, (3) a picture recording photographic color-forming unit comprising at least one silver halide emulsion layer sensitive primarily to the green region of the visible spectrum and containing a nondiffusing photographic coupler capable of reacting with oxidized aromatic primary amine color developing agent to form a nondiffusing magenta dye, said color-forming units having minimum sensitivity to at least the region of the spectrum bridging the red- and green-sensitive color-forming units and (4) a sound recording silver halide emulsion layer sensitized to said region of minimum sensitivity with anhydro-3',9-diethyl-5-methoxy-5-phenyl-3-(3-sulfobutyl)-oxaselenacarbocyanine hydroxide and containing as a nondiffusible ballasted silver beach inhibitor 1-(3-undecanamidophenyl)-5-mercaptotetrazole, said auxiliary sound recording layer not forming an image upon image-forming exposure of said picture recording units, said red-sensitive and said green-sensitive color-forming units having a photographic speed of from 2 to 15 times the photographic speed of said auxiliary layer when selectively exposed in said region of minimum sensitivity.

15. The process of preparing a multicolor motion picture record on film having a silver sound track with an imagewise exposed multilayer color photographic film having a picture recording area and a sound track recording area comprising a transparent support having coated thereon: (1) three picture recording photographic color-forming units, each unit comprising at least one silver halide emulsion layer which units are so disposed and sensitized that each is essentially sensitive to a different primary color region of the visible spectrum and records essentially blue, green or red light, said color-forming units having minimum sensitivity to at least one region of the spectrum bridging adjacently sensitized color-forming units and (2) an auxiliary sound recording silver halide emulsion layer sensitive to said region of minimum sensitivity, said auxiliary sound recording layer not forming an image upon image-forming exposure of said picture recording units, said color-forming units of adjacent spectral sensitivity having a photographic speed of from 2 to 15 times the photographic speed of said auxiliary layer when selectively exposed in said region of minimum sensitivity, which process comprises: (A) forming a picture record comprising silver and a nondiffusible dye in the picture recording areas and a sound record comprising silver in the sound track area and contacting the silver of the auxiliary layer with a ballasted silver bleach inhibitor and (B) removing the bleachable silver images remaining after step (A) and the residual or undeveloped silver halide.

16. The process of preparing a multicolor motion picture record on film having a silver sound track with an imagewise exposed multilayer photographic film having a picture recording area and a sound track recording area which film comprises a transparent support having coated thereon, in order from the support, (1) three picture recording photographic color-forming units, each unit comprising at least one silver halide emulsion layer, which units are so disposed and sensitized that each is essentially sensitive to a different primary color region of the visible spectrum and contains a nondiffusing photographic coupler which is capable of reacting with oxidized aromatic primary amine color developing agent to form a nondiffusing dye complementary in color to the sensitivity of the unit in which it is incorporated, said color-forming units having minimum sensitivity to at least one region of the spectrum bridging adjacently sensitized color-forming units and (2) an auxiliary sound recording silver halide emulsion layer sensitive to said region of minimum sensitivity and containing a substantially colorless nondiffusible compound which reacts with oxidized aromatic primary amine color developing agent and which decreases the rate of diffusion of a ballasted silver bleach inhibitor through said auxiliary layer, said auxiliary sound recording layer not forming an image upon image-forming exposure of said picture recording units, one of said adjacently sensitized color-forming units being coated adjacent to said auxiliary sound recording layer and having a photographic speed of from 2 to 5 times the photographic speed of said auxiliary layer when selectively exposed in said region of minimum sensitivity and the remaining color-forming unit of said adjacently sensitized color-forming units having a photographic speed of from 2 to 15 times the photographic speed of said auxiliary layer when exposed in said region of minimum sensitivity, which imagewise exposure having been made to visible radiation from a multicolor picture record and to a narrow band of visible radiation having its maximum intensity at about said region of minimum sensitivity from a sound track record, which process comprises the following steps including steps (B) and (C) in either sequence, (A) developing a sound track record in the sound track recording area comprising silver, (B) developing silver halide to form a picture record in the picture recording area comprising silver and a nondiffusible dye, (C) contacting the auxiliary layer with a ballasted silver bleach inhibitor to adsorb said bleach inhibitor onto at least the silver of the auxiliary layer and (D) removing the bleachable silver images remaining after step (C) and the residual or undeveloped silver halide.

17. The process of preparing a multicolor motion picture record on film having a silver sound track with an imagewise exposed multilayer photographic color film having a picture recording area and a sound track recording area which film comprises a transparent support having coated thereon, (a) three picture recording photographic color-forming units, each unit comprising at least one silver halide emulsion layer, which units are so disposed and sensitized that each is essentially sensitive to a different primary color region of the visible spectrum and contains a nondiffusing photographic coupler which is capable of reacting with oxidized aromatic primary amine color developing agent to form a nondiffusing dye complementary in color to the sensitivity to the unit in which it is incorporated, said color-forming units having minimum sensitivity to at least one region of the spectrum bridging adjacently sensitized color-forming units and (2) an auxiliary sound recording silver halide emulsion layer sensitive to said region of minimum sensitivity and containing a bleach-inhibitor-releasing coupler, said auxiliary sound recording layer not forming an image upon image-forming exposure of said picture recording units, said color-forming units of adjacent spectral sensitivity having a photographic speed of from 2 to 15 times the photographic speed of said auxiliary layer when selectively exposed in said region of minimum sensitivity, which imagewise exposure having been made to visible radiation from a multicolor picture record and to a narrow band of visible radiation having its maximum intensity at about said region of minimum sensitivity from

a sound track record, which process comprises (A) developing silver halide to form a picture record in the picture recording area comprising silver and a nondiffusible dye and developing a sound track record in the sound track recording area comprising silver and (B) removing the bleachable silver images remaining after step (A) and the residual or undeveloped silver halide.

18. The process of preparing a multicolor motion picture record on film having a silver sound track with an imagewise exposed multicolor motion picture film having a picture recording area and a sound track recording area which film comprises a transparent support having coated thereon (1) three picture recording photographic color-forming units, each unit comprising at least one silver halide emulsion layer, which units are so disposed and sensitized that each color-forming unit is essentially sensitive to a different primary color region of the visible spectrum and contains a nondiffusing photographic coupler which is capable of reacting with oxidized aromatic primary amine color developing agent to form a nondiffusing dye complementary in color to the sensitivity of the unit in which it is incorporated, said color-forming units having minimum sensitivity to at least one region of the spectrum bridging adjacently sensitized color-forming units and (2) an auxiliary sound recording silver halide emulsion layer sensitive to said region of minimum sensitivity and containing a nondiffusible ballasted silver bleach inhibitor, said auxiliary sound recording layer not forming an image upon image-forming exposure of said picture recording units, said color-forming units of adjacent spectral sensitivity having a photographic speed of from 2 to 15 times the photographic speed of said auxiliary layer when selectively exposed in said region of minimum sensitivity which image-wise exposure having been made to visible radiation from a multicolor picture record and to a narrow band of visible radiation having its maximum intensity at about said region of minimum sensitivity from a sound track record, which process comprises (A) black and while developing silver halide to form a silver picture record in the picture recording area and a silver sound track record in the sound track area, (B) fogging and color developing with aromatic primary amine color developing agent to form a picture record in the picture recording area comprising silver and a nondiffusible dye and (C) removing the bleachable silver images remaining after steps (A) and (B) and the residual or undeveloped silver halide.

19. The process of preparing a multicolor motion picture record on film having a silver sound track with an imagewise exposed multilayer photographic film having a picture recording area and a sound track recording area which film comprises a transparent support having coated thereon, in order from the support, (1) a picture recording photographic color-forming unit comprising at least one silver halide emulsion layer sensitive primarily to the blue region of the visible spectrum and containing a nondiffusing photographic coupler which is capable of reacting with oxidized aromatic primary amine color developing agent to form a nondiffusing yellow dye, (2) a picture recording photographic color-forming unit comprising at least one silver halide emulsion layer sensitive primarily to the red region of the visible spectrum and containing a nondiffusing photographic coupler which is capable of reacting with oxidized aromatic primary amine color developing agent to form a nondiffusing cyan dye, (3) a picture recording photographic color-forming unit comprising at least one silver halide emulsion layer sensitive primarily to the green region of the visible spectrum and containing a nondiffusing photographic coupler capable of reacting with oxidized aromatic primary amine color developing agent to form a nondiffusion magenta dye, said color-forming units having minimum sensitivity to at least the region of the spectrum bridging the blue- and green-sensitive color-forming units, and (4) an auxiliary sound recording silver halide emulsion layer sensitized to said region minimum sensitivity with 3-ethyl - 5 - (3 - ethyl-2-benzothiazolinylidine)rhodaine and containing as a photographic coupler 1-(6-chloro-2,4-dimethylphenyl) - 3 - [α-(m-pentadecyclphenoxy)-butyramido]-5-pyrazolone, said auxiliary sound recording layer not forming an image upon image-forming exposure of said picture recording units, said green-sensitive color-forming unit having a photographic speed of from 2 to 5 times the photographic speed of said auxiliary layer when selectivity exposed in said region of minimum sensitivity and said blue-sensitive color-forming unit having a photographic speed of from 2 to 15 times the photographic speed of said auxiliary layer when selectively exposed in said region of minimum sensitivity, which imagewise exposure having been made to visible radiation from a multicolor picture record and to a narrow band of visible radiation having its maximum intensity at about said region of minimum sensitivity from a sound track record, which process comprises the following steps including steps (B) and (C) in either sequence, (A) developing a sound track record in a sound track recording area comprising silver, (B) developing silver halide to form a picture record in the picture recording area comprising silver and a nondiffusible dye, (C) contacting the auxiliary layer with 1-(3-nonanamidophenyl)-5-mercaptotetrazole as a ballasted silver bleach inhibitor to adsorb said bleach inhibitor onto at least the silver of the auxiliary layer and (D) removing the bleachable silver images remaining after steps (B) and (C) and the residual or undeveloped silver halide.

20. The process of producing a multicolor motion picture record on film having a silver sound track with an imagewise exposed multilayer photographic color film having a picture recording area and a sound track recording area which film comprises a transparent support having coated thereon (1) a picture recording photographic color-forming unit comprising at least one silver halide emulsion layer sensitive primarily to the blue region of the visible spectrum and containing a nondiffusing photographic coupler which is capable of reacting with oxidized aromatic primary amine color developing agent to form a nondiffusing yellow dye, (2) a picture recording photographic color-forming unit comprising at least one silver halide emulsion layer sensitive primarily to the red region of the visible spectrum and containing a nondiffusing photographic coupler which is capable of reacting with oxidized aromatic primary amine color developing agent to form a nondiffusing cyan dye, (3) a picture recording photographic color-forming unit comprising at least one silver halide emulsion layer sensitive primarily to the green region of the visible spectrum and containing a nondiffusing photographic coupler which is capable of reacting with oxidized aromatic primary amine color developing agent to form a nondiffusing magenta dye, said color-forming units having minimum sensitivity to at least the region of the spectrum bridging the blue- and green-sensitive color-forming units, and (4) an auxiliary sound recording silver halide emulsion layer sensitized to said region of minimum sensitivity with anhydro-3,3'-bis - (2 - carboxyethyl)thiazolinocarbocyanine hydroxide and containing as a bleach-inhibitor-releasing coupler 1-hydroxy-4-[1 - (3 - undecanamidophenyl) - tetrazo - 5-ylthio]-N-(2-n-tetradecyloxyphenyl) - 2 - naphthamide, said auxiliary sound recording layer not forming an image upon image-forming exposure of said picture recording units, said blue-sensitive and said green-sensitive color-forming units having a photographic speed of from 2 to 15 times the photographic speed of said auxiliary layer when selectively exposed in said region of minimum sensitivity, which imagewise exposure having been made to visible radaition from a multicolor picture record and to a narrow band of visible radiation having its maximum intensity at about said region of minimum sensitivity from a sound track record, which process comprises (A) developing silver halide to form a picture record in the

picture recording area comprising silver and a nondiffusible dye and developing a sound track record in the sound track recording area comprising silver and (B) removing the bleachable silver images remaining after step (A) and the residual or undeveloped silver halide.

21. The process of preparing a multicolor motion picture record on film having a silver sound track with an imagewise exposed multicolor motion picture film having a picture recording area and a sound track recording area, which film comprises a transparent support having coated thereon (1) a picture recording photographic color-forming unit comprising at least one silver halide emulsion layer sensitive primarily to the blue region of the visible spectrum and containing a nondiffusing photographic coupler which is capable of reacting with oxidized aromatic primary amine color developing agent to form a nondiffusing yellow dye, (2) a picture recording photographic color-forming unit comprising at least one silver halide emulsion layer sensitive primarily to the red region of the visible spectrum and containing a nondiffusing photographic coupler which is capable of reacting with oxidized aromatic primary amine color developing agent to form a nondiffusing cyan dye, (3) a picture recording photographic color-forming unit comprising at least one silver halide emulsion layer sensitive primarily to the green region of the visible spectrum and containing a nondiffusing photographic coupler capable of reacting with oxidized aromatic primary amine color developing agent to form a nondiffusing magenta dye, said color-forming units having minimum sensitivity to at least the region of the spectrum bridging the red- and green-sensitive color-forming units and (4) a sound recording silver halide emulsion layer sensitized to said region of minimum sensitivity with anhydro-3',9-diethyl-5-methoxy-5-phenyl-3-(3-sulfobutyl)-oxaselenacarbocyanine hydroxide and containing 1-(3-undecanamidophenyl)-5-mercaptotetrazole as a nondiffusible ballasted silver bleach inhibitor, said auxiliary sound recording layer not forming an image upon image-forming exposure of said picture recording units, said red-sensitive and said green-sensitive color-forming units having a photographic speed of from 2 to 15 times the photographic speed of said auxiliary layer when selectively exposed in said region of minimum sensitivity, which imagewise exposure having been made to visible radiation from a multi-color picture record and to a narrow band of visible radiation having its maximum intensity at about said region of minimum sensitivity from a sound track record, which process comprises (A) black and white developing silver halide to form a silver picture record in the picture recording area and a silver sound track record in the sound track area, (B) fogging and color developing with aromatic primary amine color developing agent to form a picture record in the picture recording area comprising silver and a nondiffusible dye and (C) removing the bleachable silver images remaining after steps (A) and (B) and the residual or undeveloped silver halide.

References Cited

UNITED STATES PATENTS

3,083,097	3/1963	Lässig	96—29 L
3,210,189	10/1965	Von Wartburg	96—59

NORMAN G. TORCHIN, Primary Examiner

A. T. S. PICO, Assistant Examiner

U.S. Cl. X.R.

96—22, 39, 55, 130

PO-1050
(5/69)

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,737,312 Dated June 5, 1973

Inventor(s) John L. Baptista and Albert C. Smith, Jr.

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 1, line 48, after "1970", insert ---and now abandoned---;

Column 2, line 22, after "1970", insert ---and now abandoned---;

Column 2, line 23, after "1971", insert ---as Serial No. 209,362---;

Column 2, line 54, after "1970", insert ---and now abandoned--;

Column 2, line 55, after "1971", insert ---as Serial No. 209,450---;

Column 3, line 22, after "1970", insert ---and now abandoned---;

Column 3, line 23, after "1971", insert ---as Serial No. 209,458---;

Column 5, line 41, "amage" should read ---image---;

Column 10, line 44, "mixtues" should read ---mixtures---;

Column 12, line 7, "made" should read -- more --;

Column 13, line 7, "bleached" should read ---bleach---;

Column 13, line 53, "of" should read ---or---;

Column 13, line 56, that part of formula reading: "R_b^3" should read ---R_b^2---;

PO-1050
(5/69)

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,737,312 Dated June 5, 1973

Inventor(s) John L. Baptista and Albert C. Smith, Jr.

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 15, line 70, "2,522,240" should read ---2,552,240---;

Column 18, line 6, "Elemet" should read ---Element---;

Column 18, line 66, before "3", insert ---g---;

Column 20, lines 55 and 56, under the heading "Element number", the numbers:

--- 1
2 ---

should be placed in vertical order;

Column 20, line 55, "41.20" should read ---1.20---;

Column 21, line 46, "ofr" should read ---for---;

Column 24, line 25, (claim 3), "uaxiliary" should read ---auxiliary---;

Column 26, line 22, (claim 12), "primarly" should read ---primarily---;

Column 29, line 71, (claim 19), "nondiffusion" should read ---nondiffusing---;

Column 30, line 1, (claim 19), after "region", insert ---of---;

Column 30, line 2, (claim 19), "rhodaine" should read ---rhodanine---;

Column 30, line 4, (claim 19), "pentadecyclphenoxy" should read ---pentadecylphenoxy---;

PO-1050
(5/69)

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,737,312 Dated June 5, 1973

Inventor(s) John L. Baptista and Albert C. Smith, Jr.

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 30, line 10, (claim 19), "selectivity" should read ---selectively---;

Column 30, line 62, (claim 20), "tetrazo" should read ---tetrazol---;

Column 30, line 71, (claim 20), "radaition" should read ---radiation---;

Signed and sealed this 8th day of January 1974.

(SELA)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

RENE D. TEGTMEYER
Acting Commissioner of Patents